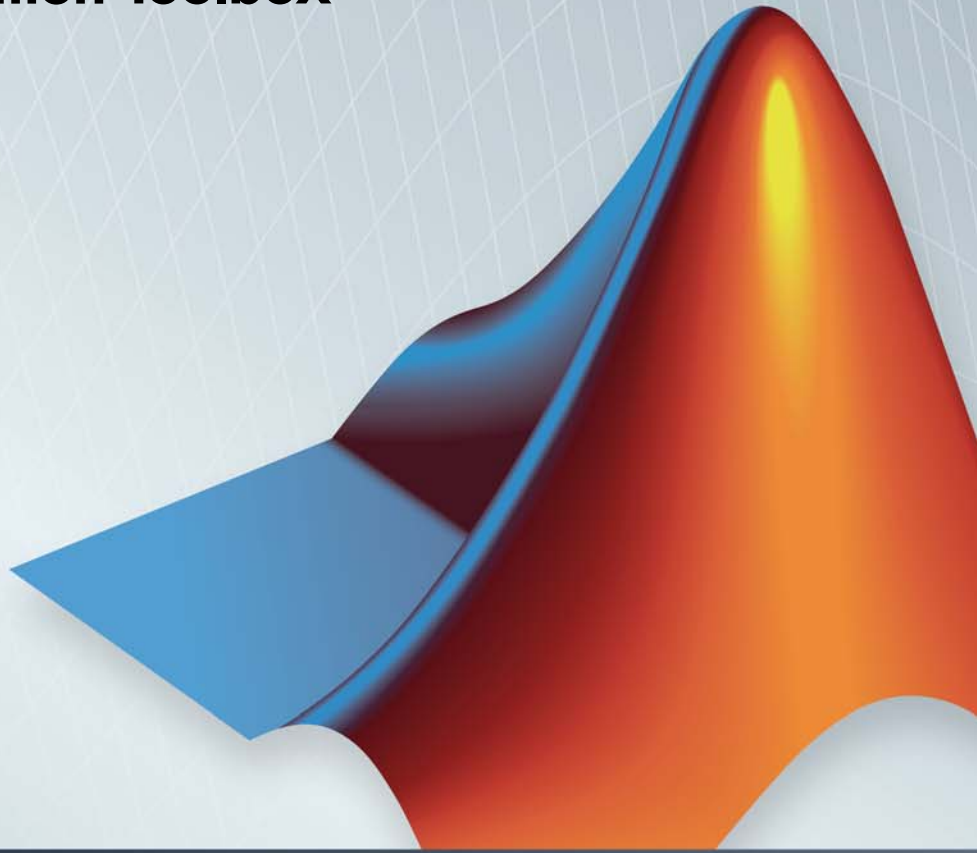


Image Acquisition Toolbox™

User's Guide

R2013b



MATLAB®



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Image Acquisition Toolbox™ User's Guide

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Getting Started

The best way to learn about Image Acquisition Toolbox™ capabilities is to look at a simple example. This chapter introduces the toolbox and illustrates the basic steps to create an image acquisition application by implementing a simple motion detection application. The example cross-references other sections that provide more details about relevant concepts.

- “Image Acquisition Toolbox Product Description” on page 1-2
- “Product Overview” on page 1-3
- “Image Acquisition Tool (GUI)” on page 1-6
- “Getting Started Doing Image Acquisition Programmatically” on page 1-7

Image Acquisition Toolbox Product Description

Acquire images and video from industry-standard hardware

Image Acquisition Toolbox enables you to acquire images and video from cameras and frame grabbers directly into MATLAB® and Simulink®. You can detect hardware automatically, and configure hardware properties. Advanced workflows let you trigger acquisition while processing in-the-loop, perform background acquisition, and synchronize sampling across several multimodal devices. With support for multiple hardware vendors and industry standards, you can use imaging devices, ranging from inexpensive Web cameras to high-end scientific and industrial devices that meet low-light, high-speed, and other challenging requirements.

Key Features

- Support for industry standards, including DCAM, Camera Link®, and GigE Vision
- Support for common OS interfaces for webcams, including DirectShow®, QuickTime, and Video4Linux2
- Support for a range of industrial and scientific hardware vendors
- Multiple acquisition modes and buffer management options
- Synchronization of multimodal acquisition devices with hardware triggering
- Image Acquisition app for rapid hardware configuration, image acquisition, and live video previewing
- Support for C code generation in Simulink

Product Overview

In this section...
“Introduction” on page 1-3
“Installation and Configuration Notes” on page 1-4
“The Image Processing Toolbox Software Required to Use the Image Acquisition Toolbox Software” on page 1-4
“Related Products” on page 1-4
“Supported Hardware” on page 1-5

Introduction

The Image Acquisition Toolbox software is a collection of functions that extend the capability of the MATLAB numeric computing environment. The toolbox supports a wide range of image acquisition operations, including:

- Acquiring images through many types of image acquisition devices, from professional grade frame grabbers to USB-based webcams
- Viewing a preview of the live video stream
- Triggering acquisitions (includes external hardware triggers)
- Configuring callback functions that execute when certain events occur
- Bringing the image data into the MATLAB workspace

Many of the toolbox functions are MATLAB files. You can view the MATLAB code for these functions using this statement:

```
type function_name
```

You can extend Image Acquisition Toolbox capabilities by writing your own MATLAB files, or by using the toolbox in combination with other toolboxes, such as the Image Processing Toolbox™ software and the Data Acquisition Toolbox™ software.

The Image Acquisition Toolbox software also includes a Simulink block, called From Video Device, that you can use to bring live video data into a model.

Installation and Configuration Notes

To determine if the Image Acquisition Toolbox software is installed on your system, type this command at the MATLAB prompt:

```
ver
```

When you enter this command, MATLAB displays information about the version of MATLAB you are running, including a list of all toolboxes installed on your system and their version numbers.

For information about installing the toolbox, see the MATLAB Installation Guide.

For the most up-to-date information about system requirements, see the system requirements page, available in the products area at the MathWorks Web site (www.mathworks.com).

The Image Processing Toolbox Software Required to Use the Image Acquisition Toolbox Software

The Image Acquisition Toolbox product, including the Image Acquisition Tool, now requires you to have a license for the Image Processing Toolbox product starting in R2008b.

If you already have the Image Processing Toolbox product, you do not need to do anything.

If you do not have the Image Processing Toolbox product, the Image Acquisition Toolbox software R2008a and earlier will continue to work. If you want to use R2008b or future releases, and you have a current active license for the Image Acquisition Toolbox software, you can download the Image Processing Toolbox product for free. New customers will need to purchase both products to use the Image Acquisition Toolbox product.

If you have any questions, please contact MathWorks customer service.

Related Products

MathWorks provides several products that are relevant to the kinds of tasks you can perform with the Image Acquisition Toolbox software and that extend

the capabilities of MATLAB. For information about these related products, see www.mathworks.com/products/imaq/related.html.

Supported Hardware

The list of hardware that the Image Acquisition Toolbox software supports can change in each release, since hardware support is frequently added. The MathWorks Web site is the best place to check for the most up to date listing.

To see the full list of hardware that the toolbox supports, visit the Image Acquisition Toolbox product page at the MathWorks Web site www.mathworks.com/products/imaq and click the **Supported Hardware** link.

Image Acquisition Tool (GUI)

The functionality of the Image Acquisition Toolbox software is available in a desktop application. You connect directly to your hardware in the tool and can set acquisition parameters, and preview and acquire image data. You can log the data to MATLAB in several formats, and also generate an AVI file, right from the tool.

To open the tool, type `imaqtool` at the MATLAB command line, or select **Image Acquisition** on the **Apps** tab in MATLAB. The tool has extensive Help in the desktop. As you click in different panes of the user interface, the relevant Help appears in the **Image Acquisition Tool Help** pane.

Most of the User's Guide describes performing tasks using the toolbox via the MATLAB command line. To learn how to use the desktop tool, see "Getting Started with the Image Acquisition Tool" on page 3-5.

Getting Started Doing Image Acquisition Programmatically

In this section...

“Overview” on page 1-7

“Step 1: Install Your Image Acquisition Device” on page 1-8

“Step 2: Retrieve Hardware Information” on page 1-9

“Step 3: Create a Video Input Object” on page 1-12

“Step 4: Preview the Video Stream (Optional)” on page 1-13

“Step 5: Configure Object Properties (Optional)” on page 1-16

“Step 6: Acquire Image Data” on page 1-19

“Step 7: Clean Up” on page 1-23

Overview

This section illustrates the basic steps required to create an image acquisition application by implementing a simple motion detection application. The application detects movement in a scene by performing a pixel-to-pixel comparison in pairs of incoming image frames. If nothing moves in the scene, pixel values remain the same in each frame. When something moves in the image, the application displays the pixels that have changed values.

The example highlights how you can use the Image Acquisition Toolbox software to create a working image acquisition application with only a few lines of code.

Note To run the sample code in this example, you must have an image acquisition device connected to your system. The device can be a professional grade image acquisition device, such as a frame grabber, or a generic Microsoft® Windows® image acquisition device, such as a webcam. The code can be used with various types of devices with only minor changes.

To use the Image Acquisition Toolbox software to acquire image data, you must perform the following basic steps.

Step	Description
Step 1:	Install and configure your image acquisition device
Step 2:	Retrieve information that uniquely identifies your image acquisition device to the Image Acquisition Toolbox software
Step 3:	Create a video input object
Step 4:	Preview the video stream (Optional)
Step 5:	Configure image acquisition object properties (Optional)
Step 6:	Acquire image data
Step 7:	Clean up

The Image Processing Toolbox Software Required to Use the Image Acquisition Toolbox Software

The Image Acquisition Toolbox product, including the Image Acquisition Tool, requires you to have a license for the Image Processing Toolbox product starting in R2008b.

If you already have the Image Processing Toolbox product, you do not need to do anything.

If you do not have the Image Processing Toolbox product, the Image Acquisition Toolbox software R2008a and earlier will continue to work. If you want to use R2008b or future releases, and you have a current active license for the Image Acquisition Toolbox software, you can download the Image Processing Toolbox product for free. New customers will need to purchase both products to use the Image Acquisition Toolbox product.

If you have any questions, please contact MathWorks customer service.

Step 1: Install Your Image Acquisition Device

Follow the setup instructions that come with your image acquisition device. Setup typically involves:

- Installing the frame grabber board in your computer.
- Installing any software drivers required by the device. These are supplied by the device vendor.
- Connecting a camera to a connector on the frame grabber board.
- Verifying that the camera is working properly by running the application software that came with the camera and viewing a live video stream.

Generic Windows image acquisition devices, such as webcams and digital video camcorders, typically do not require the installation of a frame grabber board. You connect these devices directly to your computer via a USB or FireWire port.

After installing and configuring your image acquisition hardware, start MATLAB on your computer by double-clicking the icon on your desktop. You do not need to perform any special configuration of MATLAB to perform image acquisition.

Step 2: Retrieve Hardware Information

In this step, you get several pieces of information that the toolbox needs to uniquely identify the image acquisition device you want to access. You use this information when you create an image acquisition object, described in “Step 3: Create a Video Input Object” on page 1-12.

The following table lists this information. You use the `imaqhwinfo` function to retrieve each item.

Device Information	Description
Adaptor name	An <i>adaptor</i> is the software that the toolbox uses to communicate with an image acquisition device via its device driver. The toolbox includes adaptors for certain vendors of image acquisition equipment and for particular classes of image acquisition devices. See “Determining the Adaptor Name” on page 1-10 for more information.
Device ID	The <i>device ID</i> is a number that the adaptor assigns to uniquely identify each image acquisition device with which

Device Information	Description
	<p>it can communicate. See “Determining the Device ID” on page 1-11 for more information.</p> <hr/> <p>Note Specifying the device ID is optional; the toolbox uses the first available device ID as the default.</p> <hr/>
Video format	<p>The <i>video format</i> specifies the image resolution (width and height) and other aspects of the video stream. Image acquisition devices typically support multiple video formats. See “Determining the Supported Video Formats” on page 1-11 for more information.</p> <hr/> <p>Note Specifying the video format is optional; the toolbox uses one of the supported formats as the default.</p> <hr/>

Determining the Adaptor Name

To determine the name of the adaptor, enter the `imaqhwinfo` function at the MATLAB prompt without any arguments.

```

imaqhwinfo
ans =

    InstalledAdaptors: {'dcam' 'winvideo'}
    MATLABVersion: '7.4 (R2007a)'
    ToolboxName: 'Image Acquisition Toolbox'
    ToolboxVersion: '2.1 (R2007a)'

```

In the data returned by `imaqhwinfo`, the `InstalledAdaptors` field lists the adaptors that are available on your computer. In this example, `imaqhwinfo` found two adaptors available on the computer: `'dcam'` and `'winvideo'`. The listing on your computer might contain only one adaptor name. Select the adaptor name that provides access to your image acquisition device. For more information, see “Determining the Device Adaptor Name” on page 4-3.

Determining the Device ID

To find the device ID of a particular image acquisition device, enter the `imaqhwinfo` function at the MATLAB prompt, specifying the name of the adaptor as the only argument. (You found the adaptor name in the first call to `imaqhwinfo`, described in “Determining the Adaptor Name” on page 1-10.) In the data returned, the `DeviceIDs` field is a cell array containing the device IDs of all the devices accessible through the specified adaptor.

Note This example uses the DCAM adaptor. You should substitute the name of the adaptor you would like to use.

```
info = imaqhwinfo('dcam')
info =

    AdaptorDllName: [1x77 char]
  AdaptorDllVersion: '2.1 (R2007a)'
    AdaptorName: 'dcam'
    DeviceIDs: {[1]}
    DeviceInfo: [1x1 struct]
```

Determining the Supported Video Formats

To determine which video formats an image acquisition device supports, look in the `DeviceInfo` field of the data returned by `imaqhwinfo`. The `DeviceInfo` field is a structure array where each structure provides information about a particular device. To view the device information for a particular device, you can use the device ID as a reference into the structure array. Alternatively, you can view the information for a particular device by calling the `imaqhwinfo` function, specifying the adaptor name and device ID as arguments.

To get the list of the video formats supported by a device, look at the `SupportedFormats` field in the device information structure. The `SupportedFormats` field is a cell array of strings where each string is the name of a video format supported by the device. For more information, see “Determining Supported Video Formats” on page 4-6.

```
dev_info = imaqhwinfo('dcam',1)
```

```
dev_info =  
  
    DefaultFormat: 'F7_Y8_1024x768'  
    DeviceFileSupported: 0  
    DeviceName: 'XCD-X700 1.05'  
    DeviceID: 1  
    VideoInputConstructor: 'videoinput('dcam', 1)'  
    VideoDeviceConstructor: 'imaq.VideoDevice('dcam', 1)'  
    SupportedFormats: {'F7_Y8_1024x768' 'Y8_1024x768'}
```

Step 3: Create a Video Input Object

In this step you create the video input object that the toolbox uses to represent the connection between MATLAB and an image acquisition device. Using the properties of a video input object, you can control many aspects of the image acquisition process. For more information about image acquisition objects, see “Creating Image Acquisition Objects” on page 4-9.

To create a video input object, use the `videoinput` function at the MATLAB prompt. The `DeviceInfo` structure returned by the `imaqhwinfo` function contains the default `videoinput` function syntax for a device in the `VideoInputConstructor` field. For more information the device information structure, see “Determining the Supported Video Formats” on page 1-11.

The following example creates a video input object for the DCAM adaptor. Substitute the adaptor name of the image acquisition device available on your system.

```
vid = videoinput('dcam',1,'Y8_1024x768')
```

The `videoinput` function accepts three arguments: the adaptor name, device ID, and video format. You retrieved this information in step 2. The adaptor name is the only required argument; the `videoinput` function can use defaults for the device ID and video format. To determine the default video format, look at the `DefaultFormat` field in the device information structure. See “Determining the Supported Video Formats” on page 1-11 for more information.

Instead of specifying the video format, you can optionally specify the name of a device configuration file, also known as a camera file. Device configuration files are typically supplied by frame grabber vendors. These files contain

all the required configuration settings to use a particular camera with the device. See “Using Device Configuration Files (Camera Files)” on page 4-14 for more information.

Viewing the Video Input Object Summary

To view a summary of the video input object you just created, enter the variable name (`vid`) at the MATLAB command prompt. The summary information displayed shows many of the characteristics of the object, such as the number of frames that will be captured with each trigger, the trigger type, and the current state of the object. You can use video input object properties to control many of these characteristics. See “Step 5: Configure Object Properties (Optional)” on page 1-16 for more information.

```
vid
```

```
Summary of Video Input Object Using 'XCD-X700 1.05'.
```

```
Acquisition Source(s): input1 is available.
```

```
Acquisition Parameters: 'input1' is the current selected source.
                        10 frames per trigger using the selected source.
                        'Y8_1024x768' video data to be logged upon START.
                        Grabbing first of every 1 frame(s).
                        Log data to 'memory' on trigger.
```

```
Trigger Parameters: 1 'immediate' trigger(s) on START.
```

```
Status: Waiting for START.
        0 frames acquired since starting.
        0 frames available for GETDATA.
```

Step 4: Preview the Video Stream (Optional)

After you create the video input object, MATLAB is able to access the image acquisition device and is ready to acquire data. However, before you begin, you might want to see a preview of the video stream to make sure that the image is satisfactory. For example, you might want to change the position of the camera, change the lighting, correct the focus, or make some other change to your image acquisition setup.

Note This step is optional at this point in the procedure because you can preview a video stream at any time after you create a video input object.

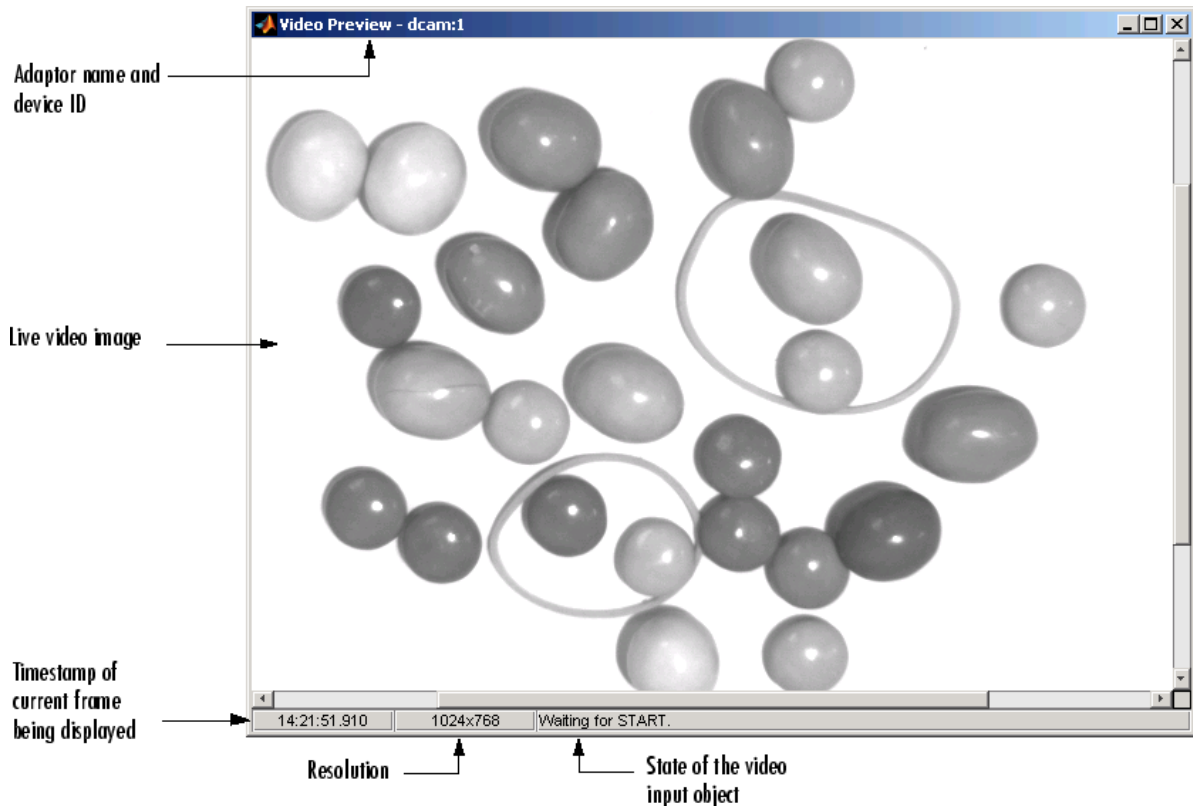
To preview the video stream in this example, enter the `preview` function at the MATLAB prompt, specifying the video input object created in step 3 as an argument.

```
preview(vid)
```

The `preview` function opens a Video Preview figure window on your screen containing the live video stream. To stop the stream of live video, you can call the `stoppreview` function. To restart the preview stream, call `preview` again on the same video input object.

While a preview window is open, the video input object sets the value of the `Previewing` property to `'on'`. If you change characteristics of the image by setting image acquisition object properties, the image displayed in the preview window reflects the change.

The following figure shows the Video Preview window for the example.



Video Preview Window

To close the Video Preview window, click the **Close** button in the title bar or use the `closepreview` function, specifying the video input object as an argument.

```
closepreview(vid)
```

Calling `closepreview` without any arguments closes all open Video Preview windows.

Step 5: Configure Object Properties (Optional)

After creating the video input object and previewing the video stream, you might want to modify characteristics of the image or other aspects of the acquisition process. You accomplish this by setting the values of image acquisition object properties. This section

- Describes the types of image acquisition objects used by the toolbox
- Describes how to view all the properties supported by these objects, with their current values
- Describes how to set the values of object properties

Types of Image Acquisition Objects

The toolbox uses two types of objects to represent the connection with an image acquisition device:

- Video input objects
- Video source objects

A video input object represents the connection between MATLAB and a video acquisition device at a high level. The properties supported by the video input object are the same for every type of device. You created a video input object using the `videoinput` function in step 3.

When you create a video input object, the toolbox automatically creates one or more video source objects associated with the video input object. Each video source object represents a collection of one or more physical data sources that are treated as a single entity. The number of video source objects the toolbox creates depends on the device and the video format you specify. At any one time, only one of the video source objects, called the *selected* source, can be active. This is the source used for acquisition. For more information about these image acquisition objects, see “Creating Image Acquisition Objects” on page 4-9.

Viewing Object Properties

To view a complete list of all the properties supported by a video input object or a video source object, use the `get` function. To list the properties of the video input object created in step 3, enter this code at the MATLAB prompt.


```
get(vid)
```

The `get` function lists all the properties of the object with their current values.

General Settings:

```
DeviceID = 1
DiskLogger = []
DiskLoggerFrameCount = 0
EventLog = [1x0 struct]
FrameGrabInterval = 1
FramesAcquired = 0
FramesAvailable = 0
FramesPerTrigger = 10
Logging = off
LoggingMode = memory
Name = Y8_1024x768-dcam-1
NumberOfBands = 1
Previewing = on
ReturnedColorSpace = grayscale
ROIPosition = [0 0 1024 768]
Running = off
Tag =
Timeout = 10
Type = videoinput
UserData = []
VideoFormat = Y8_1024x768
VideoResolution = [1024 768]
.
.
.
```

To view the properties of the currently selected video source object associated with this video input object, use the `getselectedsource` function in conjunction with the `get` function. The `getselectedsource` function returns the currently active video source. To list the properties of the currently selected video source object associated with the video input object created in step 3, enter this code at the MATLAB prompt.

```
get(getselectedsource(vid))
```

The `get` function lists all the properties of the object with their current values.

Note Video source object properties are device specific. The list of properties supported by the device connected to your system might differ from the list shown in this example.

General Settings:

```
Parent = [1x1 videoinput]
Selected = on
SourceName = input1
Tag =
Type = videosource
```

Device Specific Properties:

```
FrameRate = 15
Gain = 2048
Shutter = 2715
```

Setting Object Properties

To set the value of a video input object property or a video source object property, you can use the `set` function or you can reference the object property as you would a field in a structure, using dot notation.

Some properties are read only; you cannot set their values. These properties typically provide information about the state of the object. Other properties become read only when the object is running. To view a list of all the properties you can set, use the `set` function, specifying the object as the only argument.

To implement continuous image acquisition, the example sets the `TriggerRepeat` property to `Inf`. To set this property using the `set` function, enter this code at the MATLAB prompt.

```
set(vid, 'TriggerRepeat', Inf);
```

To help the application keep up with the incoming video stream while processing data, the example sets the `FrameGrabInterval` property to 5. This specifies that the object acquire every fifth frame in the video stream. (You might need to experiment with the value of the `FrameGrabInterval` property to find a value that provides the best response with your image acquisition

setup.) This example shows how you can set the value of an object property by referencing the property as you would reference a field in a MATLAB structure.

```
vid.FrameGrabInterval = 5;
```

To set the value of a video source object property, you must first use the `getselectedsource` function to retrieve the object. (You can also get the selected source by searching the video input object `Source` property for the video source object that has the `Selected` property set to 'on'.)

To illustrate, the example assigns a value to the `Tag` property.

```
vid_src = getselectedsource(vid);  
  
set(vid_src, 'Tag', 'motion detection setup');
```

Step 6: Acquire Image Data

After you create the video input object and configure its properties, you can acquire data. This is typically the core of any image acquisition application, and it involves these steps:

- **Starting the video input object** — You start an object by calling the `start` function. Starting an object prepares the object for data acquisition. For example, starting an object locks the values of certain object properties (they become read only). Starting an object does not initiate the acquiring of image frames, however. The initiation of data logging depends on the execution of a trigger.

The following example calls the `start` function to start the video input object. Objects stop when they have acquired the requested number of frames. Because the example specifies a continuous acquisition, you must call the `stop` function to stop the object.

- **Triggering the acquisition** — To acquire data, a video input object must execute a trigger. Triggers can occur in several ways, depending on how the `TriggerType` property is configured. For example, if you specify an immediate trigger, the object executes a trigger automatically, immediately after it starts. If you specify a manual trigger, the object waits for a call to the `trigger` function before it initiates data acquisition. For more information, see “Acquiring Image Data” on page 5-2.

In the example, because the `TriggerType` property is set to `'immediate'` (the default) and the `TriggerRepeat` property is set to `Inf`, the object automatically begins executing triggers and acquiring frames of data, continuously.

- **Bringing data into the MATLAB workspace** — The toolbox stores acquired data in a memory buffer, a disk file, or both, depending on the value of the video input object `LoggingMode` property. To work with this data, you must bring it into the MATLAB workspace. To bring multiple frames into the workspace, use the `getdata` function. Once the data is in the MATLAB workspace, you can manipulate it as you would any other data. For more information, see “Working with Image Data in MATLAB Workspace” on page 6-12.

Note The toolbox provides a convenient way to acquire a single frame of image data that doesn't require starting or triggering the object. See “Bringing a Single Frame into the Workspace” on page 6-10 for more information.

Running the Example

To run the example, enter the following code at the MATLAB prompt. The example loops until a specified number of frames have been acquired. In each loop iteration, the example calls `getdata` to bring the two most recent frames into the MATLAB workspace. To detect motion, the example subtracts one frame from the other, creating a difference image, and then displays it. Pixels that have changed values in the acquired frames will have nonzero values in the difference image.

The `getdata` function removes frames from the memory buffer when it brings them into the MATLAB workspace. It is important to move frames from the memory buffer into the MATLAB workspace in a timely manner. If you do not move the acquired frames from memory, you can quickly exhaust all the memory available on your system.

Note The example uses functions in the Image Processing Toolbox software.

```
% Create video input object.
```

```
vid = videoinput('dcam',1,'Y8_1024x768')

% Set video input object properties for this application.
% Note that example uses both SET method and dot notation method.
set(vid,'TriggerRepeat',100);
vid.FrameGrabInterval = 5;

% Set value of a video source object property.
vid_src = getselectedsource(vid);
set(vid_src,'Tag','motion detection setup');

% Create a figure window.
figure;

% Start acquiring frames.
start(vid)

% Calculate difference image and display it.
while(vid.FramesAvailable >= 2)
    data = getdata(vid,2);
    diff_im = imabsdiff(data(:,:,,1),data(:,:,,2));
    imshow(diff_im);
    drawnow % update figure window
end

stop(vid)
```

Note that a `drawnow` is used after the call to `imshow` in order to ensure that the figure window is updated. This is good practice when updating a GUI or figure inside a loop.

The following figure shows how the example displays detected motion. In the figure, areas representing movement are displayed.

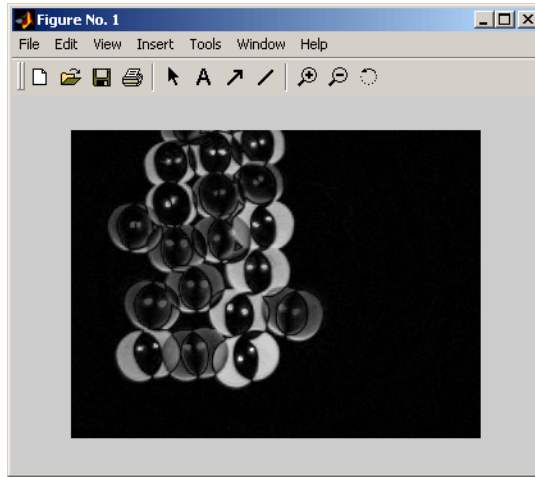


Figure Window Displayed by Example

Image Data in the MATLAB Workspace

In the example, the `getdata` function returns the image frames in the variable `data` as a 480-by-640-by-1-by-10 array of 8-bit data (`uint8`).

```
whos
      Name          Size          Bytes  Class
      data          4-D          3072000  uint8 array
      dev_info      1x1          1601    struct array
      info          1x1          2467    struct array
      vid           1x1          1138    videoinput object
      vid_src       1x1          726    videosource object
```

The height and width of the array are primarily determined by the video resolution of the video format. However, you can use the `ROIPosition` property to specify values that supersede the video resolution. Devices typically express video resolution as column-by-row; MATLAB expresses matrix dimensions as row-by-column.

The third dimension represents the number of color bands in the image. Because the example data is a grayscale image, the third dimension is 1. For RGB formats, image frames have three bands: red is the first, green is the second, and blue is the third. The fourth dimension represents the number of frames that have been acquired from the video stream.

Step 7: Clean Up

When you finish using your image acquisition objects, you can remove them from memory and clear the MATLAB workspace of the variables associated with these objects.

```
delete(vid)
clear
close(gcf)
```

For more information, see “Deleting Image Acquisition Objects” on page 4-28.

Introduction

This chapter describes the Image Acquisition Toolbox software and its components.

- “Toolbox Components Overview” on page 2-2
- “Setting Up Image Acquisition Hardware” on page 2-7
- “Previewing Data” on page 2-10

Toolbox Components Overview

In this section...
“Introduction” on page 2-2
“Toolbox Components” on page 2-3
“The Image Processing Toolbox Software Required to Use the Image Acquisition Toolbox Software” on page 2-4
“The Image Acquisition Tool (GUI)” on page 2-5
“Supported Devices” on page 2-5

Introduction

Image Acquisition Toolbox enables you to acquire images and video from cameras and frame grabbers directly into MATLAB and Simulink. You can detect hardware automatically, and configure hardware properties. Advanced workflows let you trigger acquisitions while processing in-the-loop, perform background acquisitions, and synchronize sampling across several multimodal devices. With support for multiple hardware vendors and industry standards, you can use imaging devices, ranging from inexpensive Web cameras to high-end scientific and industrial devices that meet low-light, high-speed, and other challenging requirements.

The Image Acquisition Toolbox software implements an object-oriented approach to image acquisition. Using toolbox functions, you create an object that represents the connection between MATLAB and specific image acquisition devices. Using properties of the object you can control various aspects of the acquisition process, such as the amount of video data you want to capture. “Creating Image Acquisition Objects” on page 4-9 describes how to create objects.

Once you establish a connection to a device, you can acquire image data by executing a trigger. In the toolbox, all image acquisition is initiated by a trigger. The toolbox supports several types of triggers that let you control when an acquisition takes place. For example, using hardware triggers you can synchronize an acquisition with an external device. “Acquiring Image Data” on page 5-2 describes how to trigger the acquisition of image data.

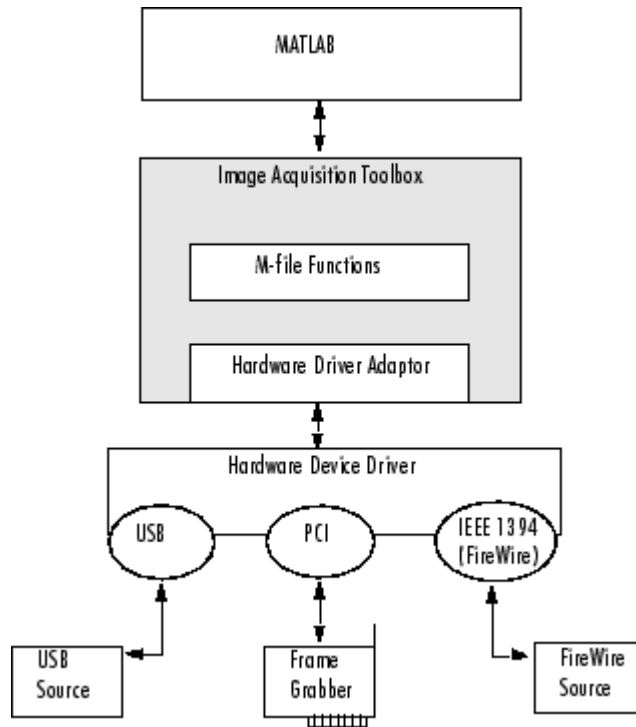
To work with the data you acquire, you must bring it into the MATLAB workspace. When the frames are acquired, the toolbox stores them in a memory buffer. The toolbox provides several ways to bring one or more frames of data into the workspace where you can manipulate it as you would any other multidimensional numeric array. “Bringing Image Data into the MATLAB Workspace” on page 6-3 describes this process.

Finally, you can enhance your image acquisition application by using event callbacks. The toolbox has defined certain occurrences, such as the triggering of an acquisition, as events. You can associate the execution of a particular function with a particular event. “Using Events and Callbacks” on page 7-2 describes this process.

Toolbox Components

The toolbox uses components called hardware device adaptors to connect to devices through their drivers. The toolbox includes adaptors that support devices produced by several vendors of image acquisition equipment. In addition, the toolbox includes an adaptor for generic Windows video acquisition devices.

The following figure shows these components and their relationship.



The Image Acquisition Toolbox™ Software Components

The Image Processing Toolbox Software Required to Use the Image Acquisition Toolbox Software

The Image Acquisition Toolbox product, including the Image Acquisition Tool, now requires you to have a license for the Image Processing Toolbox product starting in R2008b.

If you already have the Image Processing Toolbox product, you do not need to do anything.

If you do not have the Image Processing Toolbox product, the Image Acquisition Toolbox software R2008a and earlier will continue to work. If you want to use R2008b or future releases, and you have a current active license

for the Image Acquisition Toolbox software, you can download the Image Processing Toolbox product for free. New customers will need to purchase both products to use the Image Acquisition Toolbox product.

If you have any questions, please contact MathWorks customer service.

The Image Acquisition Tool (GUI)

The functionality of the Image Acquisition Toolbox software is available in a desktop application. You connect directly to your hardware in the tool and can then set acquisition parameters, and preview and acquire image data. You can log the data to MATLAB in several formats, and also generate an AVI file, right from the tool.

To open the tool, type `imaqtool` at the MATLAB command line, or select **Image Acquisition** on the **Apps** tab in MATLAB. The tool has extensive Help in the desktop. As you click in different panes of the user interface, the relevant Help appears in the **Image Acquisition Tool Help** pane.

Most of the User's Guide describes performing tasks using the toolbox via the MATLAB command line. To learn how to use the desktop tool, see "Getting Started with the Image Acquisition Tool" on page 3-5.

Supported Devices

The Image Acquisition Toolbox software includes adaptors that provide support for several vendors of professional grade image acquisition equipment, devices that support the IIDC 1394-based Digital Camera Specification (DCAM), and devices that provide Windows Driver Model (WDM) or Video for Windows (VFW) drivers, such as USB and IEEE® 1394 (FireWire, i.LINK®) Web cameras, Digital video (DV) camcorders, and TV tuner cards. For the latest information about supported hardware, visit the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

The DCAM specification, developed by the 1394 Trade Association, describes a generic interface for exchanging data with IEEE 1394 (FireWire) digital cameras that is often used in scientific applications. The toolbox's DCAM adaptor supports Format 7, also known as partial scan mode. The toolbox uses the prefix `F7_` to identify Format 7 video format names.

Note The toolbox supports only connections to IEEE 1394 (FireWire) DCAM-compliant devices using the Carnegie Mellon University DCAM driver. The toolbox is not compatible with any other vendor-supplied driver, even if the driver is DCAM compliant.

You can add support for additional hardware by writing an adaptor. For more information, see “Support for Additional Hardware” on page 12-2.

Setting Up Image Acquisition Hardware

In this section...

“Introduction” on page 2-7

“Setting Up Frame Grabbers” on page 2-7

“Setting Up Generic Windows Video Acquisition Devices” on page 2-8

“Setting Up DCAM Devices” on page 2-8

“Resetting Your Image Acquisition Hardware” on page 2-8

“A Note About Frame Rates and Processing Speed” on page 2-8

Introduction

To acquire image data, you must perform the setup required by your particular image acquisition device. In a typical image acquisition setup, an image acquisition device, such as a camera, is connected to a computer via an image acquisition board, such as a frame grabber, or via a Universal Serial Bus (USB) or IEEE 1394 (FireWire) port. The setup required varies with the type of device.

After installing and configuring your image acquisition hardware, start MATLAB on your computer by double-clicking the icon on your desktop. You do not need to perform any special configuration of MATLAB to acquire data.

Setting Up Frame Grabbers

For frame grabbers, also known as imaging boards, setup typically involves the following tasks:

- Installing the frame grabber in your computer
- Installing any software drivers required by the frame grabber. These are supplied by the device vendor.
- Connecting the camera, or other image acquisition device, to a connector on the frame grabber
- Verifying that the camera is working properly by running the application software that came with the frame grabber and viewing a live video stream

Setting Up Generic Windows Video Acquisition Devices

IEEE 1394 (FireWire) and generic Windows video acquisition devices that use Windows Driver Model (WDM) or Video for Windows (VFW) device drivers typically require less setup. Plug the device into the USB or IEEE 1394 (FireWire) port on your computer and install the device driver provided by the vendor.

Setting Up DCAM Devices

If you intend to access a DCAM-compliant IEEE 1394 (FireWire) camera, you must install and configure the Carnegie Mellon University (CMU) DCAM driver. The toolbox is not compatible with any other vendor-supplied driver, even if the driver is DCAM compliant. See “Installing the CMU DCAM Driver on Windows” on page 13-10 for more information.

Resetting Your Image Acquisition Hardware

To return MATLAB and your image acquisition hardware to a known state, where no image acquisition objects exist and the hardware is not configured, use the `imaqreset` function.

If you connect another image acquisition device to your system after MATLAB is started, you can use `imaqreset` to make the toolbox aware of the new hardware.

A Note About Frame Rates and Processing Speed

The frame rate describes how fast an image acquisition device provides data, typically measured as frames per second.

Devices that support industry-standard video formats must provide frames at the rate specified by the standard. For RS170 and NTSC, the standard dictates a frame rate of 30 frames per second (30 Hz). The CCIR and PAL standards define a frame rate of 25 Hz. Nonstandard devices can be configured to operate at higher rates. Generic Windows image acquisition devices, such as webcams, might support many different frame rates. Depending on the device being used, the frame rate might be configurable using a device-specific property of the image acquisition object.

The rate at which the Image Acquisition Toolbox software can process images depends on the processor speed, the complexity of the processing algorithm, and the frame rate. Given a fast processor, a simple algorithm, and a frame rate tuned to the acquisition setup, the Image Acquisition Toolbox software can process data as it comes in.

Previewing Data

In this section...
“Introduction” on page 2-10
“Opening a Video Preview Window” on page 2-11
“Stopping the Preview Video Stream” on page 2-12
“Closing a Video Preview Window” on page 2-13
“Previewing Data in Custom GUIs” on page 2-13
“Performing Custom Processing of Previewed Data” on page 2-15

Introduction

After you connect MATLAB to the image acquisition device you can view the live video stream using the Video Preview window. Previewing the video data can help you make sure that the image being captured is satisfactory.

For example, by looking at a preview, you can verify that the lighting and focus are correct. If you change characteristics of the image, by using video input object and video source object properties, the image displayed in the Video Preview window changes to reflect the new property settings.

The following sections provide more information about using the Video Preview window.

- “Opening a Video Preview Window” on page 2-11
- “Stopping the Preview Video Stream” on page 2-12
- “Closing a Video Preview Window” on page 2-13

Instead of using the toolbox’s Video Preview window, you can display the live video preview stream in any Handle Graphics® image object you specify. In this way, you can include video previewing in a GUI of your own creation. The following sections describe this capability.

- “Previewing Data in Custom GUIs” on page 2-13
- “Performing Custom Processing of Previewed Data” on page 2-15

Note The Image Acquisition Toolbox Preview window and the Preview window that is built into the Image Acquisition Tool support the display of up to 16-bit image data. The Preview window was designed to only show 8-bit data, but many cameras return 10-, 12-, 14-, or 16-bit data. The Preview window display supports these higher bit-depth cameras. However, larger bit data is scaled to 8-bit for the purpose of displaying previewed data. If you need the full resolution of the data, use the `getsnapshot` or `getdata` functions.

Opening a Video Preview Window

To open a Video Preview window, use the `preview` function. The Video Preview window displays the live video stream from the device. You can only open one preview window per device. If multiple devices are used, you can open multiple preview windows at the same time.

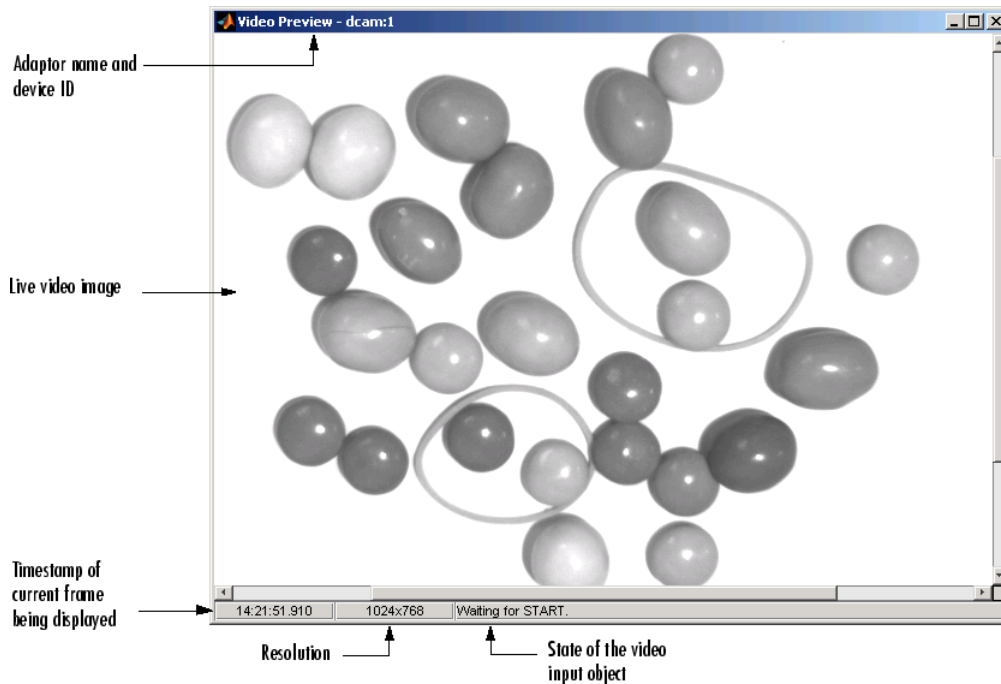
The following example creates a video input object and then opens a Video Preview window for the video input object.

```
vid = videoinput('winvideo');  
preview(vid);
```

The following figure shows the Video Preview window created by this example. The Video Preview window displays the live video stream. The size of the preview image is determined by the value of the video input object's `ROIposition` property. The Video Preview window displays the video data at 100% magnification (one screen pixel represents one image pixel).

In addition to the preview image, the Video Preview window includes information about the image, such as the timestamp of the video frame, the video resolution, and the current status of the video input object.

Note Because video formats typically express resolution as width-by-height, the Video Preview window expresses the size of the image frame as column-by-row, rather than the standard MATLAB row-by-column format.



Note The Image Acquisition Toolbox Preview window and the Preview window that is built into the Image Acquisition Tool support the display of up to 16-bit image data. The Preview window was designed to only show 8-bit data, but many cameras return 10-, 12-, 14-, or 16-bit data. The Preview window display supports these higher bit-depth cameras. However, larger bit data is scaled to 8-bit for the purpose of displaying previewed data. If you need the full resolution of the data, use the `getsnapshot` or `getdata` functions.

Stopping the Preview Video Stream

When you use the `preview` function to start previewing image data, the Video Preview window displays a view of the live video stream coming from the device. To stop the updating of the live video stream, call the `stoppreview` function.

This example creates a video input object and opens a Video Preview window. The example then calls the `stoppreview` function on this video input object. The Video Preview window stops updating the image displayed and stops updating the timestamp. The status displayed in the Video Preview window also changes to indicate that previewing has been stopped.

```
vid = videoinput('winvideo');  
preview(vid)  
stoppreview(vid)
```

To restart the video stream in the Video Preview window, call `preview` again on the same video input object.

```
preview(vid)
```

Closing a Video Preview Window

To close a particular Video Preview window, use the `closepreview` function, specifying the video input object as an argument. You do not need to stop the live video stream displayed in the Video Preview window before closing it.

```
closepreview(vid)
```

To close all currently open Video Preview windows, use the `closepreview` function without any arguments.

```
closepreview
```

Note When called without an argument, the `closepreview` function only closes Video Preview windows. The `closepreview` function does not close any other figure windows in which you have directed the live preview video stream. For more information, see “Previewing Data in Custom GUIs” on page 2-13.

Previewing Data in Custom GUIs

Instead of using the toolbox’s Video Preview window, you can use the `preview` function to direct the live video stream to any Handle Graphics image object. In this way, you can incorporate the toolbox’s previewing capability in a GUI of your own creation. (You can also perform custom processing as the live video is displayed. For information, see “Performing Custom Processing of Previewed Data” on page 2-15.)

To use this capability, create an image object and then call the `preview` function, specifying a handle to the image object as an argument. The `preview` function outputs the live video stream to the image object you specify.

The following example creates a figure window and then creates an image object in the figure, the same size as the video frames. The example then calls the `preview` function, specifying a handle to the image object.

```
% Create a video input object.
vid = videoinput('winvideo');

% Create a figure window. This example turns off the default
% toolbar, menubar, and figure numbering.

figure('Toolbar','none',...
       'Menubar', 'none',...
       'NumberTitle','Off',...
       'Name','My Preview Window');

% Create the image object in which you want to display
% the video preview data. Make the size of the image
% object match the dimensions of the video frames.

vidRes = get(vid, 'VideoResolution');
nBands = get(vid, 'NumberOfBands');
hImage = image( zeros(vidRes(2), vidRes(1), nBands) );

% Display the video data in your GUI.

preview(vid, hImage);
```

When you run this example, it creates the GUI shown in the following figure.



Custom Preview

Performing Custom Processing of Previewed Data

When you specify an image object to the preview function (see “Previewing Data in Custom GUIs” on page 2-13), you can optionally also specify a function that preview executes every time it receives an image frame.

To use this capability, follow these steps:

- 1** Create the function you want executed for each image frame, called the update preview window function. For information about this function, see “Creating the Update Preview Window Function” on page 2-16.
- 2** Create an image object.
- 3** Configure the value of the image object’s ‘UpdatePreviewWindowFcn’ application-defined data to be a function handle to your update preview window function. For more information, see “Specifying the Update Preview Function” on page 2-17.
- 4** Call the preview function, specifying the handle of the image object as an argument.

Note If you specify an update preview window function, in addition to whatever processing your function performs, it must display the video data in the image object. You can do this by updating the `CData` of the image object with the incoming video frames. For some performance guidelines about updating the data displayed in an image object, see Technical Solution 1-1B022.

Creating the Update Preview Window Function

When `preview` calls the update preview window function you specify, it passes your function the following arguments.

Argument	Description								
<code>obj</code>	Handle to the video input object being previewed								
<code>event</code>	A data structure containing the following fields: <table border="1" data-bbox="601 817 1328 1326"> <tbody> <tr> <td><code>Data</code></td> <td>Current image frame specified as an H-by-W-by-B array, where H is the image height and W is the image width, as specified in the <code>ROIPosition</code> property, and B is the number of color bands, as specified in the <code>NumberOfBands</code> property</td> </tr> <tr> <td><code>Resolution</code></td> <td>Text string specifying the current image width and height, as defined by the <code>ROIPosition</code> property</td> </tr> <tr> <td><code>Status</code></td> <td>String describing the status of the video input object</td> </tr> <tr> <td><code>Timestamp</code></td> <td>String specifying the time associated with the current image frame, in the format <code>hh:mm:ss:ms</code></td> </tr> </tbody> </table>	<code>Data</code>	Current image frame specified as an H-by-W-by-B array, where H is the image height and W is the image width, as specified in the <code>ROIPosition</code> property, and B is the number of color bands, as specified in the <code>NumberOfBands</code> property	<code>Resolution</code>	Text string specifying the current image width and height, as defined by the <code>ROIPosition</code> property	<code>Status</code>	String describing the status of the video input object	<code>Timestamp</code>	String specifying the time associated with the current image frame, in the format <code>hh:mm:ss:ms</code>
<code>Data</code>	Current image frame specified as an H-by-W-by-B array, where H is the image height and W is the image width, as specified in the <code>ROIPosition</code> property, and B is the number of color bands, as specified in the <code>NumberOfBands</code> property								
<code>Resolution</code>	Text string specifying the current image width and height, as defined by the <code>ROIPosition</code> property								
<code>Status</code>	String describing the status of the video input object								
<code>Timestamp</code>	String specifying the time associated with the current image frame, in the format <code>hh:mm:ss:ms</code>								
<code>himage</code>	Handle to the image object in which the data is to be displayed								

The following example creates an update preview window function that displays the timestamp of each incoming video frame as a text label in the

custom GUI. The update preview window function uses `getappdata` to retrieve a handle to the text label `uicontrol` object from application-defined data in the image object. The custom GUI stores this handle to the text label `uicontrol` object — see “Specifying the Update Preview Function” on page 2-17.

Note that the update preview window function also displays the video data by updating the `CData` of the image object.

```
function mypreview_fcn(obj,event,himage)
% Example update preview window function.

% Get timestamp for frame.
tstampstr = event.Timestamp;

% Get handle to text label uicontrol.
ht = getappdata(himage, 'HandleToTimestampLabel');

% Set the value of the text label.
set(ht, 'String', tstampstr);

% Display image data.
set(himage, 'CData', event.Data)
```

Specifying the Update Preview Function

To use an update preview window function, store a function handle to your function in the `'UpdatePreviewWindowFcn'` application-defined data of the image object. The following example uses the `setappdata` function to configure this application-defined data to a function handle to the update preview window function described in “Creating the Update Preview Window Function” on page 2-16.

This example extends the simple custom preview window created in “Previewing Data in Custom GUIs” on page 2-13. This example adds three push button `uicontrol` objects to the GUI: **Start Preview**, **Stop Preview**, and **Close Preview**.

In addition, to illustrate using an update preview window function, the example GUI includes a text label `uicontrol` object to display the timestamp

value. The update preview window function updates this text label each time a frame is received. The example uses `setappdata` to store a handle to the text label `uicontrol` object in application-defined data in the image object. The update preview window function retrieves this handle to update the timestamp display.

```
% Create a video input object.
vid = videoinput('winvideo');

% Create a figure window. This example turns off the default
% toolbar and menubar in the figure.
hFig = figure('Toolbar','none',...
             'Menubar','none',...
             'NumberTitle','Off',...
             'Name','My Custom Preview GUI');

% Set up the push buttons
uicontrol('String','Start Preview',...
         'Callback','preview(vid)',...
         'Units','normalized',...
         'Position',[0 0 0.15 0.07]);
uicontrol('String','Stop Preview',...
         'Callback','stoppreview(vid)',...
         'Units','normalized',...
         'Position',[.17 0 0.15 0.07]);
uicontrol('String','Close',...
         'Callback','close(gcf)',...
         'Units','normalized',...
         'Position',[0.34 0 0.15 0.07]);

% Create the text label for the timestamp
hTextLabel = uicontrol('style','text','String','Timestamp', ...
                     'Units','normalized',...
                     'Position',[0.85 0.04 0.15 0.08]);

% Create the image object in which you want to
% display the video preview data.
vidRes = get(vid, 'VideoResolution');
imWidth = vidRes(1);
imHeight = vidRes(2);
```

```
nBands = get(vid, 'NumberOfBands');
hImage = image( zeros(imHeight, imWidth, nBands) );

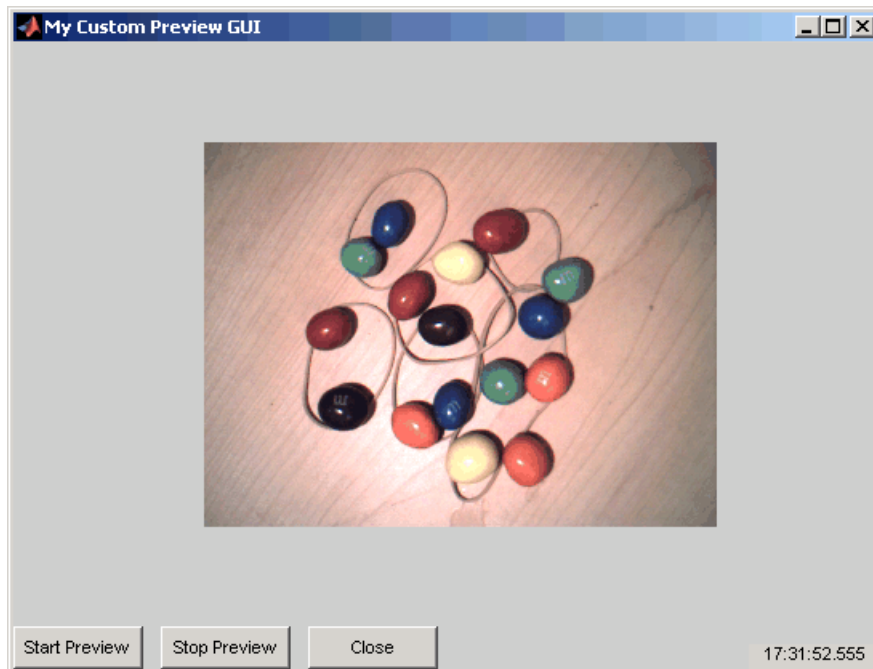
% Specify the size of the axes that contains the image object
% so that it displays the image at the right resolution and
% centers it in the figure window.
figSize = get(hFig, 'Position');
figWidth = figSize(3);
figHeight = figSize(4);
set(gca, 'unit', 'pixels', ...
        'position', [ ((figWidth - imWidth)/2)...
                      ((figHeight - imHeight)/2)...
                      imWidth imHeight ]);

% Set up the update preview window function.
setappdata(hImage, 'UpdatePreviewWindowFcn', @mypreview_fcn);

% Make handle to text label available to update function.
setappdata(hImage, 'HandleToTimestampLabel', hTextLabel);

preview(vid, hImage);
```

When you run this example, it creates the GUI shown in the following figure. Each time preview receives a video frame, it calls the update preview window function that you specified, which updates the timestamp text label in the GUI.



Custom Preview GUI with Timestamp Text Label

Using the Image Acquisition Tool GUI

- “The Image Acquisition Tool Desktop” on page 3-2
- “Getting Started with the Image Acquisition Tool” on page 3-5
- “Selecting Your Device in Image Acquisition Tool” on page 3-8
- “Setting Acquisition Parameters in Image Acquisition Tool” on page 3-11
- “Previewing and Acquiring Data in Image Acquisition Tool” on page 3-31
- “Exporting Data in the Image Acquisition Tool” on page 3-38
- “Saving Image Acquisition Tool Configurations” on page 3-42
- “Exporting Image Acquisition Tool Hardware Configurations to MATLAB” on page 3-44
- “Saving and Copying Image Acquisition Tool Session Log” on page 3-46
- “Registering a Third-Party Adaptor in the Image Acquisition Tool” on page 3-49

The Image Acquisition Tool Desktop

In this section...
“Opening the Tool” on page 3-2
“Parts of the Desktop” on page 3-2

Opening the Tool

Image Acquisition Toolbox functionality is available in a desktop application. You connect directly to your hardware in the tool and can preview and acquire image data. You can log the data to MATLAB in several formats, and also generate a VideoWriter or AVI file, right from the tool.

The Image Acquisition Tool provides a desktop environment that integrates a preview/acquisition area with Acquisition Parameters so that you can change settings and see the changes dynamically applied to your image data.

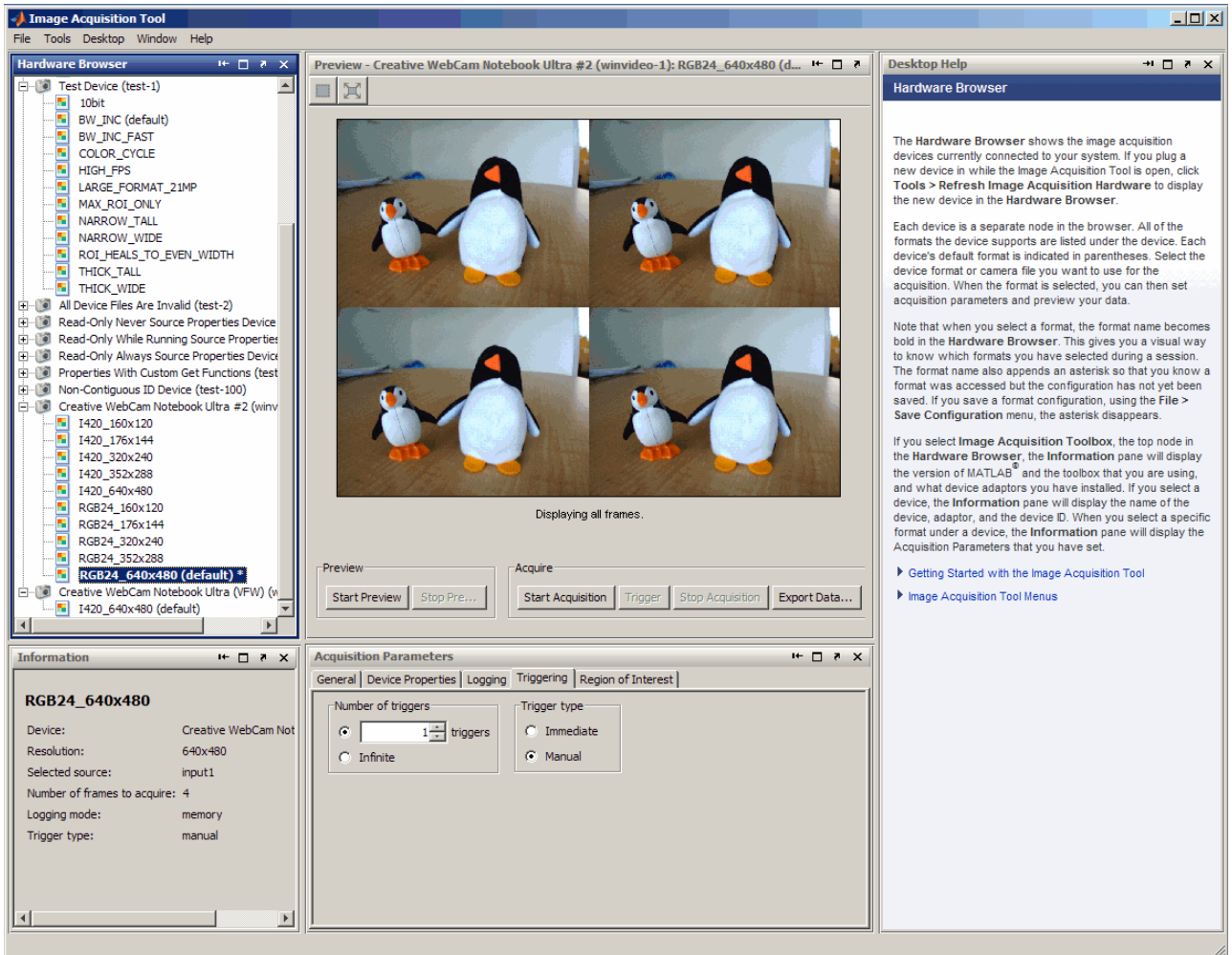
To open the Image Acquisition Tool, do one of the following:

- Type `imaqtool` at the MATLAB command line.
- Select **Image Acquisition** on the **Apps** tab in MATLAB.

Note The right pane in the tool is the **Desktop Help** pane. As you work in the tool the Help will provide information for the part of the interface that you are working in. If the **Desktop Help** is closed, you can open it by selecting **Desktop > Desktop Help**.

Parts of the Desktop

The Image Acquisition Tool has the following panes.



- **Hardware Browser** – Shows the image acquisition devices currently connected to your system. Each device is a separate node in the browser. All of the formats the device supports are listed under the device. Each device's default format is indicated in parentheses. Select the device format or camera file you want to use for the acquisition. When the format is selected, you can then set acquisition parameters and preview your data.

See “Selecting Your Device in Image Acquisition Tool” on page 3-8 for more information about using the **Hardware Browser**.

- **Preview window** – Use to preview and acquire image data from the selected device format, and to export data that has been acquired in memory to a MAT-file, the MATLAB Workspace, VideoWriter, or to tools provided by the Image Processing Toolbox software. See “Previewing and Acquiring Data in Image Acquisition Tool” on page 3-31 for more information about using the **Preview window**.
- **Acquisition Parameters** – Use these tabs to set up general acquisition parameters, such as frames per trigger and color space, device-specific properties, logging options, triggering options, and region of interest. Settings you make on any tab will apply to the currently selected device format in the **Hardware Browser**. See “Setting Acquisition Parameters in Image Acquisition Tool” on page 3-11 for more information about using the **Acquisition Parameters**. Also see the Help for each tab while using the tool for more details. When you click any tab, the help for that tab will appear in the **Desktop Help** pane.
- **Information pane** – Displays a summary of information about the selected node in the **Hardware Browser**.
- **Session Log** – Displays a dynamically generated log of the commands that correspond to actions taken in the tool. You can save the log to a MATLAB code file or copy it.
- **Desktop Help** – Displays Help for the pane of the desktop that has focus. Click inside a pane for help on that area of the tool. For the **Acquisition Parameters** pane, click each tab to display information about the settings for that tab.

If the **Desktop Help** is closed, you can open it by selecting **Desktop > Desktop Help**.

Getting Started with the Image Acquisition Tool

This section describes an example of the basic work flow of using the Image Acquisition Tool to preview, acquire, and save image data. You don't need to do every step shown here, and you can change the order of some steps.

For information on the parts of the Desktop GUI or how to open the Tool, see “The Image Acquisition Tool Desktop” on page 3-2.

1 Decide which device you want to work with.

The **Hardware Browser** shows the image acquisition devices currently connected to your system. If the device you want to use is not connected to your system, plug it in and then select **Tools > Refresh Image Acquisition Hardware** to display the new device in the **Hardware Browser**.

2 Choose the format to work with.

The nodes listed under the device name are the formats the device supports. They may correspond to the different resolutions and color spaces that your device supports, or to different video standards or camera configurations. This information comes from your device adaptor. Select the format you want to use.

3 Preview to check that the device is working and the image is what you expect.

Click the **Start Preview** button.

If necessary, physically adjust the device to achieve the desired image area, or use the **Region of Interest** tab to define the acquisition region.

4 Decide how many frames you want to acquire.

The number of frames that will be acquired when you start the acquisition is dependent on what is set in the **Frames Per Trigger** field on the **General** tab and the **Number of Triggers** field on the **Triggering** tab. For example, if you set **Frames Per Trigger** to 4 and **Number of Triggers** to 2, the total number of frames acquired will be 8.

If you just want a snapshot of one frame, leave the default settings of 1 in both of those fields. If you want a specific number of frames, use the fields to set it.

Alternatively, you can set the tool to acquire continuously and use the buttons in the **Preview Window** to manually start and stop the acquisition. This is discussed in a later step.

- 5 Set any general or device-specific parameters you need to set, on those tabs of the **Acquisition Parameters** pane, or use the default settings.
- 6 Choose your log mode, which determines where the acquisition data is stored.

On the **Logging** tab, use the **Log To** field to choose to log to memory, disk, or both. Disk logging results in a saved VideoWriter file. If you choose memory logging, you can export your data after the acquisition using the **Export Data** button on the **Preview Window**.

For more information on logging, see the Help for the **Logging** tab in the **Desktop Help** pane in the tool.

- 7 Start the acquisition by clicking the **Start Acquisition** button.
 - If you set **Trigger Type** (on the **Triggering** tab) to Immediate, the tool will immediately start logging data.
 - If you set **Trigger Type** to Manual, click the **Trigger** button when you want to start logging data.
- 8 Stop the acquisition.
 - If you set **Frames Per Trigger** (on the **General** tab) to 1 or any other number, your acquisition will stop when that number of frames is reached.
 - If you set **Frames Per Trigger** to Infinite, click the **Stop Acquisition** button to stop the acquisition.

Note that you can also click **Stop Acquisition** to abort an acquisition if number of frames was specified.
- 9 Optionally you can export data that was saved to memory.

You can export the data that has been acquired in memory to a MAT-file, the MATLAB Workspace, VideoWriter, or to the Image Tool, Image File, or Movie Player tools that are provided by the Image Processing Toolbox software using the **Export Data** button. For more information, see the “Exporting Data” section of the **Desktop Help** on the **Preview Window** in the **Desktop Help** pane in the tool.

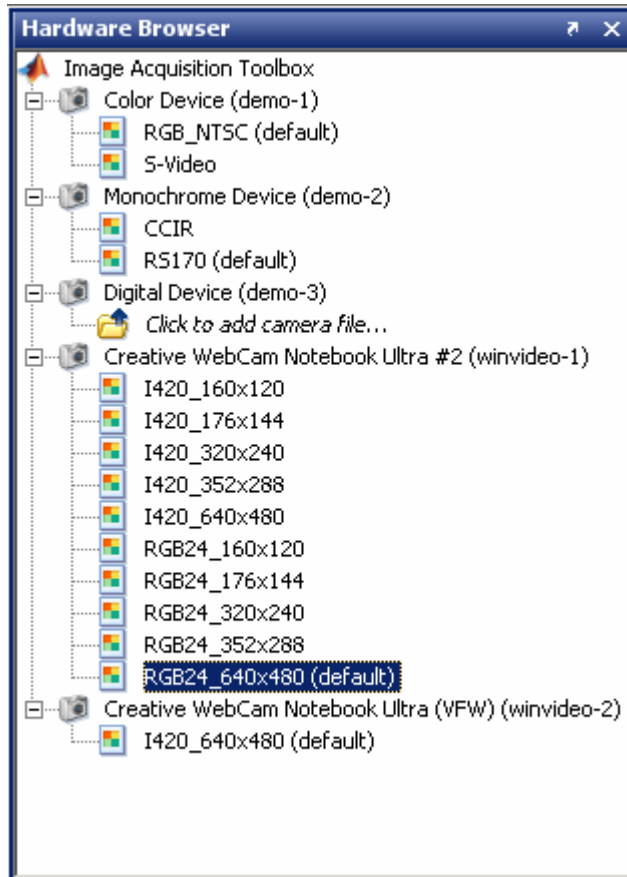
- 10** Optionally you can save your configuration(s), using the **File > Save Configuration** or **File > Export Hardware Configuration** menus. For more information about these commands, see the “Image Acquisition Tool Menus” section of the **Help** on the **Hardware Browser** in the **Desktop Help** pane in the tool.

Selecting Your Device in Image Acquisition Tool

In this section...
“Selecting a Device and Format” on page 3-8
“Adding New Hardware” on page 3-9
“Using a Camera File” on page 3-10

Selecting a Device and Format

The **Hardware Browser** pane shows the image acquisition devices currently connected to your system. Each device is a separate node in the browser. All of the formats the device supports are listed under the device. Each device's default format is indicated in parentheses. The format information displayed under a device comes from the device's adaptor.



Select the device format or camera file you want to use for the acquisition by clicking its name in the tree. When the format is selected, you can then set acquisition parameters and preview your data.

Adding New Hardware

When you open the Image Acquisition Tool, the **Hardware Browser** automatically shows the image acquisition devices supported by the toolbox that are currently connected to your system. If you plug a new device in while the Image Acquisition Tool is open, select **Tools > Refresh Image**

Acquisition Hardware to display the new device in the **Hardware Browser**.

Using a Camera File

If your device supports the use of a camera file, also known as a device configuration file, you can select it under the device name in the **Hardware Browser**. For example, some frame grabbers support them.

Under the device name in the **Hardware Browser**, you would see a node that says *Click to add camera file...* if the device supports the use of camera files.

To use a camera file:

- 1** In the **Hardware Browser**, single-click the node under your device name that says *Click to add camera file...*
- 2** In the Specify camera file dialog box, type the path and name of the file, or click the **Browse** button to locate it, and then click **OK**.

The camera file will then become a new node under the device, similar to any of the formats listed under a device. You can then set acquisition parameters, preview, and acquire data using it.

Note The tool ignores hardware trigger configurations included in a camera file. To configure hardware triggering, use the **Trigger** tab in the **Acquisition Parameters** pane.

Setting Acquisition Parameters in Image Acquisition Tool

In this section...

“Using the Acquisition Parameters Pane” on page 3-11

“Setting Frames Per Trigger” on page 3-12

“Setting the Color Space” on page 3-13

“Setting Device-Specific Parameters” on page 3-13

“Logging Your Data” on page 3-16

“Setting Up Triggering” on page 3-21

“Setting a Region of Interest” on page 3-24

“Restoring Default Parameters” on page 3-30

Using the Acquisition Parameters Pane

The tool allows you to set acquisition parameters directly in the desktop using the **Acquisition Parameters** pane. Settings you make will apply to the currently selected device format in the **Hardware Browser**.

The **Acquisition Parameters** pane contains the following tabs:

- **General** – Use to set up general acquisition parameters, such as frames per trigger and color space.
- **Device Properties** – Use to view or change device-specific properties.
- **Logging** – Use to set up logging options, such as logging mode, which determines whether your acquired data is logged to memory, disk, or both. If you want to generate a VideoWriter file of your data, use the **Disk Logging** option on this tab.
- **Triggering** – Use to set up triggering options, such as number of triggers and trigger type. If you want to do manual triggering using the **Trigger** button, use the **Trigger Type** option on this tab.
- **Region of Interest** – Use to set a Region of Interest (ROI) if you only want to use part of an image.

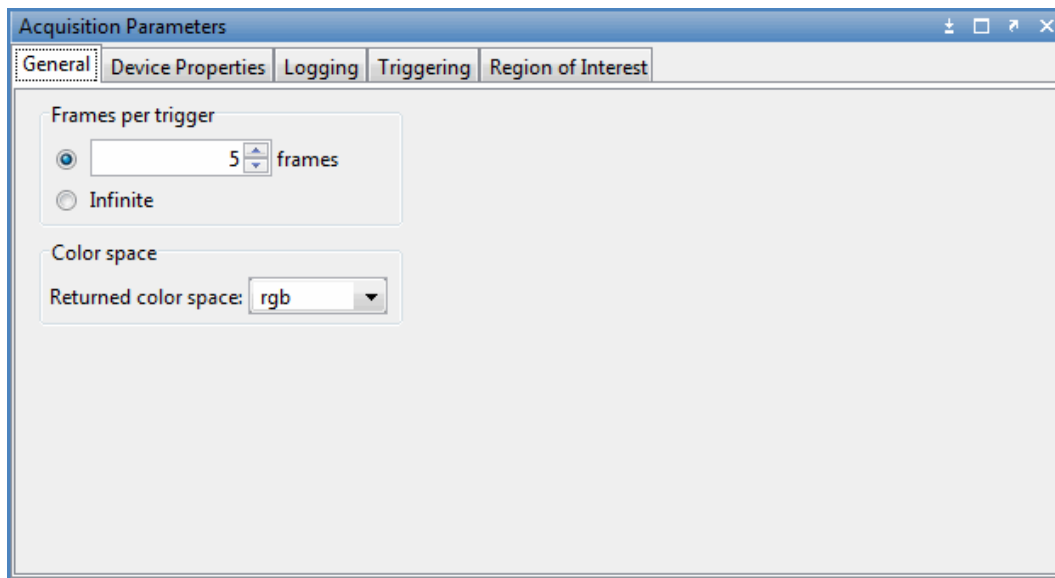
For more detailed information about the settings on each tab, see the Help topic for the tab while using the tool. When you click a tab, the corresponding topic will appear in the **Desktop Help** pane.

Note Once you have changed parameters of a device, you can restore the device's default parameters by selecting the device format in the **Hardware Browser** and right-clicking **Clear Selected Hardware Configuration**.

Setting Frames Per Trigger

The **Frames Per Trigger** field on the **General** tab is used to set the number of frames per trigger you want to acquire.

- If you want your acquisition to be a specific number of frames per trigger, use the default of 1 frame, or use the arrows to select the number of frames or type in the number.
- If you want to acquire frames continuously, set the **Frames Per Trigger** to **infinite** and then use the **Stop Acquisition** button to stop the acquisition, or do manual triggering using the **Triggering** tab.



The number of frames that will be acquired when you start an acquisition depends on what is set in the **Frames Per Trigger** field on the **General** tab and the **Number of Triggers** field on the **Triggering** tab. For example, if you set **Frames Per Trigger** to 4 and **Number of Triggers** to 2, the total number of frames acquired will be 8.

Note that if you set **Frames Per Trigger** to infinite, you cannot set **Number of Triggers** on the **Triggering** tab.

Note Some devices need a few frames to warm up, or may always skip the first frame. If your device does that, change the number of frames accordingly to adjust for that. You can also adjust for camera warm-up by using manual triggering on the **Triggering** tab.

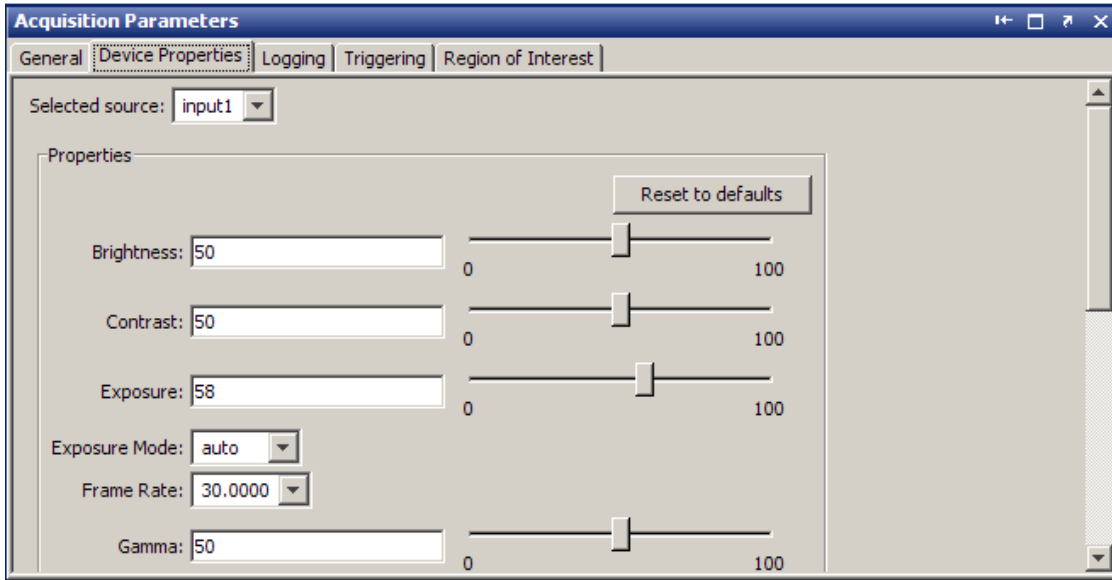
Setting the Color Space

Use **Color Space** on the **General** tab to set the color space for the selected device format. The **Returned Color Space** field has three options: `rgb`, `YCbCr`, and `grayscale`. The setting that is your device format's default color space is shown as the default. You can use the arrow to select another setting.

Additionally, if the default color space is `grayscale`, a value of `bayer` will be available in the **Returned Color Space** field for some devices, and the **Bayer Sensor Alignment** field will also be displayed. Use the drop-down list to select one of the four possible sensor alignments. This feature allows the tool to demosaic Bayer patterns returned by the hardware and interpolate them into standard RGB color images. For more information about this feature, see the `BayerSensorAlignment` property reference page.

Setting Device-Specific Parameters

View or change device-specific properties using the **Device Properties** tab. The selected device's properties appear in the **Properties** area. The specific properties that appear depend on your device.



The **Selected source** field specifies the name of the selected source for the current device. Many device adaptors only have one input source, so for example, this might show something like `input1`, `port1`, or `input0` by default. If your device supports multiple source names, they will appear in the drop-down list.

Use the **Properties** area to view or edit properties:

- If a property has an edit box or slider, that value is editable.
- If a property has an arrow indicating a drop-down list, then you can select a value from the list.
- If a property has a value listed that is grayed out, then that value is not currently editable.

Changes you make in the **Properties** area are applied to your acquisition or preview dynamically. For example, to change the exposure for the camera you are using, edit the value in the **Exposure** property text field or use the slider to change it. You will immediately see the change in the **Preview window** if you are previewing at the time, or in the next acquisition when you click the **Start Acquisition** button.

Click the **Reset to defaults** button to undo any modifications you made and restore the default settings of the device.

Property Help

To get help on any of the properties in the **Device Properties** tab, right-click a property and select **What's This?**. A **Help** window opens and displays the help for the selected property, as well as the rest of the properties, which are available by scrolling. This is the same information as the device help you access using the `imaqhelp` command. For more detailed information on device-specific properties, see your device's documentation.

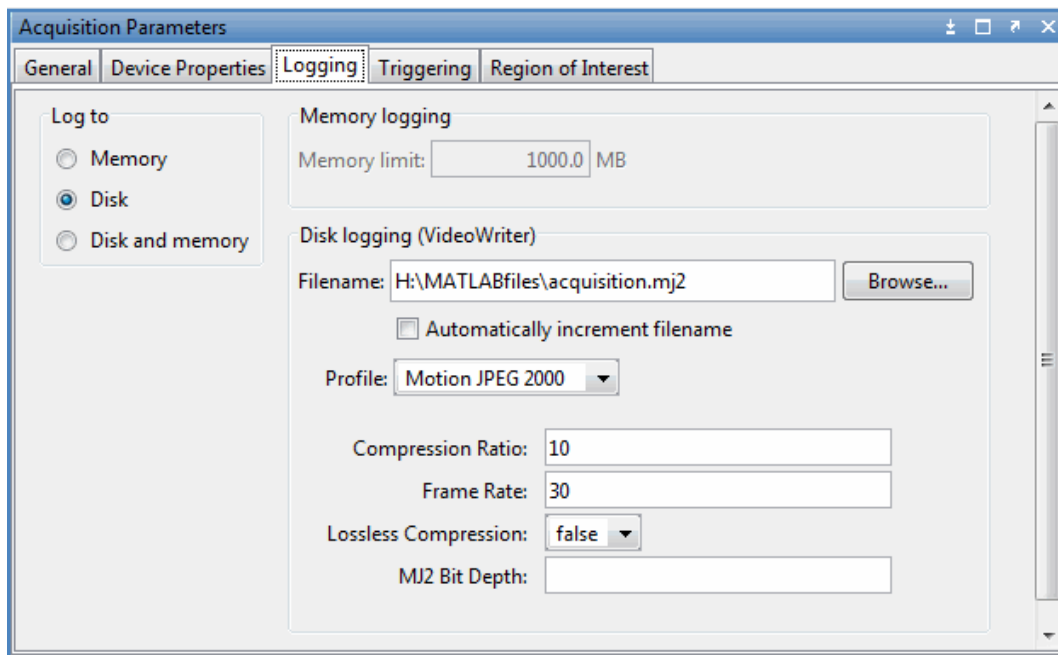
Note About Frame Rate

If `FrameRate` appears in the **Properties** area, that means your device has a `FrameRate` property. The information in the table comes from your device. The value set there will be the frame rate that your device uses, in frames per second.

If `FrameRate` does not appear in the list, your device does not support that property.

Logging Your Data

Set logging options using the **Logging** tab. This determines where your data is logged to when you do an acquisition.



Use the **Log to** options to select where to log your acquisition. Select one of the following:

- **Memory** — Acquisition is logged to memory. This means that the acquired data that you do not otherwise save (using **Export Data**) will be logged to your system's memory, and will be available to you only during the acquisition session. The data will be lost if you do another acquisition, or you close the tool without exporting the data. This is the default setting.
- **Disk** — Acquisition is logged to disk as a VideoWriter file, in the location you specify in the **Disk logging** area. This means that the acquired data will be logged to disk and will be available to you there after the acquisition session. After selecting **Disk**, the **Disk logging** area becomes editable and you can enter or browse to the location and name the file.

- **Disk and memory** — Acquisition will be logged to both disk, in the location you specify in the **Disk logging** area, and memory.

Memory Logging

If you select **Memory** or **Disk and memory** in the **Log to** options, the **Memory limit** field displays how much memory is available on your system.

This equals the total number of bytes that image acquisition frames can occupy in memory. By default, the tool sets this limit to equal all available physical memory when you first use the tool, or 1 GB, whichever is less.

Disk Logging

If you select **Disk** or **Disk and memory** in the **Log to** options, the **Disk logging** area becomes editable so you can designate a file and location to save to.

Note Disk logging generates a VideoWriter file. If you select a VideoWriter profile that generates an AVI file, note that AVI files are limited to a bit-depth of 8 bits per pixel for each band. If you have higher bit data, you should not log it to an AVI file because the AVI format is restricted to 8-bit data. If you log higher bit data to an AVI file, it will be scaled and then logged as 8-bit data.

To use disk logging:

- 1 Click the **Browse** button to select a location for the file, or enter the name of the location.
- 2 In the Save dialog box, browse to the location and then enter a name in the **File name** field, and click **Save**.

Uncompressed AVI is the default profile for color devices and **Grayscale AVI** is the default profile for monochrome devices, so the .avi extension is appended to the name on the **Logging** tab initially, and the other fields become editable. You can change the profile in step 4.

- 3 Optionally select **Automatically increment filename** if you want the tool to name subsequent acquisitions using the same root name,

plus an incremented number. For example, if you enter the file name `experiment.avi` and then select this option, it will be replaced by `experiment_0001.avi`, followed by `experiment_0002.avi`, etc.

This option is useful if you need to acquire multiple videos of one or more subjects. For example, a lab technician might want to acquire 10 seconds of video on a group of five different cultures and save them for later analysis. The technician may want resulting file names such as `sample_0001.avi`, `sample_0002.avi`, etc.

4 You can use any of the profiles offered by VideoWriter. Accept the default profile (**Uncompressed AVI** for color devices and **Grayscale AVI** for monochrome devices) or select another. Currently supported profiles are:

- 'Motion JPEG 2000' — Compressed Motion JPEG 2000 file. Can log single-banded (grayscale) data as well as multi-byte data.
- 'Archival' — Motion JPEG 2000 file with lossless compression.
- 'Motion JPEG AVI' — Compressed AVI file using Motion JPEG codec.
- 'Uncompressed AVI' — Uncompressed AVI file with RGB24 video.
- 'MPEG-4' — Compressed MPEG-4 file with H.264 encoding (systems with Windows 7 or Mac OS X 10.7 and later).
- 'Grayscale AVI' — Uncompressed AVI file with grayscale video. Only used for monochrome devices.
- 'Indexed AVI' — Uncompressed AVI file with indexed video. Only used for monochrome devices.

5 Additional logging options appear dynamically after you select a profile.

If you select `Motion JPEG 2000` or `Archival` as your profile, you can set the **Compression Ratio**, **Frame Rate**, **Lossless Compression**, and **MJ2 Bit Depth** options. Accept the default values or change them.

If you select `Motion JPEG AVI` or `MPEG-4` as your profile, you can set the **Frame Rate** and **Quality** options. Accept the default values or change them.

If you select `Uncompressed AVI` or `Grayscale AVI` as your profile, you can set the **Frame Rate** option. Accept the default value or change it.

If you select **Indexed AVI** as your profile, you can set the **Frame Rate** and **Colormap** options. Accept the default value for **Frame Rate** or change it. You must enter a **Colormap** value. See the “VideoWriter Options” section below for more information.

VideoWriter Options

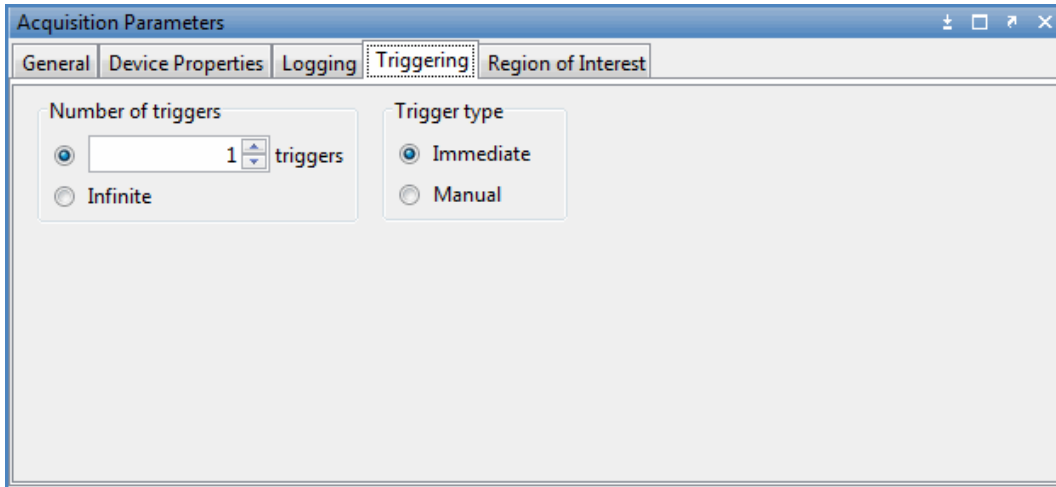
- **Compression Ratio** is a number greater than 1 that specifies the target ratio between the number of bytes in the input image and the number of bytes in the compressed image. The data is compressed as much as possible, up to the specified target. This is only available for objects associated with Motion JPEG 2000 files. The default is 10.
 - **Frame Rate** is the rate of playback for the video in frames per second. The default is 30. If your device has a set frame rate, that will be used instead.
 - **Lossless Compression** is a Boolean value (logical true or false) only available for objects associated with Motion JPEG 2000 files. If you select true, VideoWriter uses reversible mode so that the decompressed data is identical to the input data, and ignores any specified value for **CompressionRatio**. The default is false for the Motion JPEG 2000 profile, and true for the Archival profile.
 - **MJ2 Bit Depth** is the number of least significant bits in the input image data, from 1 to 16. This is only available for objects associated with Motion JPEG 2000 files. If you do not specify a value, VideoWriter sets the bit depth based on the input data type. For example, if the input data is an array of uint8 or int8 values, MJ2BitDepth is 8.
 - **Quality** is a number from 0 to 100. Higher quality numbers result in higher video quality and larger file sizes. Lower quality numbers result in lower video quality and smaller file sizes. Only available for objects associated with the Motion JPEG AVI profile. The default is 75.
 - **Colormap** is a value that specifies the intensity of red, green, and blue for the image. Type in a value, such as `hsv(128)`, or the name of one of the built-in MATLAB colormaps, such as `jet` or `hot`. For a list of the built-in colormaps, see the `colormap` function in the MATLAB documentation.
- 6 After setting your profile and options, start your acquisition to log a VideoWriter file to disk.

Note about bit size of AVI files

AVI files are limited to a bit depth of 8 bits per pixel for each band. If you have higher bit data, you should not log it to a profile that creates an AVI file because the AVI format is restricted to 8-bit data. If you log higher bit data to an AVI file, it will be scaled and then logged as 8-bit data. The **Archival** and **Motion JPEG 2000** profiles do not have this issue.

Setting Up Triggering

Use the **Triggering** tab to set up triggering options.



The total number of frames that will be acquired when you start an acquisition depends on what is set in the **Frames Per Trigger** field on the **General** tab and the **Number of Triggers** field on the **Triggering** tab. For example, if you set **Frames Per Trigger** to 4 and **Number of Triggers** to 2, the total number of frames in the acquisition will be 8.

Selecting the Number of Triggers

If you want to do an acquisition that is comprised of a finite number of frames, set the **Number of Triggers** to any number, or use the default of 1 trigger.

If you want to control the start and stop of the acquisition, regardless of the number of frames acquired, select *infinite*. With an infinite number of triggers, you stop the acquisition manually by clicking the **Stop Acquisition** button in the **Preview window**.

Selecting the Trigger Type

The default of *Immediate* means that when you start an acquisition using the **Start Acquisition** button, the acquisition begins immediately.

If you change the setting to **Manual**, the **Trigger** button is activated in the **Preview window**, and you use it to start the acquisition.

To perform manual triggering:

- 1 Select your device format and optionally click **Start Preview** to preview the device.
- 2 Optionally set any acquisition parameters and stop the preview.
- 3 Select **Manual** in the **Trigger Type** field on the **Triggering** tab.
- 4 Click the **Start Acquisition** button to get live feed from the device.

The **Trigger** button is activated in the **Preview window** once the acquisition starts.

- 5 Click the **Trigger** button when you want to start logging data.

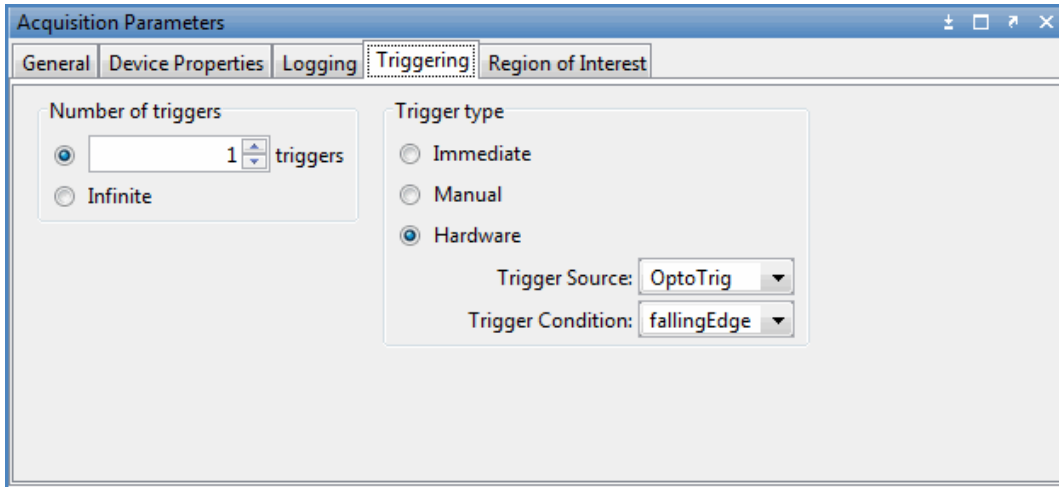
If you have a defined number of triggers (not infinite), then the acquisition will stop when you have acquired that number of frames, based on the **Frames Per Trigger** field on the **General** tab.

If **Number of Triggers** is set to infinite, use the **Stop Acquisition** button to stop the acquisition.

If your device supports hardware triggering, that option will also appear in the **Trigger Type** field.

To perform hardware triggering:

- 1 Select your device format and optionally click **Start Preview** to preview the device.
- 2 Optionally set any acquisition parameters and stop the preview.
- 3 Select **Hardware** in the **Trigger Type** field on the **Triggering** tab.



- 4 Select your **Trigger Source**. This indicates the hardware source that is monitored for trigger conditions. When the condition specified in **Trigger Condition** is met, the trigger is executed and the acquisition starts. **Trigger Source** is device-specific. The drop-down list will show the mechanisms your particular device uses to generate triggers. For example, it might be something like Port0 and Port1, or OptoTrig and TTL.
- 5 Select your **Trigger Condition**. This specifies the condition that must be met, via the **Trigger Source**, before a trigger event occurs. **Trigger Condition** is device-specific. The drop-down list will show the conditions your particular device uses to generate triggers. For example, it might be something like risingEdge and fallingEdge.
- 6 Click the **Start Acquisition** button to get live feed from the device.
- 7 When the **Trigger Condition** is met, the acquisition begins.

If you have a defined number of triggers (not infinite), then the acquisition will stop when you have acquired that number of frames, based on the **Frames Per Trigger** field on the **General** tab.

If **Number of Triggers** is set to infinite, use the **Stop Acquisition** button to stop the acquisition.

Setting a Region of Interest

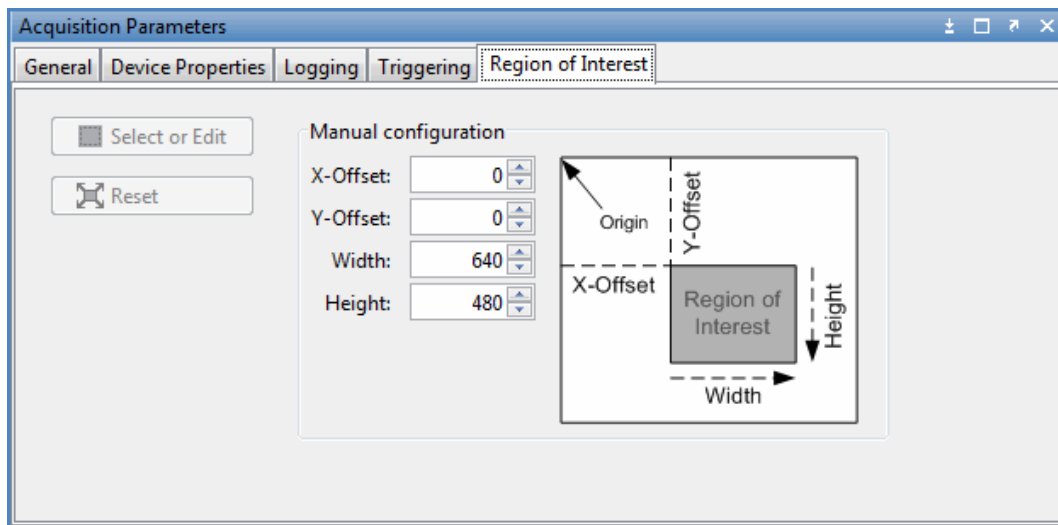
By default your acquisition will consist of the entire frame that the device acquires, which is equal to the selected format's resolution. If you want to acquire a portion of the frame, use the **Region of Interest** tab to set the desired region. The ROI window defines the actual size of the frame logged by the tool, measured with respect to the top-left corner of an image frame.

You can set a Region of Interest (ROI) manually by using the **Manual Configuration** settings on the **Region of Interest** tab, or interactively in the **Preview Window**.

Setting Region of Interest Manually

To set up an ROI manually using the **Manual Configuration** field on the **Region of Interest** tab:

- 1 Start your preview by clicking the **Start Preview** button in the **Preview Window**.
- 2 Adjust one or more of the **X-Offset**, **Y-Offset**, **Width**, or **Height** settings until you reach the desired region.



Use the arrows in each field to adjust the numbers. The preview resizes as you make changes.

- 3** When the region is the desired size, start your acquisition by clicking the **Start Acquisition** button.

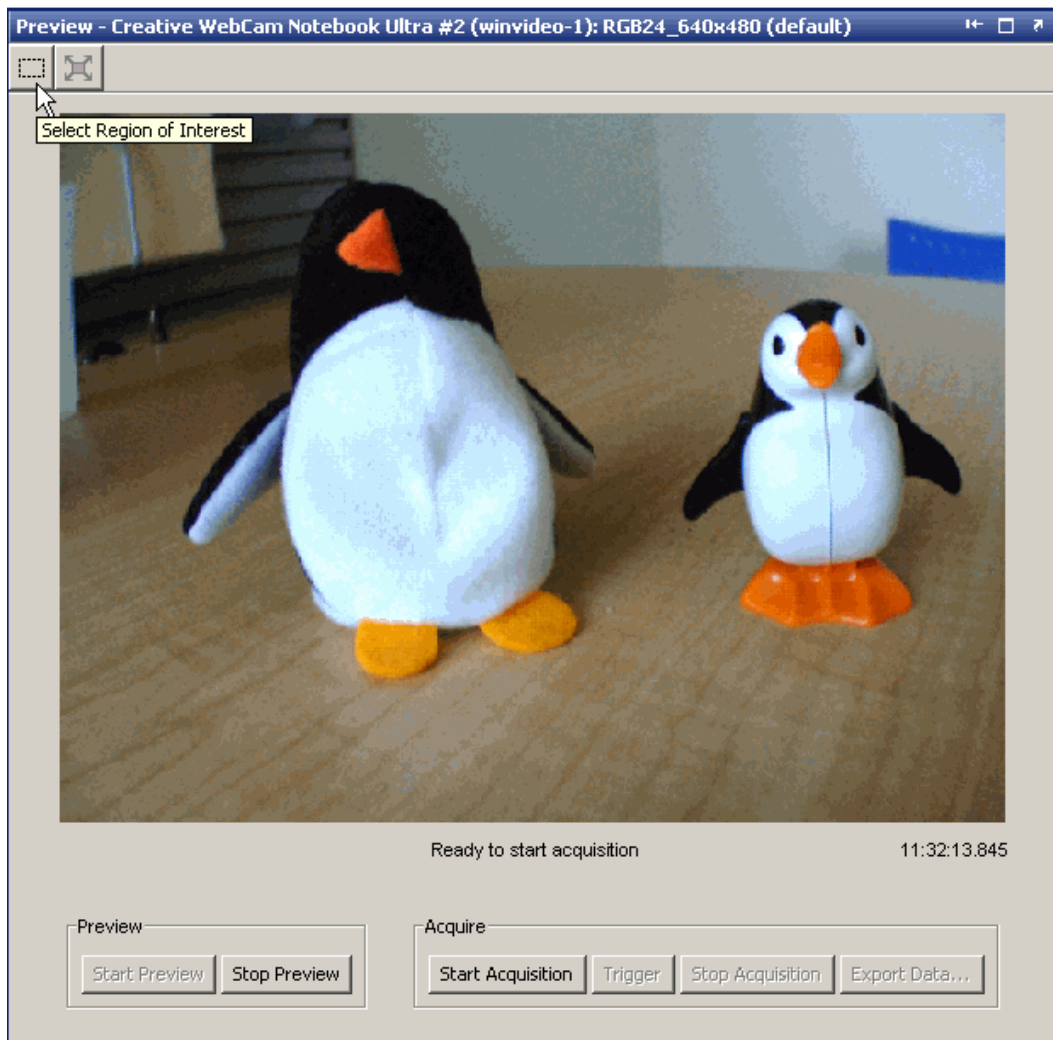
Note: You cannot adjust the ROI after starting the acquisition.

Setting Region of Interest Interactively

You can also set a region of interest interactively while previewing your image.

To set a region of interest interactively:

- 1** Start your preview by clicking the **Start Preview** button in the **Preview Window**.
- 2** Click the **Select Region of Interest** button in the top-left corner of the **Preview Window** to activate the interactive ROI feature.

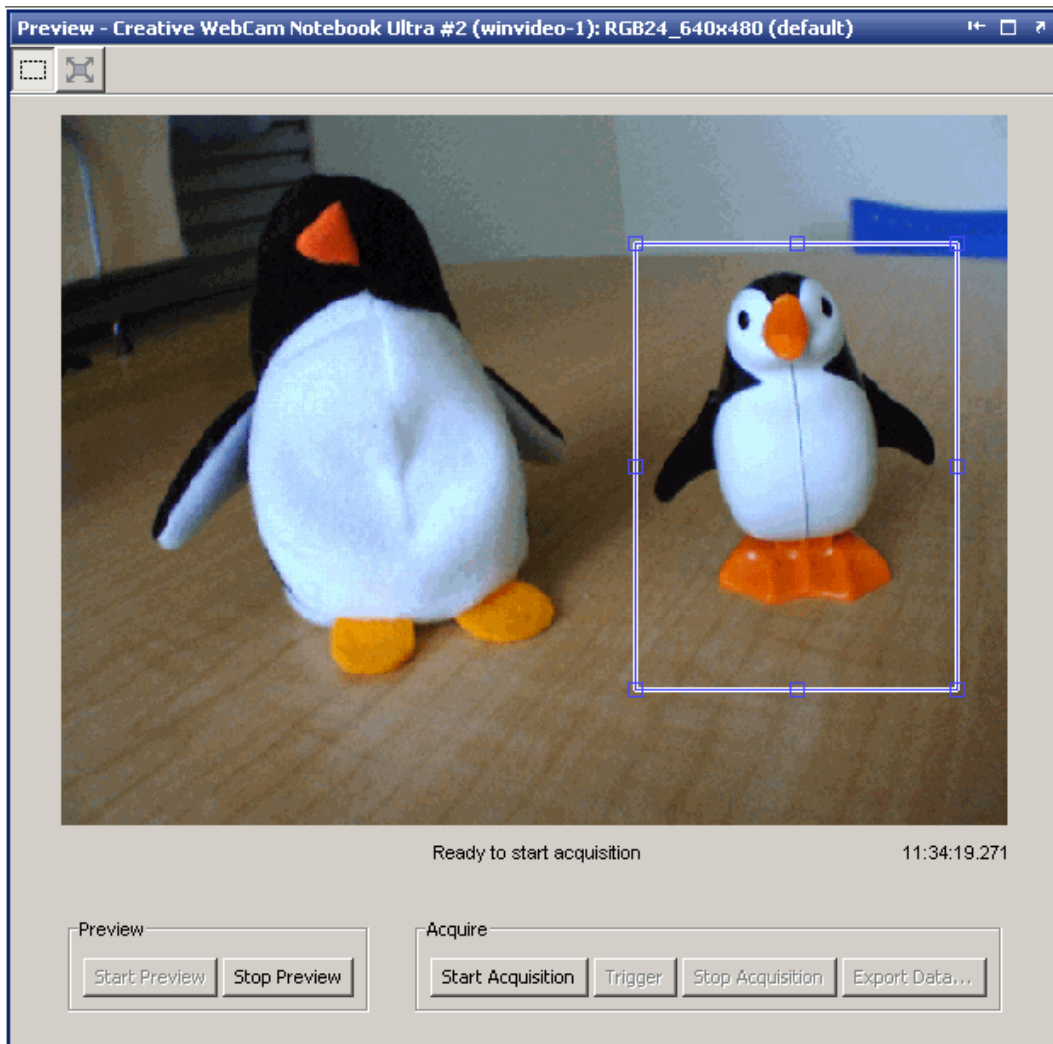


Your cursor becomes a selection tool.

Note that the **Select Region of Interest** button is enabled only during preview mode.

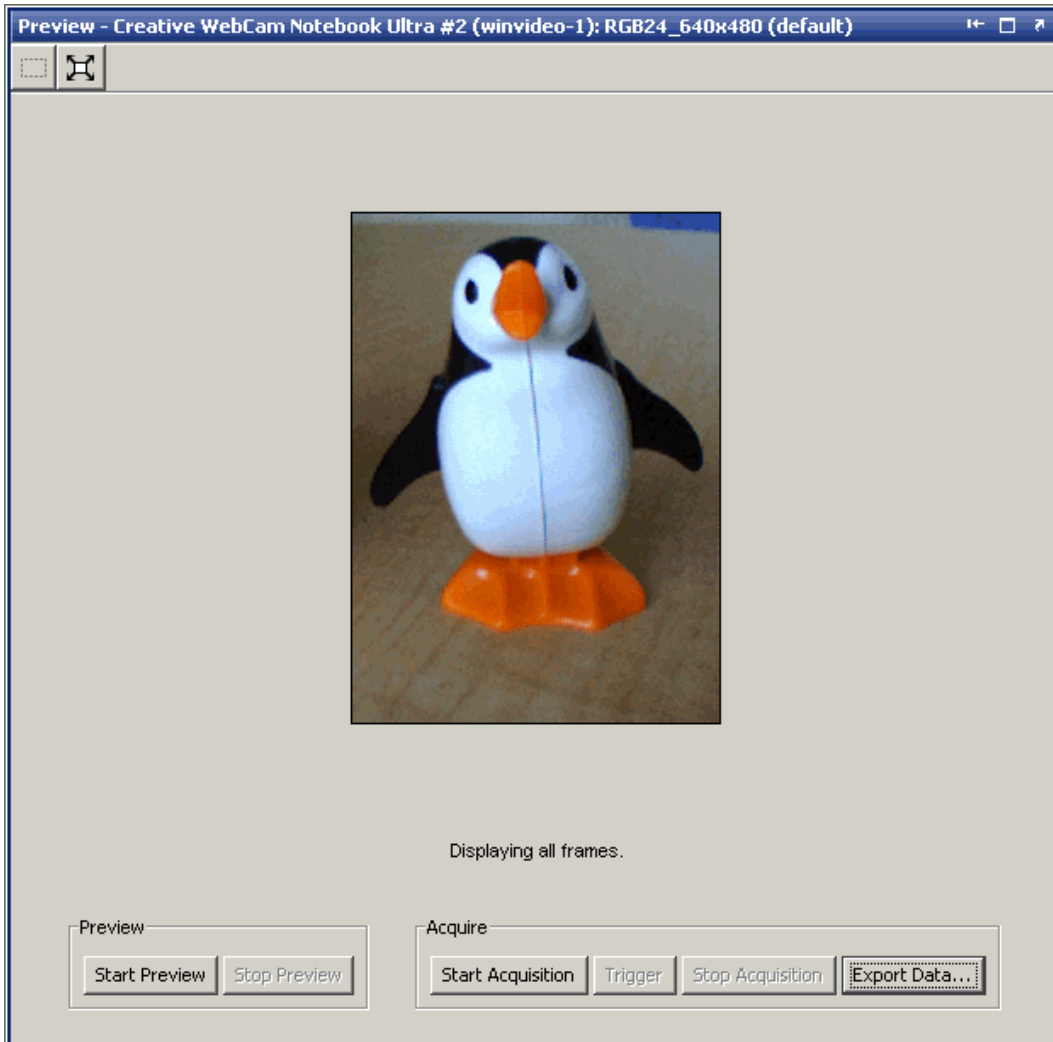
- 3** Position the cursor at one of the edges of the region you want to capture and click the left mouse button. Hold the button while dragging the selection tool over the image to outline the region you want to capture.
- 4** Release the mouse button to freeze the region.

The region is not set until you take action to commit it.



- 5 If the selected area is the region you want to use, start your acquisition by clicking the **Start Acquisition** button.

In this case, the region appears as follows.



Before starting the acquisition, if you want to adjust the region further, you can drag the selected region around while still in selection mode. You can also drag any of the handles on the region outline to change the dimensions of the region. You can then commit the region by pressing **Enter** or using the right-click menu **Commit Region of Interest** inside the region. You

can also commit a region by pressing the space bar or double-clicking inside the selection, or starting the acquisition.

You can clear the drawn region before you commit it by single-clicking anywhere in the **Preview Window** outside of the selected area. You will still be in ROI selection mode. If you want to clear the selected region and exit ROI selection mode, press the **Delete** key, press the **Escape** key, or use the right-click menu **Exit Region of Interest Mode** inside the region.

Note: If you start another acquisition with the same device, the ROI that you set will remain the default that is used in subsequent acquisitions. To reset to the original image size, click the **Reset Region of Interest to Maximum** button in the **Preview Window** or the **Reset** button on the **Region of Interest** tab.

Restoring Default Parameters

Once you have changed parameters of a device, you can restore the device's default parameters by selecting the device format in the **Hardware Browser** and right-clicking **Clear Selected Hardware Configuration**. That clears any changes you have made and resets the default parameters of that device format.

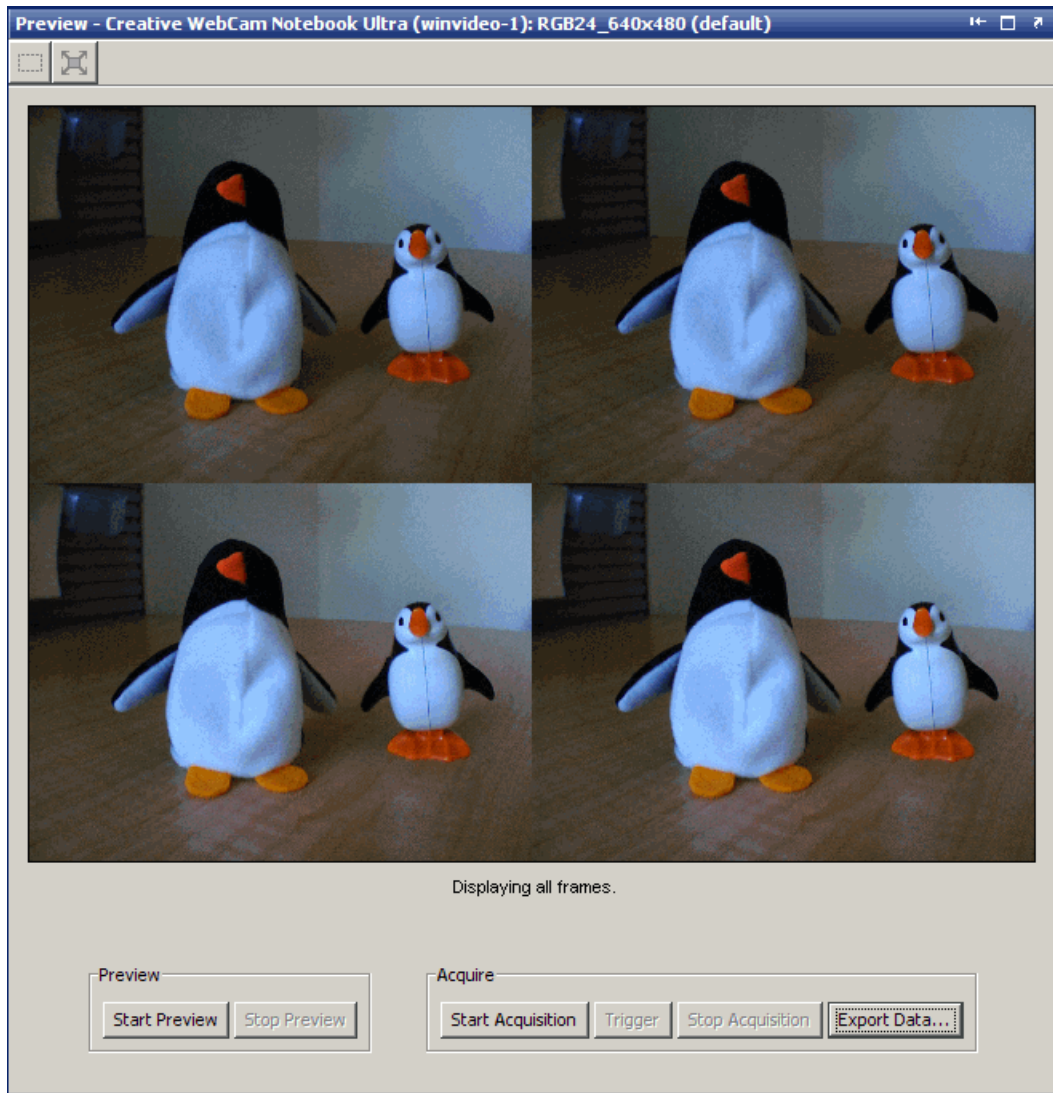
If you want to save a configuration before clearing it, first select **Export Selected Hardware Configuration** from the right-click menu.

Previewing and Acquiring Data in Image Acquisition Tool

In this section...
“The Preview Window” on page 3-31
“Previewing Data” on page 3-33
“Acquiring Data” on page 3-34

The Preview Window

The **Preview window** displays the image data when you preview or acquire data.



Use the buttons in the **Preview window** to:

- Preview your image. See “Previewing Data” on page 3-33 for more information.

- Acquire data. See “Acquiring Data” on page 3-34 for more information.
- Export data. See “Exporting Data in the Image Acquisition Tool” on page 3-38 for more information.
- Set Region of Interest. See “Setting a Region of Interest” on page 3-24 for more information.

Below the area that displays the frames you will see text messages with information relative to the current state of the window. For example in the figure above, that text indicates that all the frames that were acquired are being displayed. After you start and stop a preview, the text will indicate that the tool is ready to acquire data.

During an acquisition, a running timer appears under the display area that indicates the actual time of the frame acquisition.

Note The Image Acquisition Toolbox Preview window and the Preview window that is built into the Image Acquisition Tool now support the display of up to 16-bit image data. The Preview window was designed to only show 8-bit data, but many cameras return 10-, 12-, 14-, or 16-bit data. The Preview window display now supports these higher bit-depth cameras.

Previewing Data

To preview data:

- 1** Select the device and format in the **Hardware Browser**.
- 2** Click the **Start Preview** button to test your device.
- 3** If necessary, adjust the device to achieve the desired image.
- 4** Set the **Frames Per Trigger** on the **General** tab and the **Number of Triggers** on the **Triggering** tab, to set the total number of frames for the acquisition.
- 5** Set any other acquisition parameters to adjust the quality of the image or other acquisition factors.

You are now ready to start the acquisition.

Acquiring Data

To acquire data:

- 1 Select the device and format in the **Hardware Browser**. The **Hardware Browser** shows the image acquisition devices currently connected to your system. If the device you want to use is not connected to your system, plug it in and then select **Tools > Refresh Image Acquisition Hardware** to display the new device in the **Hardware Browser**.

The nodes listed under the device name are the formats the device supports. They may correspond to the different resolutions and color spaces that your device supports, or to different video standards or camera configurations. This information comes from your device adaptor. Select the format you want to use.

See “Selecting Your Device in Image Acquisition Tool” on page 3-8 for more information about devices and formats.

- 2 Use the Preview feature to test and set up your device by clicking the **Start Preview** button. If necessary, physically adjust the device to achieve the desired image area, or use the **Region of Interest** tab of the **Acquisition Parameters** pane to constrain the image.

See “Previewing Data” on page 3-33 for more information on previewing.

- 3 Set the **Frames Per Trigger** on the **General** tab and the **Number of Triggers** on the **Triggering** tab, to set the total number of frames for the acquisition, if you did not do so while previewing.

For example, if you set **Frames Per Trigger** to 4 and **Number of Triggers** to 2, the total number of frames acquired will be 8.

If you just want a snapshot of one frame, leave the default settings of 1 in both fields. If you want a specific number of frames, use the fields to set it.

Alternatively, you can set the tool to acquire continuously and use the buttons in the **Preview window** to manually start and stop the acquisition.

- 4 Set any necessary acquisition parameters if you did not do so while previewing. See “Setting Acquisition Parameters in Image Acquisition Tool” on page 3-11 for more information.
- 5 Choose your log mode, which determines where the acquisition data is stored.

On the **Logging** tab, use the **Log To** field to choose to log to memory, disk, or both. Disk logging results in a saved VideoWriter file. If you choose memory logging, you can export your data after the acquisition using the **Export Data** button on the **Preview window**.

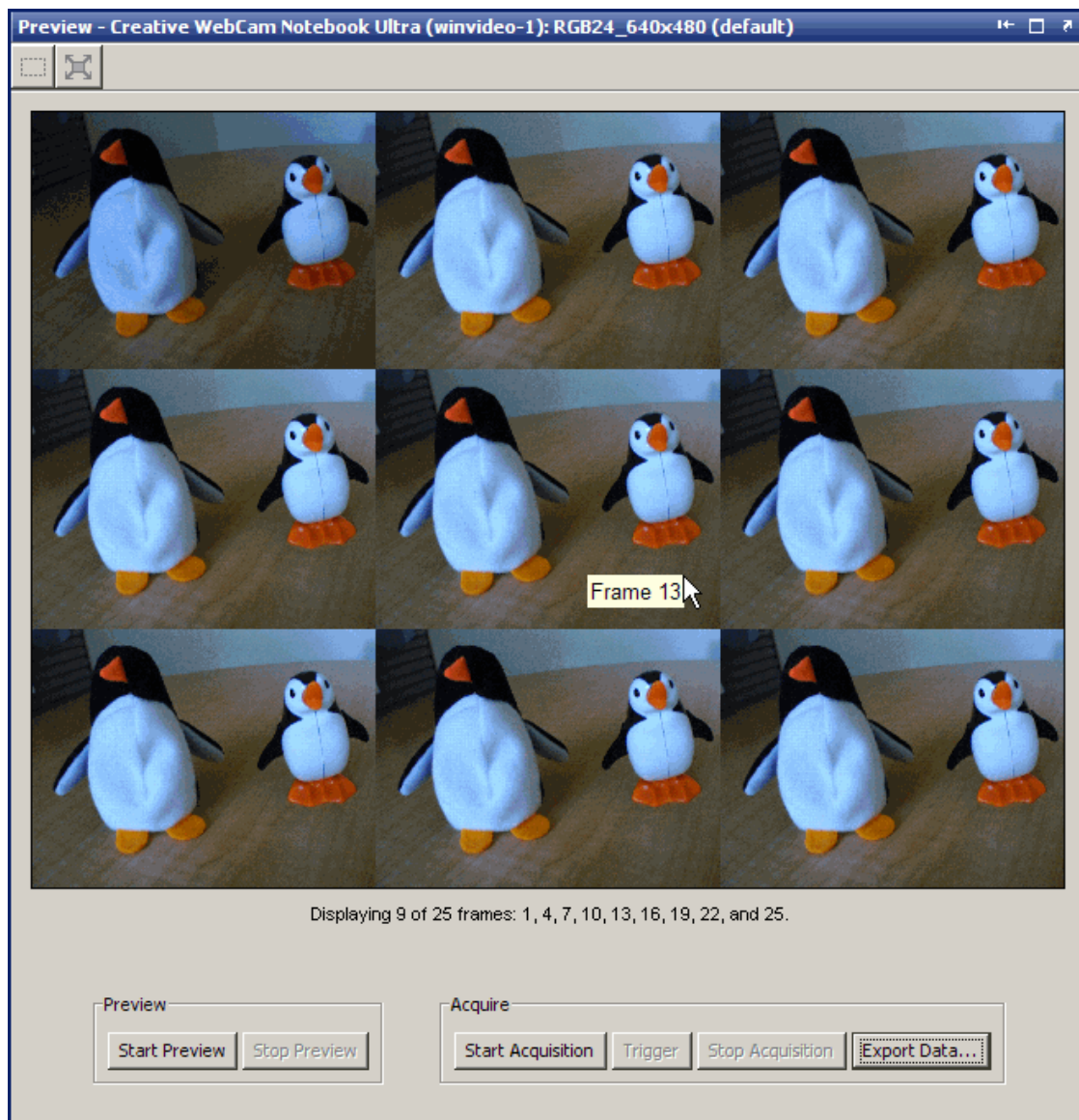
For more information about logging, see “Logging Your Data” on page 3-16.

- 6 Start the acquisition by clicking the **Start Acquisition** button.
 - If you set **Trigger Type** (on the **Triggering** tab) to **Immediate**, the tool will immediately start logging data.
 - If you set **Trigger Type** to **Manual**, click the **Trigger** button when you want to start logging data. For more information about manual triggering, see “Setting Up Triggering” on page 3-21.
- 7 Stop the acquisition:
 - If you set **Frames Per Trigger** (on the **General** tab) to 1 or any other number, your acquisition will stop when that number of frames is reached.
 - If you set **Frames Per Trigger** to **infinite**, click the **Stop Acquisition** button to stop the acquisition.

Note that you can also click **Stop Acquisition** to abort an acquisition if the number of frames was specified.

When the acquisition stops, if you logged to memory or disk and memory, the **Preview window** will display all or some of the frames of the acquisition. The window can show up to nine frames. If you acquire more than nine frames, it will display frames at an even interval based on the total number of frames. The montage of nine frames are indexed linearly from the acquired images. The text under the images will list which frames are shown. You can also hover your cursor over each frame to see which frame number it is, as shown in the following figure.

3 Using the Image Acquisition Tool GUI



If Images Are Blurry or Dark

If the first one or more frames of your acquisition are blurry, black, or of low quality, your camera may need to warm up before you capture frames.

You can allow for device warm-up by using manual triggering. This allows you to start the acquisition after the device has warmed up and is acquiring image data that meets your needs.

To use manual triggering, go to the **Triggering** tab of the **Acquisition Parameters** pane and select **Manual** in the **Trigger Type** field.

For more detailed instructions about manual triggering, see “Selecting the Trigger Type” on page 3-21.

For more information about troubleshooting specific devices, see “Troubleshooting Overview” on page 13-3 in the Troubleshooting chapter.

Exporting Data in the Image Acquisition Tool

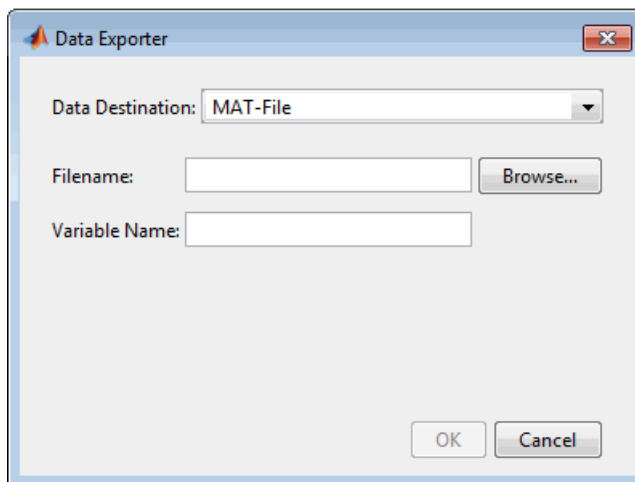
You can export the data that has been acquired in memory to a MAT-file, the MATLAB Workspace, VideoWriter, or other options.

To export the acquisition data:

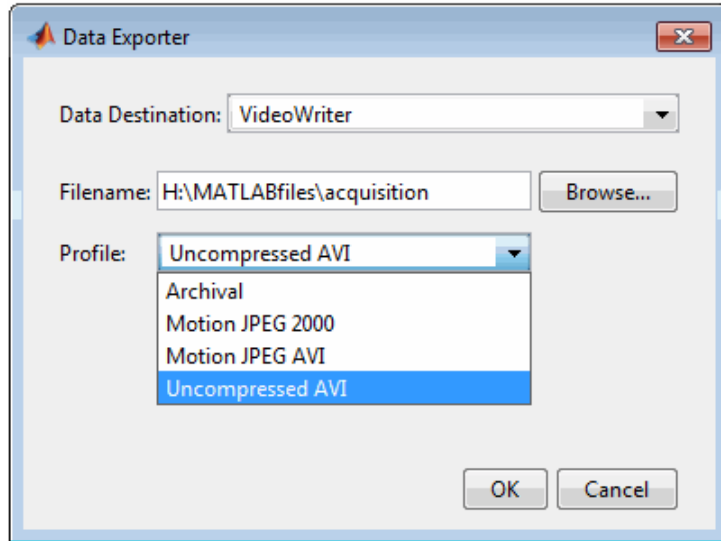
- 1 Click the **Export Data** button in the **Preview window** to export the last acquisition that was logged to memory.
- 2 In the Data Exporter dialog box, select MAT-File, MATLAB Workspace, or one of the other options in the **Data Destination** field. You can choose Image Tool or Image File for single-frame acquisitions.

These two options are provided by the Image Processing Toolbox software. The Movie Player tool is also provided by the Image Processing Toolbox software and is only available for multiple-frame acquisitions. VideoWriter is part of core MATLAB and is recommended.

- 3 If you selected MAT-File or MATLAB Workspace, then enter a name for the new variable in the **Variable Name** field, and click **OK**.



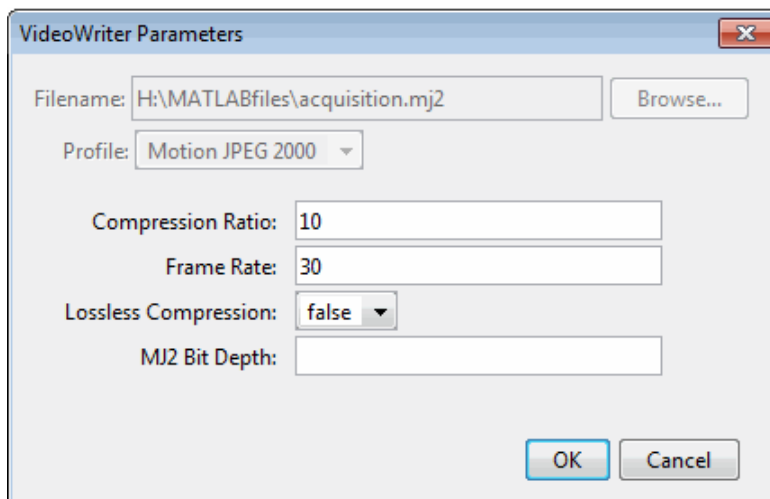
- 4 If you selected VideoWriter, you need to select a profile from the **Profile** list. For information on the profiles, see “Disk Logging” on page 3-17.



The VideoWriter Parameters dialog box opens after you select a file name and profile and click **OK**. If you selected **Motion JPEG 2000** or **Archival** as your profile, you can set the **Compression Ratio**, **Frame Rate**, **Lossless Compression**, and **MJ2 Bit Depth** options. Accept the default values or change them.

If you selected **Motion JPEG AVI** as your profile, you can set the **Frame Rate** and **Quality** options. Accept the default values or change them.

If you selected **Uncompressed AVI** as your profile, you can set the **Frame Rate** option. Accept the default value or change it.



VideoWriter Options

- **Compression Ratio** is a number greater than 1 that specifies the target ratio between the number of bytes in the input image and the number of bytes in the compressed image. The data is compressed as much as possible, up to the specified target. This is only available for objects associated with Motion JPEG 2000 files. The default is 10.
- **Frame Rate** is the rate of playback for the video in frames per second. The default is 30.
- **Lossless Compression** is a Boolean value (logical true or false) only available for objects associated with Motion JPEG 2000 files. If you select true, VideoWriter uses reversible mode so that the decompressed data is identical to the input data, and ignores any specified value for **CompressionRatio**. The default is false for the Motion JPEG 2000 profile, and true for the Archival profile.
- **MJ2 Bit Depth** is the number of least significant bits in the input image data, from 1 to 16. This is only available for objects associated with Motion JPEG 2000 files. If you do not specify a value, VideoWriter sets the bit depth based on the input data type. For example, if the input data is an array of uint8 or int8 values, MJ2BitDepth is 8.
- **Quality** is a number from 0 to 100. Higher quality numbers result in higher video quality and larger file sizes. Lower quality numbers result

in lower video quality and smaller file sizes. Only available for objects associated with the Motion JPEG AVI profile. The default is 75.

- 5** If you exported to the MATLAB Workspace, the dialog box closes and the data is saved to the Workspace.

If you exported to a MAT-File, the dialog box closes and the file is saved to the location you specified in the Data Exporter dialog box.

If you exported to Image Tool, Image File, or Movie Player, the file immediately opens in that tool.

If you exported to VideoWriter, the file is created and saved in the location you specified in the Data Exporter dialog box.

Saving Image Acquisition Tool Configurations

You can save the configuration information about any of your device formats. This includes any parameters you set on any of the tabs in the **Acquisition Parameters** pane. Then when you return to the tool, you can load the configuration so that you do not have to reset those parameters.

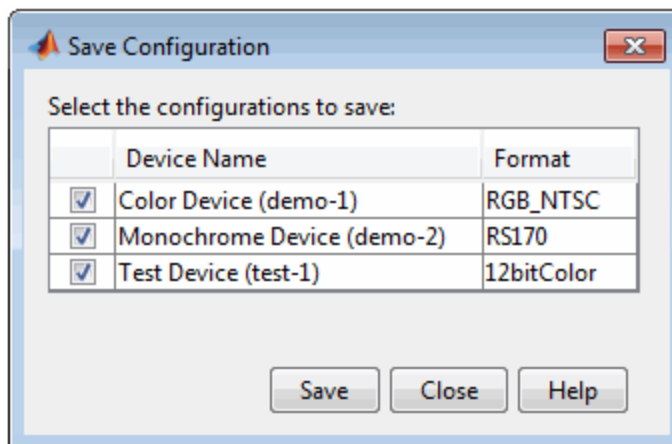
To save a configuration:

- 1 Select **File > Save Configuration**.

The Save Configuration dialog box opens.

- 2 Decide what configuration(s) to save.

The Save Configuration dialog box lists the currently selected device format, as well as any others you selected in the **Hardware Browser** during the tool session. All formats are selected by default, meaning their configurations will be saved. If you do not want to save a configuration, clear it from the list.



- 3 Click **Save**.

The Save File dialog box opens.

- 4 Enter a file name and click **Save**.

The configuration is saved to an Image Acquisition Tool (IAT) file in the location you specified.

You can then open the saved configuration file in a future tool session by selecting **File > Open Configuration**. In the Open Configuration dialog box, browse to an IAT file and click **Open**.

Note You can also export hardware configuration information to other formats such as a MATLAB code file or a MAT-file that can be accessed from MATLAB. See “Exporting Image Acquisition Tool Hardware Configurations to MATLAB” on page 3-44.

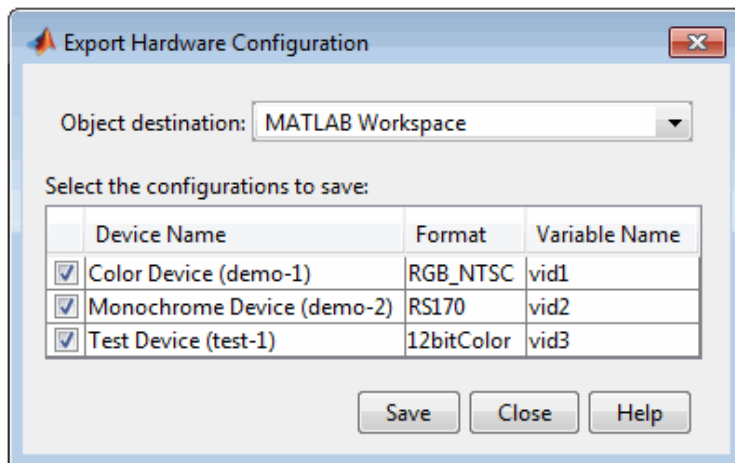
Exporting Image Acquisition Tool Hardware Configurations to MATLAB

You can export the video input objects and their configured parameters from the tool to a choice of multiple formats. You can then access the video object in MATLAB.

To export a hardware configuration:

- 1 Select **File > Export Hardware Configuration**.

The Export Hardware Configuration dialog box opens.



- 2 Select the file format from the **Object destination** list.
 - MATLAB Workspace saves the video input object to the MATLAB Workspace for the duration of the MATLAB session. (You can then save it before exiting MATLAB if you want to retain it.)
 - MATLAB Code File is the same as the **File > Generate MATLAB Code File** command. It generates an MATLAB code file containing the video input object and its configured parameters. You could then incorporate the MATLAB code file into other MATLAB code or projects.
 - MAT-File saves the video input object and its parameters to a MAT-file.

3 Decide what object configuration(s) to export.

The Object Exporter dialog box lists the currently selected device format, as well as any others you selected in the **Hardware Browser** during the tool session. All formats are selected by default, meaning their configurations will be saved. If you do not want to save a configuration, clear it from the list.

4 Click **Save**.

If you exported to the MATLAB Workspace, the dialog box closes and the data is saved to the MATLAB Workspace.

5 If you export to a MAT-file or MATLAB code file, an Export dialog box opens. Select the save location and type a file name, and then click **Save**.

Note You can also save configuration information to an Image Acquisition Tool (IAT) file that can then be loaded in the tool in a future session. See “Saving Image Acquisition Tool Configurations” on page 3-42.

Saving and Copying Image Acquisition Tool Session Log

In this section...
“About the Session Log” on page 3-46
“Saving the Session Log” on page 3-46
“Copying the Session Log” on page 3-47

About the Session Log

The session log dynamically records every action you perform in the Image Acquisition Tool. The corresponding command-line functionality for actions on a videoinput object or videosource object is reflected in the log. The title displays the name of the device, as shown in the **Hardware Browser**.

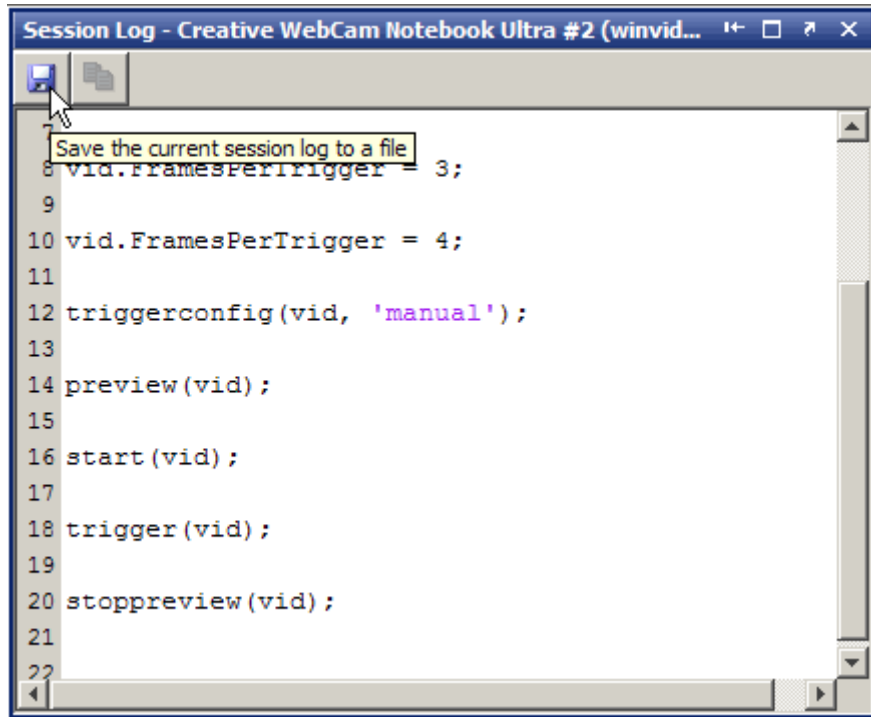
You cannot directly edit in the **Session Log** pane. You can save the contents to a MATLAB code file or copy it to another destination, and then edit the contents.

Each device format has its own session log, independent of any other formats. If you switch to a different device or format, the contents of the session log will reflect the currently selected device. If you switch back to a previous node in the **Hardware Browser**, the session log for that device will remain in the same state it was in before you switched nodes.

Saving the Session Log

To save the contents to a MATLAB code file:

- 1 Click the **Save the current session log to a file** button in the Session Log toolbar. You can also right-click in the log pane and select **Save**.



- 2 In the Save Session Log dialog box, browse to the location where you want to save the file.
- 3 Use the default name, `imaqtoolSessionLog.m`, or rename it.
- 4 When you click the **Save** button, the file will open in the MATLAB Editor. You can then either edit it or close it.

Note that the entire contents of the session log is saved. If you just want to save a portion of the log, use the **Copy** command instead.

Copying the Session Log

To copy all or part of the contents to the clipboard:

- 1 Select the portion of the log that you want to copy.

The **Copy** command is then enabled.

- 2** Click the **Copy** button in the **Session Log** toolbar. You can also right-click in the log pane and select **Copy**.

This copies the selected contents to the system clipboard.

- 3** Go to the application or file that you wish to copy it into, and right-click **Paste**.

You can then edit or save it as your application allows.

Registering a Third-Party Adaptor in the Image Acquisition Tool

If you are using a third-party adaptor that requires the use of the `imaqregister` function, you can use this menu as an easier way to add the adaptor. Note that this function is not documented in the Image Acquisition Toolbox User's Guide, but is documented in the Image Acquisition Toolbox Adaptor Kit User's Guide.

To register an adaptor:

- 1** Click **Tools > Register a Third-Party Adaptor** on the Image Acquisition Tool menu.
- 2** In the Register a 3rd Party Adaptor dialog box, browse to the `.dll` file that represents your adaptor.
- 3** Select the file and click **OK** to register the adaptor.

Connecting to Hardware

To connect to an image acquisition device from within MATLAB, you must create a video input object. This object represents the connection between MATLAB and the device. You can use object properties to control various aspects of the acquisition. Before you can create the object, you need several pieces of information about the device that you want to connect to.

- “Getting Hardware Information” on page 4-2
- “Creating Image Acquisition Objects” on page 4-9
- “Configuring Image Acquisition Object Properties” on page 4-17
- “Starting and Stopping a Video Input Object” on page 4-24
- “Deleting Image Acquisition Objects” on page 4-28
- “Saving Image Acquisition Objects” on page 4-30
- “Image Acquisition Toolbox Properties” on page 4-31

Getting Hardware Information

In this section...
“Getting Hardware Information” on page 4-2
“Determining the Device Adaptor Name” on page 4-3
“Determining the Device ID” on page 4-3
“Determining Supported Video Formats” on page 4-6

Getting Hardware Information

To connect to an image acquisition device from within MATLAB, you must create a video input object. This object represents the connection between MATLAB and the device. You can use object properties to control various aspects of the acquisition. Before you can create the object, you need several pieces of information about the device that you want to connect to.

To access an image acquisition device, the toolbox needs several pieces of information:

- The name of the adaptor the toolbox uses to connect to the image acquisition device
- The device ID of the device you want to access
- The video format of the video stream or, optionally, a device configuration file (camera file)

You use the `imaqhwinfo` function to retrieve this information, as described in the following subsections.

Note When using `imaqhwinfo` to get information about a device, especially devices that use a Video for Windows (VFW) driver, you might encounter dialog boxes reporting an assertion error. Make sure that the software drivers are installed correctly and that the acquisition device is connected to the computer.

Determining the Device Adaptor Name

An adaptor is the software the toolbox uses to communicate with an image acquisition device via its device driver. The toolbox includes adaptors for some vendors of image acquisition equipment and for particular classes of image acquisition devices. For the latest information about supported hardware, visit the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

To determine which adaptors are available on your system, call the `imaqhwinfo` function. The `imaqhwinfo` function returns information about the toolbox software and lists the adaptors available on the system in the `InstalledAdaptors` field. In this example, there are two adaptors available on the system.

```
imaqhwinfo
ans =

    InstalledAdaptors: {'matrox'  'winvideo'}
    MATLABVersion:   '7.4 (R2007a)'
    ToolboxName:     'Image Acquisition Toolbox'
    ToolboxVersion:  '2.1 (R2007a)'
```

Note While every adaptor supported by the Image Acquisition Toolbox software is installed with the toolbox, `imaqhwinfo` lists only adaptors in the `InstalledAdaptors` field that are loadable. That is, the device drivers required by the vendor are installed on the system. Note, however, that inclusion in the `InstalledAdaptors` field does not necessarily mean that an adaptor is connected to a device.

Determining the Device ID

The adaptor assigns a unique number to each device with which it can communicate. The adaptor assigns the first device it detects the device ID 1, the second it detects the device ID 2, and so on.

To find the device ID of a particular image acquisition device, call the `imaqhwinfo` function, specifying the name of the adaptor as the only argument. When called with this syntax, `imaqhwinfo` returns a structure

containing information about all the devices available through the specified adaptor.

In this example, the `imaqhwinfo` function returns information about all the devices available through the Matrox[®] adaptor.

```
info = imaqhwinfo('matrox');  
info =  
  
    AdaptorDllName: [1x73 char]  
    AdaptorDllVersion: '2.1 (R2007a)'  
    AdaptorName: 'matrox'  
    DeviceIDs: {[1]}  
    DeviceInfo: [1x1 struct]
```

The fields in the structure returned by `imaqhwinfo` provide the following information.

Field	Description
AdaptorDllName	Text string that identifies the name of the adaptor dynamic link library (DLL)
AdaptorDllVersion	Information about the version of the adaptor DLL
AdaptorName	Name of the adaptor
DeviceIDs	Cell array containing the device IDs of all the devices accessible through this adaptor
DeviceInfo	Array of device information structures. See “Getting More Information About a Particular Device” on page 4-4 for more information.

Getting More Information About a Particular Device

If an adaptor provides access to multiple devices, you might need to find out more information about the devices before you can select a device ID. The `DeviceInfo` field is an array of device information structures. Each device information structure contains detailed information about a particular device available through the adaptor.

To view the information for a particular device, you can use the device ID as a reference into the `DeviceInfo` structure array. Call `imaqhwinfo` again, this time specifying a device ID as an argument.

```
dev_info = imaqhwinfo('matrox',1)

dev_info =

    DefaultFormat: 'M_RS170'
    DeviceFileSupported: 1
    DeviceName: 'Orion'
    DeviceID: 1
    VideoInputConstructor: 'videoinput('matrox', 1)'
    VideoDeviceConstructor: 'imaq.VideoDevice('matrox', 1)'
    SupportedFormats: {1x10 cell}
```

The fields in the device information structure provide the following information about a device.

Field	Description
DefaultFormat	Text string that identifies the video format used by the device if none is specified at object creation time
DeviceFileSupported	If set to 1, the device supports device configuration files; otherwise 0. See “Using Device Configuration Files (Camera Files)” on page 4-14 for more information.
DeviceName	Descriptive text string, assigned by the adaptor, that identifies the device
DeviceID	ID assigned to the device by the adaptor
VideoInputConstructor	Default syntax you can use to create a video input object to represent this device. See “Creating Image Acquisition Objects” on page 4-9 for more information.

Field	Description
VideoDeviceConstructor	Default syntax you can use to create a VideoDevice System object to represent this device.
SupportedFormats	Cell array of strings that identify the video formats supported by the device. See “Determining Supported Video Formats” on page 4-6 for more information.

Determining Supported Video Formats

The video format specifies the characteristics of the images in the video stream, such as the image resolution (width and height), the industry standard used, and the size of the data type used to store pixel information.

Image acquisition devices typically support multiple video formats. You can specify the video format when you create the video input object to represent the connection to the device. See “Creating Image Acquisition Objects” on page 4-9 for more information.

Note Specifying the video format is optional; the toolbox uses one of the supported formats as the default.

To determine which video formats an image acquisition device supports, look in the SupportedFormats field of the DeviceInfo structure returned by the `imaqhwinfo` function. To view the information for a particular device, call `imaqhwinfo`, specifying the device ID as an argument.

```
dev_info = imaqhwinfo('matrox',1)

dev_info =

    DefaultFormat: 'M_RS170'
    DeviceFileSupported: 1
    DeviceName: 'Orion'
    DeviceID: 1
    VideoInputConstructor: 'videoinput('matrox', 1)'
```

```
VideoDeviceConstructor: 'imaq.VideoDevice('matrox', 1)'  
SupportedFormats: {1x10 cell}
```

The `DefaultFormat` field lists the default format selected by the toolbox. The `SupportedFormats` field is a cell array containing text strings that identify all the supported video formats. The toolbox assigns names to the formats based on vendor-specific terminology. If you want to specify a video format when you create an image acquisition object, you must use one of the text strings in this cell array. See “Creating Image Acquisition Objects” on page 4-9 for more information.

```
celldisp(dev_info.SupportedFormats)
```

```
ans{1} =
```

```
M_RS170
```

```
ans{2} =
```

```
M_RS170_VIA_RGB
```

```
ans{3} =
```

```
M_CCIR
```

```
ans{4} =
```

```
M_CCIR_VIA_RGB
```

```
ans{5} =
```

```
M_NTSC
```

```
ans{6} =
```

```
M_NTSC_RGB
```

```
ans{7} =
```

```
M_NTSC_YC
```

ans{8} =

M_PAL

ans{9} =

M_PAL_RGB

ans{10} =

M_PAL_YC

Creating Image Acquisition Objects

In this section...

- “Types of Objects” on page 4-9
- “Video Input Objects” on page 4-9
- “Video Source Objects” on page 4-9
- “Creating a Video Input Object” on page 4-10
- “Specifying the Video Format” on page 4-12
- “Specifying the Selected Video Source Object” on page 4-15
- “Getting Information About a Video Input Object” on page 4-16

Types of Objects

After you get information about your image acquisition hardware, described in “Getting Hardware Information” on page 4-2, you can establish a connection to the device by creating an image acquisition object. The toolbox uses two types of image acquisition objects:

- Video input object
- Video source object

Video Input Objects

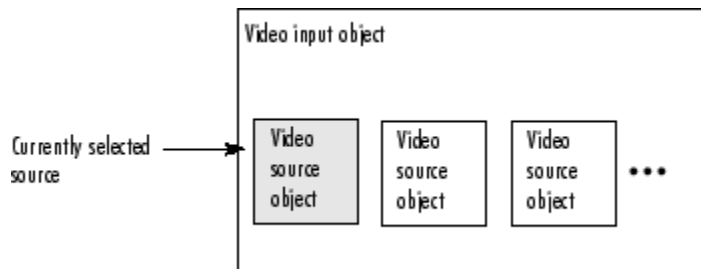
A video input object represents the connection between MATLAB and a video acquisition device at a high level. You must create the video input object using the `videoinput` function. See “Creating a Video Input Object” on page 4-10 for more information.

Video Source Objects

When you create a video input object, the toolbox automatically creates one or more video source objects associated with the video input object. Each video source object represents a collection of one or more physical data sources that are treated as a single entity. The number of video source objects the toolbox creates depends on the device and the video format you specify.

At any one time, only one of the video source objects, called the *selected* source, can be active. This is the source used for acquisition. The toolbox selects one of the video source objects by default, but you can change this selection. See “Specifying the Selected Video Source Object” on page 4-15 for more information.

The following figure illustrates how a video input object acts as a container for one or more video source objects.



Relationship of Video Input Objects and Video Source Objects

For example, a Matrox frame grabber device can support eight physical connections, which Matrox calls channels. These channels can be configured in various ways, depending upon the video format. If you specify a monochrome video format, such as RS170, the toolbox creates eight video source objects, one object for each of the eight channels on the device. If you specify a color video format, such as NTSC RGB, the Matrox device uses three physical channels to represent one RGB connection, where each physical connection provides the red data, green data, and blue data separately. With this format, the toolbox only creates two video source objects for the same device.

Creating a Video Input Object

To create a video input object, call the `videoinput` function specifying the adaptor name, device ID, and video format. You retrieved this information using the `imaqhwinfo` function (described in “Getting Hardware Information” on page 4-2). The only required argument is the adaptor name. The toolbox can use default values for the device ID and video format.

This example creates a video input object to represent the connection to a Matrox image acquisition device. The `imaqhwinfo` function includes the

default `videoinput` syntax in the `VideoInputConstructor` field of the device information structure.

```
vid = videoinput('matrox');
```

This syntax uses the default video format listed in the `DefaultFormat` field of the data returned by `imaqhwinfo`. You can optionally specify the video format. See “Specifying the Video Format” on page 4-12 for more information.

Viewing a Summary of a Video Input Object

To view a summary of the characteristics of the video input object you created, enter the variable name you assigned to the object at the command prompt. For example, this is the summary for the object `vid`.

```
vid
```

```

① Summary of Video Input Object Using 'Orion'.
② Acquisition Source(s): CH0, CH1, CH2, CH3, CH4, CH5, CH6, and
   CH7 are available.
③ Acquisition Parameters: 'CH0' is the current selected source.
   10 frames per trigger using the selected source.
   'M_RS170' video data to be logged upon START.
   Grabbing first of every 1 frame(s).
   Log data to 'memory' on trigger.
④ Trigger Parameters: 1 'immediate' trigger(s) on START.
⑤ Status: Waiting for START.
   0 frames acquired since starting.
   0 frames available for GETDATA.
```

The items in this list correspond to the numbered elements in the object summary:

- 1** The title of the summary includes the name of the image acquisition device this object represents. In the example, this is a Matrox Orion frame grabber.
- 2** The Acquisition Source section lists the name of all the video source objects associated with this video input object. For many objects, this list might only contain one video source object. In the example, the Matrox

device supports eight physical input channels and, with the default video format, the toolbox creates a video source object for each connection. For an example showing the video source objects created with another video format, see “Specifying the Video Format” on page 4-12.

- 3 The Acquisition Parameters section lists the values of key video input object properties. These properties control various aspects of the acquisition, such as the number of frames to acquire and the location where acquired frames are stored. For information about these properties, see “Acquiring Image Data” on page 5-2.
- 4 The Trigger Parameters section lists the trigger type configured for the object and the number of times the trigger is to be executed. Trigger execution initiates data logging, and the toolbox supports several types of triggers. The example object is configured by default with an immediate trigger. For more information about configuring triggers, see “Specifying the Trigger Type” on page 5-9.
- 5 The Status section lists the current state of the object. A video input object can be in one of several states:
 - Running or not running (stopped)
 - Logging or not logging
 - Previewing or not previewing

In the example, the object describes its state as `Waiting for START`. This indicates it is not running. For more information about the running state, see “Starting and Stopping a Video Input Object” on page 4-24. This section also reports how many frames of data have been acquired and how many frames are available in the buffer where the toolbox stores acquired frames. For more information about these parameters, see “Controlling Logging Parameters” on page 5-26.

Specifying the Video Format

You can optionally specify the format of the video stream when you create a video input object as a third argument to the `videoinput` function. This argument can take two forms:

- A text string specifying a video format

- A name of a device configuration file, also known as a camera file

The following sections describe these options. If you do not specify a video format, the `videoinput` function uses one of the video formats supported by the device. For Matrox and Data Translation® devices, it chooses the RS170 video format. For Windows devices, it uses the first RGB format in the list of supported formats or, if no RGB formats are supported, the device's default format.

Using a Video Format String

To specify a video format as a text string, use the `imaqhwinfo` function to determine the list of supported formats. The `imaqhwinfo` function returns this information in the `SupportedFormats` field of the device information structure. See “Determining Supported Video Formats” on page 4-6 for more information.

In this example, each of the text strings is a video format supported by a Matrox device.

```
info = imaqhwinfo('matrox');

info.DeviceInfo.SupportedFormats

ans =
    Columns 1 through 4
        'M_RS170'      'M_RS170_VIA_RGB'  'M_CCIR'      'M_CCIR_VIA_RGB'
    Columns 5 through 8
        'M_NTSC'      'M_NTSC_RGB'      'M_NTSC_YC'   'M_PAL'
    Columns 9 through 10
        'M_PAL_RGB'   'M_PAL_YC'
```

For Matrox devices, the toolbox uses the RS170 format as the default. (To find out which is the default video format, look in the `DefaultFormat` field of the device information structure returned by the `imaqhwinfo` function.)

Note For Matrox devices, the `M_NTSC_RGB` format string represents a component video format.

This example creates a video input object, specifying a color video format.

```
vid2 = videoinput('matrox', 1, 'M_NTSC_RGB');
```

Using Device Configuration Files (Camera Files)

For some devices, you can use a device configuration file, also known as a camera file, to specify the video format as well as other configuration settings. Image acquisition device vendors supply these device configuration files.

Note The toolbox ignores hardware trigger configurations included in a device configuration file. To configure a hardware trigger, you must use the toolbox `triggerconfig` function. See “Using a Hardware Trigger” on page 5-15 for more information.

For example, with Matrox frame grabbers, you can download digitizer configuration format (DCF) files, in their terminology. These files configure their devices to support particular cameras.

Some image acquisition device vendors provide utility programs you can use to create a device configuration file or edit an existing one. See your hardware vendor’s documentation for more information.

To determine if your image acquisition device supports device configuration files, check the value of the `DeviceFileSupported` field of the device information structure returned by `imaqhwinfo`. See “Getting More Information About a Particular Device” on page 4-4 for more information.

When you use a device configuration file, the value of the `VideoFormat` property of the video input object is the name of the file, not a video format string.

This example creates a video input object specifying a Matrox device configuration file as an argument.

```
vid = videoinput('matrox',1,'pulnix.dcf')
```

Summary of Video Input Object Using 'Orion'.

Acquisition Source(s): CH0 and CH1 are available.

Acquisition Parameters: 'CH0' is the current selected source.
 10 frames per trigger using the selected source.
 'C:\pulnix.dcf' video data to be logged upon START.
 Grabbing first of every 1 frame(s).
 Log data to 'memory' on trigger.

Trigger Parameters: 1 'immediate' trigger(s) on START.

Status: Waiting for START.
 0 frames acquired since starting.
 0 frames available for GETDATA.

Specifying the Selected Video Source Object

When you create a video input object, the toolbox creates one or more video source objects associated with the video input object. The number of video source objects created depends on the device and the video format. The Source property of the video input object lists these video source objects.

To illustrate, this example lists the video source objects associated with the video input object vid.

```
get(vid,'Source')
```

Display Summary for Video Source Object Array:

Index:	SourceName:	Selected:
1	'CH0'	'on'
2	'CH1'	'off'
3	'CH2'	'off'
4	'CH3'	'off'
5	'CH4'	'off'
6	'CH5'	'off'
7	'CH6'	'off'
8	'CH7'	'off'

By default, the video input object makes the first video source object in the array the selected source. To use another video source, change the value of the `SelectedSourceName` property.

This example changes the currently selected video source object from CH0 to CH1 by setting the value of the `SelectedSourceName` property.

```
vid.SelectedSourceName = 'CH1';
```

Note The `getselectedsource` function returns the video source object that is currently selected at the time the function is called. If you change the value of the `SelectedSourceName` property, you must call the `getselectedsource` function again to retrieve the new selected video source object.

Getting Information About a Video Input Object

After creating a video input object, you can get information about the device it represents using the `imaqhwinfo` function. When called with a video input object as an argument, `imaqhwinfo` returns a structure containing information about the object such as the name of the adaptor, name of the device, video resolution, and details of the vendor's device driver and version.

```
out = imaqhwinfo(vid)
out =

    AdaptorName: 'winvideo'
    DeviceName: 'IBM PC Camera'
    MaxHeight: 96
    MaxWidth: 128
    NativeDataType: 'uint8'
    TotalSources: 1
    VendorDriverDescription: 'Windows WDM Compatible Driver'
    VendorDriverVersion: 'DirectX 9.0'
```

Configuring Image Acquisition Object Properties

In this section...
“About Image Acquisition Object Properties” on page 4-17
“Viewing the Values of Object Properties” on page 4-18
“Viewing the Value of a Particular Property” on page 4-20
“Getting Information About Object Properties” on page 4-21
“Setting the Value of an Object Property” on page 4-21

About Image Acquisition Object Properties

The video input object and the video source object both support properties that enable you to control characteristics of the video image and how it is acquired.

The video input object properties control aspects of an acquisition that are common to all image acquisition devices. For example, you can use the `FramesPerTrigger` property to specify the amount of data you want to acquire.

The video source object properties control aspects of the acquisition associated with a particular source. The set of properties supported by a video source object varies with each device. For example, some image acquisition devices support properties that enable you to control the quality of the image being produced, such as `Brightness`, `Hue`, and `Saturation`.

With either type of object, you can use the same toolbox functions to

- View a list of all the properties supported by the object, with their current values
- View the value of a particular property
- Get information about a property
- Set the value of a property

Note Three video input object trigger properties require the use of a special configuration function. For more information, see “Setting Trigger Properties” on page 4-23.

Viewing the Values of Object Properties

To view all the properties of an image acquisition object, with their current values, use the `get` function. You can also use the `inspect` function to view a list of object properties in the Property Inspector window, where you can also edit their values.

This example uses the `get` function to display a list of all the properties of the video input object `vid`. “Viewing the Properties of a Video Source Object” on page 4-19 describes how to do this for video source objects.

If you do not specify a return value, the `get` function displays the object properties in four categories: General Settings, Callback Function Settings, Trigger Settings, and Acquisition Sources.

```
get(vid)
  General Settings:
    DeviceID = 1
    DiskLogger = []
    DiskLoggerFrameCount = 0
    EventLog = [1x0 struct]
    FrameGrabInterval = 1
    FramesAcquired = 0
    FramesAvailable = 0
    FramesPerTrigger = 10
    Logging = off
    LoggingMode = memory
    Name = M_RS170-matrox-1
    NumberOfBands = 1
    Previewing = off
    ReturnedColorSpace = grayscale
    ROIPosition = [0 0 640 480]
    Running = off
    Tag =
    Timeout = 10
```



```
Type = videoinput
UserData = []
VideoFormat = M_RS170
VideoResolution = [640 480]

Callback Function Settings:
ErrorFcn = @imaqcallback
FramesAcquiredFcn = []
FramesAcquiredFcnCount = 0
StartFcn = []
StopFcn = []
TimerFcn = []
TimerPeriod = 1
TriggerFcn = []

Trigger Settings:
InitialTriggerTime = [0 0 0 0 0 0]
TriggerCondition = none
TriggerFrameDelay = 0
TriggerRepeat = 0
TriggersExecuted = 0
TriggerSource = none
TriggerType = immediate

Acquisition Sources:
SelectedSourceName = CH0
Source = [1x8 videosource]
```

Viewing the Properties of a Video Source Object

To view the properties supported by the video source object (or objects) associated with a video input object, use the `getselectedsource` function to retrieve the currently selected video source object. This example lists the properties supported by the video source object associated with the video input object `vid`. Note the device-specific properties that are included.

Note The video source object for your device might not include device-specific properties. For example, devices accessed with the 'winvideo' adaptor, such as webcams, that use a Video for Windows (VFW) driver, may not provide a way for the toolbox to programmatically query for device properties. Use the configuration tools provided by the manufacturer to configure these devices.

```
get(getselectedsource(vid))
  General Settings:
    Parent = [1x1 videoinput]
    Selected = on
    SourceName = CH0
    Tag =
    Type = videosource

  Device Specific Properties:
    InputFilter = lowpass
    UserOutputBit3 = off
    UserOutputBit4 = off
    XScaleFactor = 1
    YScaleFactor = 1
```

Viewing the Value of a Particular Property

To view the value of a particular property of an image acquisition object, use the `get` function, specifying the name of the property as an argument. You can also access the value of the property as you would a field in a MATLAB structure.

This example uses the `get` function to retrieve the value of the `Previewing` property.

```
get(vid, 'Previewing')

ans =

off
```

This example illustrates how to access the same property by referencing the object as if it were a MATLAB structure.

```
vid.Previewing
```

```
ans =
```

```
off
```

Getting Information About Object Properties

To get information about a particular property, see “Image Acquisition Toolbox Properties” on page 4-31. You can also get information about a particular property at the command line by using the `propinfo` or `imaqhelp` functions.

The `propinfo` function returns a structure that contains information about the property such as its data type, default value, and a list of all possible values, if the property supports such a list. This example uses `propinfo` to get information about the `LoggingMode` property.

```
propinfo(vid, 'LoggingMode')
```

```
ans =
```

```

        Type: 'string'
      Constraint: 'enum'
ConstraintValue: {'memory' 'disk' 'disk&memory'}
  DefaultValue: 'memory'
        ReadOnly: 'whileRunning'
DeviceSpecific: 0

```

The `imaqhelp` function returns reference information about the property with a complete description. This example uses `imaqhelp` to get information about the `LoggingMode` property.

```
imaqhelp(vid, 'LoggingMode')
```

Setting the Value of an Object Property

To set the value of a particular property of an image acquisition object, use the `set` function, specifying the name of the property as an argument. You can also assign the value to the property as you would a field in a MATLAB structure.

Note Because some properties are read only, only a subset of all video input and video source properties can be set.

This example uses the `set` function to set the value of the `LoggingMode` property.

```
set(vid,'LoggingMode','disk&memory')
```

To verify the new value of the property, use the `get` function.

```
get(vid,'LoggingMode')
```

```
ans =
```

```
disk&memory
```

This example sets the value of a property by assigning the value to the object as if it were a MATLAB structure.

```
vid.LoggingMode = 'disk';  
vid.LoggingMode
```

```
ans =
```

```
disk
```

Viewing a List of All Settable Object Properties

To view a list of all the properties of a video input object or video source object that can be set, use the `set` function.

```
set(vid)
```

```

General Settings:
  DiskLogger
  FrameGrabInterval
  FramesPerTrigger
  LoggingMode: [ {memory} | disk | disk&memory ]
  Name
  ReturnedColorSpace: [ {rgb} | grayscale | YCbCr ]
  ROIPosition
  Tag
  Timeout
  UserData

Callback Function Settings:
  ErrorFcn: string -or- function handle -or- cell array
  FramesAcquiredFcn: string -or- function handle -or- cell array
  FramesAcquiredFcnCount
  StartFcn: string -or- function handle -or- cell array
  StopFcn: string -or- function handle -or- cell array
  TimerFcn: string -or- function handle -or- cell array
  TimerPeriod
  TriggerFcn: string -or- function handle -or- cell array

Trigger Settings:
  TriggerFrameDelay
  TriggerRepeat

Acquisition Sources:
  SelectedSourceName: [ {CH0} | CH1 | CH2 | CH3 | CH4 ]

```

Setting Trigger Properties

The values of certain trigger properties, `TriggerType`, `TriggerCondition`, and `TriggerSource`, are interrelated. For example, some `TriggerCondition` values are only valid with specific values of the `TriggerType` property.

To ensure that you specify only valid combinations for the values of these properties, you must use two functions:

- The `triggerinfo` function returns all the valid combinations of values for the specified video input object.
- The `triggerconfig` function sets the values of these properties.

For more information, see “Specifying Trigger Type, Source, and Condition” on page 5-6.

Starting and Stopping a Video Input Object

When you create a video input object, you establish a connection between MATLAB and an image acquisition device. However, before you can acquire data from the device, you must start the object, using the `start` function.

```
start(vid);
```

When you start an object, you reserve the device for your exclusive use and lock the configuration. Thus, certain properties become read only while running.

An image acquisition object stops running when any of the following conditions is met:

- The requested number of frames is acquired. This occurs when

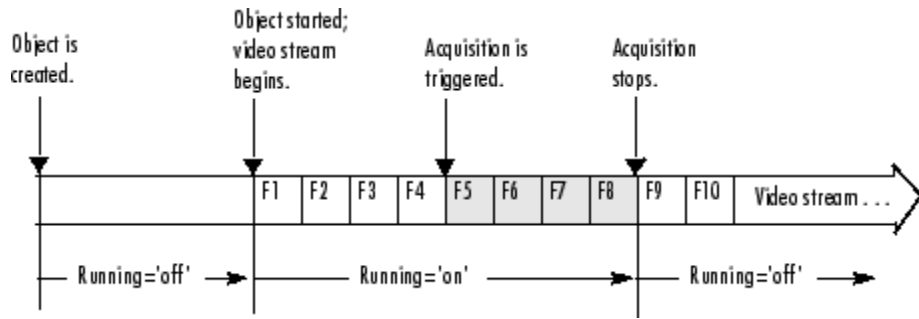
$$\text{FramesAcquired} = \text{FramesPerTrigger} * (\text{TriggerRepeat} + 1)$$

where `FramesAcquired`, `FramesPerTrigger`, and `TriggerRepeat` are properties of the video input object. For information about these properties, see “Acquiring Image Data” on page 5-2.

- A run-time error occurs.
- The object’s `Timeout` value is reached.
- You issue the `stop` function.

When an object is started, the toolbox sets the object’s `Running` property to `'on'`. When an object is not running, the toolbox sets the object’s `Running` property to `'off'`; this state is called stopped.

The following figure illustrates how an object moves from a running to a stopped state.



Transitions from Running to Stopped States

The following example illustrates starting and stopping an object:

- 1 Create an image acquisition object** — This example creates a video input object for a webcam image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

- 2 Verify that the image is in a stopped state** — Use the `isrunning` function to determine the current state of the video input object.

```
isrunning(vid)
```

```
ans =
```

```
0
```

- 3 Configure properties** To illustrate object states, set the video input object's `TriggerType` property to `'Manual'`. To set the value of certain trigger properties, including the `TriggerType` property, you must use the `triggerconfig` function. See “Setting the Values of Trigger Properties” on page 5-6 for more information.

```
triggerconfig(vid, 'Manual')
```

Configure an acquisition that takes several seconds so that you can see the video input in logging state.

```
vid.FramesPerTrigger = 100;
```

- 4 Start the image acquisition object** — Call the start function to start the image acquisition object.

```
start(vid)
```

- 5 Verify that the image is running but not logging** — Use the `isrunning` and `islogging` functions to determine the current state of the video input object. With manual triggers, the video input object is in running state after being started but does not start logging data until a trigger executes.

```
isrunning(vid)
```

```
ans =
```

```
    1
```

```
islogging(vid)
```

```
ans =
```

```
    0
```

- 6 Execute the manual trigger** — Call the `trigger` function to execute the manual trigger.

```
trigger(vid)
```

While the acquisition is underway, check the logging state of the video input object.

```
islogging(vid)
```

```
ans =
```

```
    1
```


After it acquires the specified number of frames, the video input object stops running.

```
isrunning(vid)
```

```
ans =
```

```
0
```

7 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
```

```
clear vid
```

Deleting Image Acquisition Objects

When you finish using your image acquisition objects, use the `delete` function to remove them from memory. After deleting them, clear the variables that reference the objects from the MATLAB workspace by using the `clear` function.

Note When you delete a video input object, all the video source objects associated with the video input object are also deleted.

To illustrate, this example creates several video input objects and then deletes them.

- 1 Create several image acquisition objects** — This example creates several video input objects for a single webcam image acquisition device, specifying several different video formats. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);  
vid2 = videoinput('winvideo',1,'RGB24_176x144');  
vid3 = videoinput('winvideo',1,'YV12_352x288');
```

- 2 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

You can delete image acquisition objects one at a time, using the `delete` function.

```
delete(vid)
```

You can also delete all the video input objects that currently exist in memory in one call to `delete` by using the `imaqfind` function. The `imaqfind` function returns an array of all the video input objects in memory.

```
imaqfind
```

```
Video Input Object Array:
```

Index:	Type:	Name:
1	videoinput	RGB555_128x96-winvideo-1
2	videoinput	RGB24_176x144-winvideo-1
3	videoinput	YV12_352x288-winvideo-1

Nest a call to the `imaqfind` function within the `delete` function to delete all these objects from memory.

```
delete(imaqfind)
```

Note that the variables associated with the objects remain in the workspace.

```
whos
```

Name	Size	Bytes	Class
vid	1x1	1120	videoinput object
vid2	1x1	1120	videoinput object
vid3	1x1	1120	videoinput object
vids	1x3	1280	videoinput object

These variables are not valid image acquisition objects.

```
isvalid(vid)
```

```
ans =  
    0
```

To remove these variables from the workspace, use the `clear` command.

Saving Image Acquisition Objects

In this section...
“Using the save Command” on page 4-30
“Using the obj2mfile Command” on page 4-30

Using the save Command

You can save a video input object to a MAT-file just as you would any workspace variable by using the save command. This example saves the video input object `vid` to the MAT-file `myvid.mat`.

```
save myvid vid
```

When you save a video input object, all the video source objects associated with the video input object are also saved.

To load an image acquisition object that was saved to a MAT-file into the MATLAB workspace, use the load command. For example, to load `vid` from MAT-file `myvid.mat`, use

```
load myvid
```

Note The values of read-only properties are not saved. When you load an image acquisition object into the MATLAB workspace, read-only properties revert to their default values. To determine if a property is read only, use the `propinfo` function or read the property reference page.

Using the obj2mfile Command

Another way to save a video input object is to create an M-file that contains the set of commands used to create the video input object and configure its properties. You can use the `obj2mfile` function to create such an M-file. When you execute the M-file, it can create a new video input object or reuses an existing video input object, if one exists that has the same video format and adaptor.

Image Acquisition Toolbox Properties

The following properties are available in the toolbox.

- BayerSensorAlignment
- DeviceID
- DiskLogger
- DiskLoggerFrameCount
- ErrorFcn
- EventLog
- FrameGrabInterval
- FramesAcquired
- FramesAcquiredFcn
- FramesAcquiredFcnCount
- FramesAvailable
- FramesPerTrigger
- InitialTriggerTime
- Logging
- LoggingMode
- Name
- NumberOfBands
- Parent
- Previewing
- ReturnedColorSpace
- ROIPosition
- Running
- Selected
- SelectedSourceName

- Source
- SourceName
- StartFcn
- StopFcn
- Tag
- Timeout
- TimerFcn
- TimerPeriod
- TriggerCondition
- TriggerFcn
- TriggerFrameDelay
- TriggerRepeat
- TriggersExecuted
- TriggerSource
- TriggerType
- Type
- UserData
- VideoFormat
- VideoResolution

Acquiring Image Data

Acquiring Image Data

The core of any image acquisition application is the data acquired from the input device. A *trigger* is the event that initiates the acquisition of image frames, a process called *logging*. A trigger event occurs when a certain condition is met. For some types of triggers, the condition can be the execution of a toolbox function. For other types of triggers, the condition can be a signal from an external source that is monitored by the image acquisition hardware.

The following topics describe how to configure and use the various triggering options supported by the Image Acquisition Toolbox software and control other acquisition parameters.

- “Data Logging” on page 5-3
- “Setting the Values of Trigger Properties” on page 5-6
- “Specifying the Trigger Type” on page 5-9
- “Controlling Logging Parameters” on page 5-26
- “Waiting for an Acquisition to Finish” on page 5-37
- “Managing Memory Usage” on page 5-41
- “Logging Image Data to Disk” on page 5-46

Data Logging

In this section...

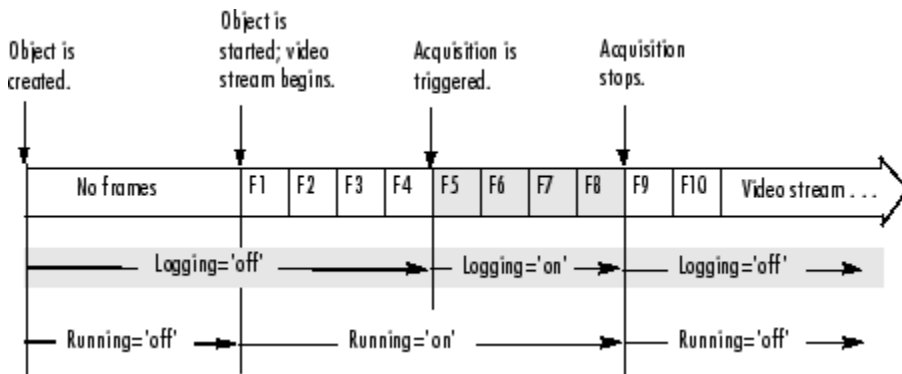
“Overview” on page 5-3

“Trigger Properties” on page 5-4

Overview

When a trigger occurs, the toolbox sets the object’s Logging property to 'on' and starts storing the acquired frames in a buffer in memory, a disk file, or both. When the acquisition stops, the toolbox sets the object’s Logging property to 'off'.

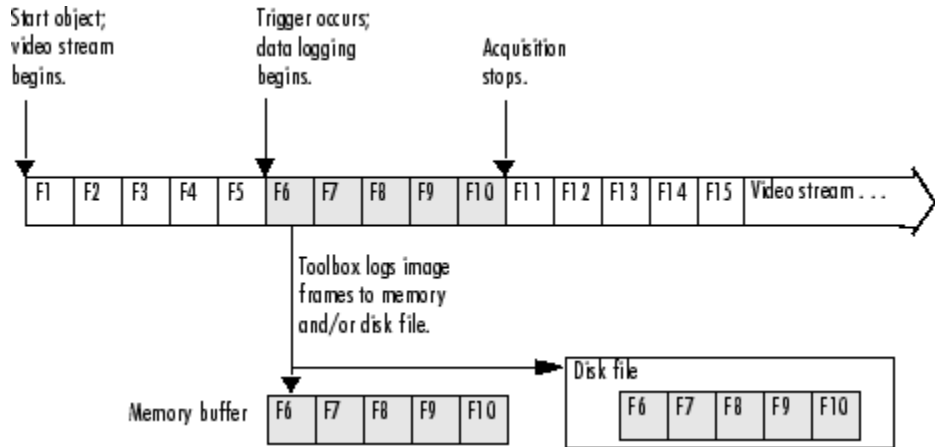
The following figure illustrates when an object moves into a logging state and the relation between running and logging states.



Logging State Transitions

Note After Logging is set to 'off', it is possible that the object might still be logging data to disk. To determine when disk logging is complete, check the value of the DiskLoggerFrameCount property. For more information, see “Logging Image Data to Disk” on page 5-46.

The following figure illustrates a group of frames being acquired from the video stream and being logged to memory and disk.



Overview of Data Logging

Trigger Properties

The video input object supports several properties that you can use to configure aspects of trigger execution. Some of these properties return information about triggers. For example, to find out when the first trigger occurred, look at the value of the `InitialTriggerTime` property. Other properties enable you to control trigger behavior. For example, you use the `TriggerRepeat` property to specify how many additional times an object should execute a trigger.

The following table provides a brief description of all the trigger-related properties supported by the video input object. For information about how to set these properties, see “Setting the Values of Trigger Properties” on page 5-6.

Property	Description
InitialTriggerTime	Reports the absolute time when the first trigger executed.
TriggerCondition	Specifies the condition that must be met for a trigger to be executed. This property is always set to 'none' for immediate and manual triggers.
TriggerFcn	Specifies the callback function to execute when a trigger occurs. For more information about callbacks, see “Using Events and Callbacks” on page 7-2.
TriggerFrameDelay	Specifies the number of frames to skip before logging data to memory, disk, or both. For more information, see “Delaying Data Logging After a Trigger” on page 5-34.
TriggerRepeat	Specifies the number of additional times to execute a trigger. If the value of TriggerRepeat is 0 (zero), the trigger executes but is not repeated any additional times. For more information, see “Specifying Multiple Triggers” on page 5-35.
TriggersExecuted	Reports the number of triggers that have been executed.
TriggerSource	Specifies the source to monitor for a trigger condition to be met. This property is always set to 'none' for immediate and manual triggers.
TriggerType	Specifies the type of trigger: 'immediate', 'manual', or 'hardware'. Use the triggerinfo function to determine whether your image acquisition device supports hardware triggers.

Setting the Values of Trigger Properties

In this section...
“About Trigger Properties” on page 5-6
“Specifying Trigger Type, Source, and Condition” on page 5-6

About Trigger Properties

Most trigger properties can be set using the same methods you use to set any other image acquisition object property: using the `set` function or referencing the property as you would a field in a structure. For example, you can use the `set` function to specify the value of the `TriggerRepeat` property, where `vid` is a video input object created using the `videoinput` function.

```
set(vid, 'TriggerRepeat', Inf)
```

For more information, see “Configuring Image Acquisition Object Properties” on page 4-17.

Some trigger properties, however, are interrelated and require the use of the `triggerconfig` function to set their values. These properties are the `TriggerType`, `TriggerCondition`, and `TriggerSource` properties. For example, some `TriggerCondition` values are only valid when the value of the `TriggerType` property is `'hardware'`.

Specifying Trigger Type, Source, and Condition

Setting the values of the `TriggerType`, `TriggerSource`, and `TriggerCondition` properties can be a two-step process:

- 1 Determine valid configurations of these properties by calling the `triggerinfo` function.
- 2 Set the values of these properties by calling the `triggerconfig` function.

For an example of using these functions, see “Using a Hardware Trigger” on page 5-15.

Determining Valid Configurations

To find all the valid configurations of the `TriggerType`, `TriggerSource`, and `TriggerCondition` properties, use the `triggerinfo` function, specifying a video input object as an argument.

```
config = triggerinfo(vid);
```

This function returns an array of structures, one structure for each valid combination of property values. Each structure in the array is made up of three fields that contain the values of each of these trigger properties. For example, the structure returned for an immediate trigger always has these values:

```
    TriggerType: 'immediate'  
    TriggerCondition: 'none'  
    TriggerSource: 'none'
```

A device that supports hardware configurations might return the following structure.

```
    TriggerType: 'hardware'  
    TriggerCondition: 'risingEdge'  
    TriggerSource: 'TTL'
```

Note The text strings used as the values of the `TriggerCondition` and `TriggerSource` properties are device specific. Your device, if it supports hardware triggers, might support different condition and source values.

Configuring Trigger Type, Source, and Condition Properties

To set the values of the `TriggerType`, `TriggerSource`, and `TriggerCondition` properties, you must use the `triggerconfig` function. You specify the value of the property as an argument to the function.

For example, this code sets the values of these properties for a hardware trigger.

```
triggerconfig(vid, 'hardware', 'risingEdge', 'TTL')
```

If you are specifying a manual trigger, you only need to specify the trigger type value as an argument.

```
triggerconfig(vid, 'manual')
```

You can also pass one of the structures returned by the `triggerinfo` function to the `triggerconfig` function and set all three properties at once.

```
triggerconfig(vid, config(1))
```

See the `triggerconfig` function documentation for more information.

Specifying the Trigger Type

In this section...
“Comparison of Trigger Types” on page 5-9
“Using an Immediate Trigger” on page 5-10
“Using a Manual Trigger” on page 5-13
“Using a Hardware Trigger” on page 5-15
“Setting DCAM-Specific Trigger Modes” on page 5-19

Comparison of Trigger Types

To specify the type of trigger you want to execute, set the value of the `TriggerType` property of the video input object. You must use the `triggerconfig` function to set the value of this property. The following table lists all the trigger types supported by the toolbox, with information about when to use each type of trigger.

Comparison of Trigger Types

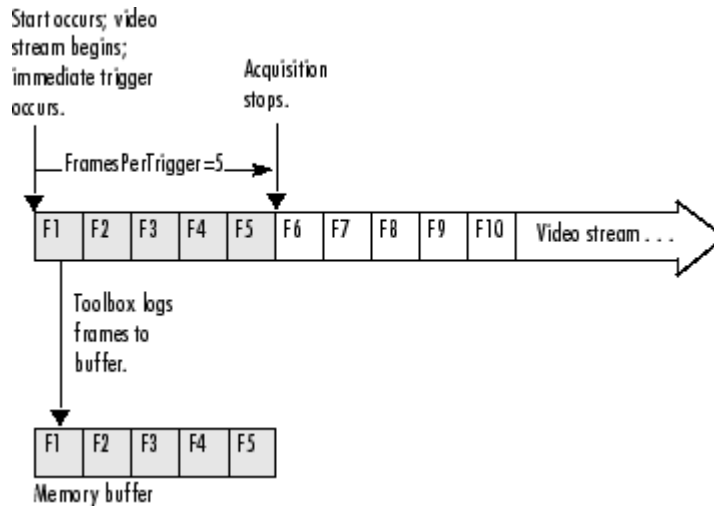
TriggerType Value	TriggerSource and TriggerCondition Values	Description
'immediate'	Always 'none'	The trigger occurs automatically, immediately after the <code>start</code> function is issued. This is the default trigger type. For more information, see “Using an Immediate Trigger” on page 5-10.
'manual'	Always 'none'	The trigger occurs when you issue the <code>trigger</code> function. A manual trigger can provide more control over image acquisition. For example, you can monitor the video stream being acquired, using the <code>preview</code> function, and manually execute the

Comparison of Trigger Types (Continued)

TriggerType Value	TriggerSource and TriggerCondition Values	Description
		trigger when you observe a particular condition in the scene. For more information, see “Using a Manual Trigger” on page 5-13.
'hardware '	Device-specific	<p>Hardware triggers are external signals that are processed directly by the hardware. This type of trigger is used when synchronization with another device is part of the image acquisition setup or when speed is required. A hardware device can process an input signal much faster than software. For more information, see “Using a Hardware Trigger” on page 5-15.</p> <hr/> <p>Note Only a subset of image acquisition devices supports hardware triggers. To determine the trigger types supported by your device, see “Determining Valid Configurations” on page 5-7.</p> <hr/>

Using an Immediate Trigger

To use an immediate trigger, simply create a video input object. Immediate triggering is the default trigger type for all video input objects. With an immediate trigger, the object executes the trigger immediately after you start the object running with the start command. The following figure illustrates an immediate trigger.



Immediate Trigger

The following example illustrates how to use an immediate trigger:

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

Verify that the object has not acquired any frames.

```
get(vid, 'FramesAcquired')
ans =
```

```
0
```

- 2 Configure properties** — To use an immediate trigger, you do not have to configure the `TriggerType` property because `'immediate'` is the default trigger type. You can verify this by using the `triggerconfig` function to view the current trigger configuration or by viewing the video input object's properties.

```
triggerconfig(vid)
ans =

    TriggerType: 'immediate'
    TriggerCondition: 'none'
    TriggerSource: 'none'
```

This example sets the value of the `FramesPerTrigger` property to 5. (The default is 10 frames per trigger.)

```
set(vid, 'FramesPerTrigger', 5)
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object. By default, the object executes an immediate trigger and acquires five frames of data, logging the data to a memory buffer. After logging the specified number of frames, the object stops running.

```
start(vid)
```

To verify that the object acquired data, view the value of the `FramesAcquired` property. The object updates the value of this property as it acquires data.

```
vid.FramesAcquired
ans =
```

```
5
```

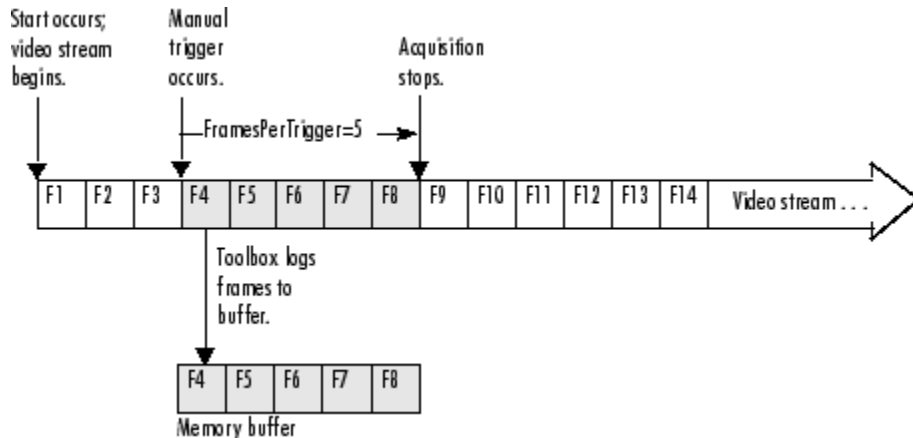
To execute another immediate trigger, you must restart the object. Note, however, that this deletes the data acquired by the first trigger. To execute multiple immediate triggers, specify a value for the `TriggerRepeat` property. See “Specifying Multiple Triggers” on page 5-35 for more information.

- 4 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Using a Manual Trigger

To use a manual trigger, create a video input object and set the value of the `TriggerType` property to `'manual'`. A video input object executes a manual trigger after you issue the `trigger` function. The following figure illustrates a manual trigger.



Manual Trigger

The following example illustrates how to use a manual trigger:

- 1 Create an image acquisition object** — This example creates a video input object for a webcam image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

Verify that the object has not acquired any frames.

```
get(vid,'FramesAcquired')
ans =
    0
```

- 2 Configure properties** — Set the video input object's `TriggerType` property to `'Manual'`. To set the values of certain trigger properties,

including the `TriggerType` property, you must use the `triggerconfig` function. See “Setting the Values of Trigger Properties” on page 5-6 for more information.

```
triggerconfig(vid, 'Manual')
```

This example also sets the value of the `FramesPerTrigger` property to 5. (The default is 10 frames per trigger.)

```
set(vid, 'FramesPerTrigger', 5)
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid);
```

The video object is now running but not logging. With manual triggers, the video stream begins when the object starts but no frames are acquired until the trigger executes.

```
isrunning(vid)
```

```
ans =
```

```
1
```

```
islogging(vid)
```

```
ans =
```

```
0
```

Verify that the object has still not acquired any frames.

```
get(vid, 'FramesAcquired')
```

```
ans =
```

```
0
```

- 4 Execute the manual trigger** — Call the `trigger` function to execute the manual trigger.

```
trigger(vid)
```

The object initiates the acquisition of five frames. Check the `FramesAcquired` property again to verify that five frames have been acquired.

```
get(vid, 'FramesAcquired')
ans =
    5
```

After it acquires the specified number of frames, the video input object stops running.

```
isrunning(vid)

ans =

    0
```

To execute another manual trigger, you must first restart the video input object. Note that this deletes the frames acquired by the first trigger. To execute multiple manual triggers, specify a value for the `TriggerRepeat` property. See “Specifying Multiple Triggers” on page 5-35 for more information.

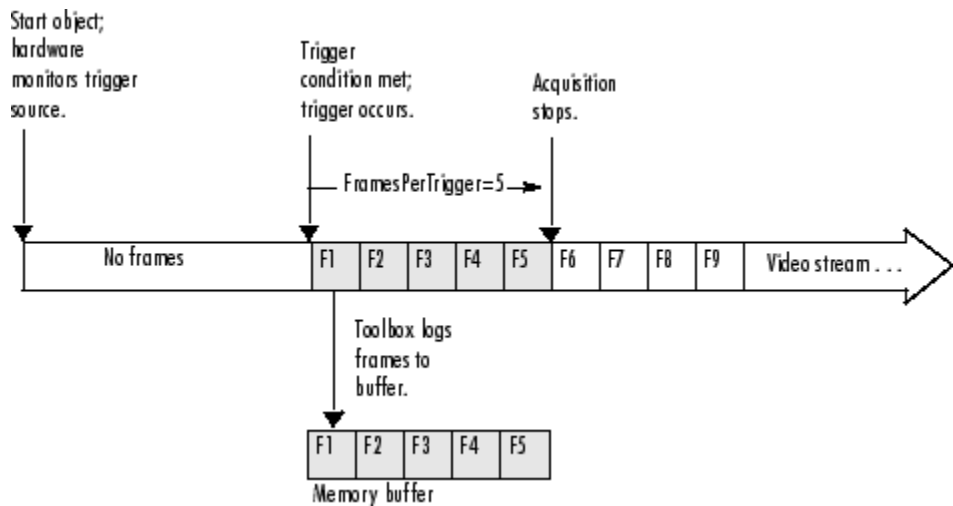
5 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Using a Hardware Trigger

To use a hardware trigger, create a video input object and set the value of the `TriggerType` property to `'hardware'`. You must also specify the source of the hardware trigger and the condition type. The hardware monitors the source you specify for the condition you specify. The following figure illustrates a hardware trigger. For hardware triggers, the video stream does not start until the trigger occurs.

Note Trigger sources and the conditions that control hardware triggers are device specific. Use the `triggerinfo` function to determine whether your image acquisition device supports hardware triggers and, if it does, which conditions you can configure. Refer to the documentation that came with your device for more detailed information about its hardware triggering capabilities.



Hardware Trigger

The following example illustrates how to use a hardware trigger:

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code. The device must support hardware triggers.

```
vid = videoinput('matrox',1);
```

- 2 Determine valid trigger property configurations** — Use the `triggerinfo` function to determine if your image acquisition device supports hardware triggers, and if it does, to find out valid configurations of

the `TriggerSource` and `TriggerCondition` properties. See “Determining Valid Configurations” on page 5-7 for more information.

In this example, `triggerinfo` returns the following valid trigger configurations.

```
triggerinfo(vid)
```

Valid Trigger Configurations:

TriggerType:	TriggerCondition:	TriggerSource:
'immediate'	'none'	'none'
'manual'	'none'	'none'
'hardware'	'risingEdge'	'TTL'
'hardware'	'fallingEdge'	'TTL'

- 3 Configure properties** — Configure the video input object trigger properties to one of the valid combinations returned by `triggerinfo`. You can specify each property value as an argument to the `triggerconfig` function

```
triggerconfig(vid, 'hardware', 'risingEdge', 'TTL')
```

Alternatively, you can set these values by passing one of the structures returned by the `triggerinfo` function to the `triggerconfig` function.

```
configs = triggerinfo(vid);
triggerconfig(vid, configs(3));
```

This example also sets the value of the `FramesPerTrigger` property to 5. (The default is 10 frames per trigger.)

```
set(vid, 'FramesPerTrigger', 5)
```

- 4 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object is running but not logging any data.

```
isrunning(vid)
```

```
ans =  
  
    1  
  
islogging(vid)  
  
ans =  
  
    0
```

The hardware begins monitoring the trigger source for the specified condition. When the condition is met, the hardware executes a trigger and begins providing image frames to the object. The object acquires the number of frames specified by the `FramesPerTrigger` property. View the value of the `FramesAcquired` property to see how much data was acquired. The object updates the value of this property as it acquires data.

```
vid.FramesAcquired  
ans =  
  
    5
```

After it executes the trigger and acquires the specified number of frames, the video input object stops running.

```
isrunning(vid)  
  
ans =  
  
    0
```

To execute another hardware trigger, you must first restart the video input object. Note that this deletes the frames acquired by the first trigger. To execute multiple triggers, specify a value for the `TriggerRepeat` property. See “Specifying Multiple Triggers” on page 5-35 for more information.

- 5 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```


Setting DCAM-Specific Trigger Modes

You can now use all trigger modes and all trigger inputs that DCAM cameras support. Previous toolbox releases supported only trigger mode 0. Support for additional trigger modes and inputs do not affect any existing code you use.

Control trigger functionality using the `triggerinfo` and `triggerconfig` functions and the `triggersource` property. Before R2010a, one `triggersource` was available, `externalTrigger`. Selecting `externalTrigger` configures the camera to use trigger mode 0 with trigger source 0.

The `triggersource` property is now composed of the trigger type (internal or external), the trigger source (0, 1, 2, etc.), and the mode number (0 through 5, 14 and 15). The following table summarizes the options.

Trigger Mode	Parameter	External Source	Multiple Frames Per Trigger
0	none	yes	yes
1	none	yes	no
2	(N >= 2)	yes	no
3	(N >= 1)	no	yes
4	(N >= 1)	yes	no
5	(N >= 1)	yes	no
14	unknown	unknown	unknown
15	unknown	unknown	unknown

For example, the second `triggersource` for trigger mode 1 is called `externalTrigger1-mode1`. To use mode 3, the `triggersource` is `internalTrigger-mode3`.

Note Toolbox versions before R2010a supported DCAM trigger mode 0 with the first available `triggersource` as `externalTrigger`. The existing `externalTrigger` property will be maintained so to prevent backward compatibility issues. In addition, in order to preserve symmetry with the new functionality, `triggersource externalTrigger0-mode0`, which is synonymous, will also be supported. The new trigger modes do not work before R2010a.

Usage Notes

If a trigger mode has multiple trigger sources (modes 0, 1, 2, 4, and 5), then `triggersource` has a digit indicating the corresponding camera source, even if only one camera source is available. For example, if the camera has only a single `triggersource` available, the toolbox reports the `triggersource` name as `externalTrigger0-modeX`. If the trigger mode does not have multiple sources (mode 3), then no source digit appears in the name (i.e., `internalTriggerMode3` instead of `internalTriggerMode3-Source0`).

The DCAM adaptor includes a `TriggerParameter` property that is passed to the camera when you set trigger configurations. The `TriggerParameter` property is validated when you call `START` after selecting a hardware trigger mode.

If the selected trigger mode prohibits multiple frames per trigger, then an error appears when you call `START` without setting `FramesPerTrigger` to 1.

If the camera supports only trigger mode 0 with source 0, then the original functionality of having only the `externalTrigger triggersource` is supported.

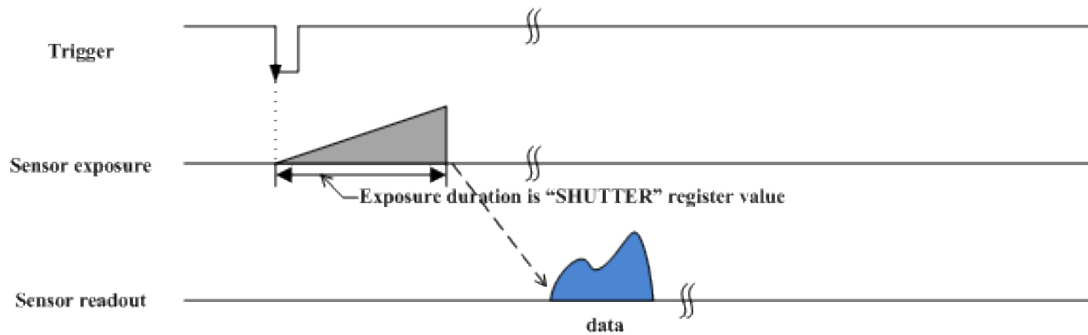
Trigger modes 14 and 15 are vendor-specific and are assumed to be external triggers and have no restrictions on any settings. You must validate any settings you use.

The following sections detail the trigger modes.

Trigger Mode 0

This is the only trigger mode supported before R2010a. When a trigger is received, a frame is acquired. You can acquire multiple frames per trigger by switching the camera for hardware triggered mode to free running mode when a triggered frame is acquired.

No parameter is required.

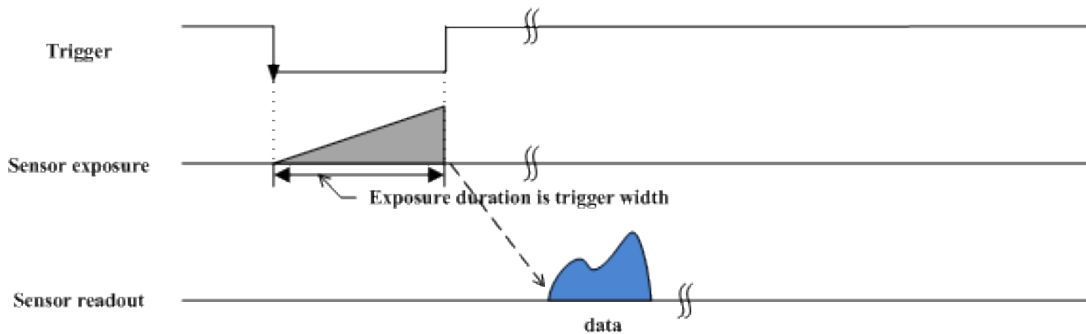


The camera starts the integration of the incoming light from the external trigger input falling edge.

Trigger Mode 1

In this mode, the duration of the trigger signal is used to control the integration time of the incoming light. This mode is used to synchronize the exposure time of the camera to an external event.

No parameter is required.

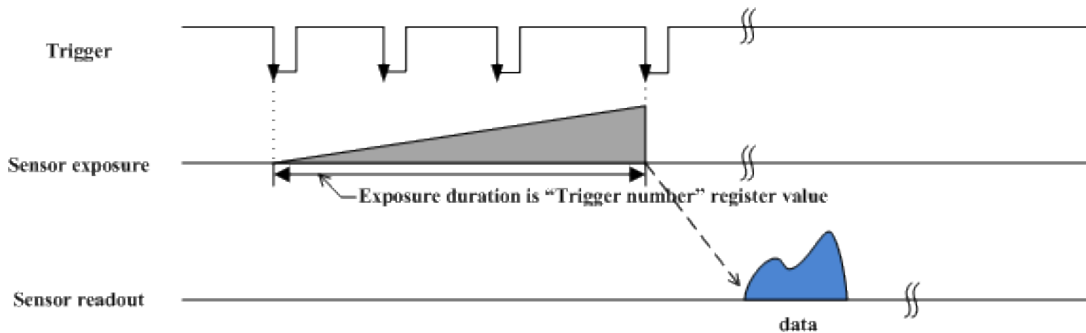


The camera starts the integration of the incoming light from the external trigger input falling edge. Integration time is equal to the low state time of the external trigger input if `triggersource` is `fallingEdge`, otherwise it is equal to the high state time.

Trigger Mode 2

This mode is similar to mode 1, except the duration of the trigger signal does govern integration time. Instead the number of trigger signals received does. Integration commences upon the start of the first trigger signal and continues until the start of the Nth trigger signal.

Parameter N is required and describes the number of trigger signals in an integration.

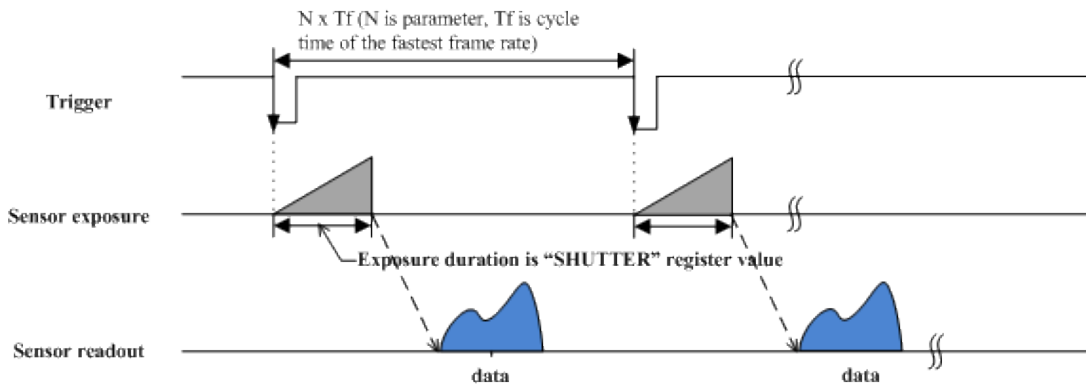


The camera starts the integration of the incoming light from the first external trigger input falling edge. At the Nth external trigger input falling edge, integration stops. Parameter N is required and must be 2 or greater. ($N \geq 2$).

Trigger Mode 3

Use this internal trigger mode to achieve a lower frame rate. When the trigger generates internally, a frame is acquired and returned. A new frame is not acquired for $N \times T_f$ when N is the parameter and T_f is the cycle time of the fastest frame rate supported by the camera.

A parameter is required, as described above.



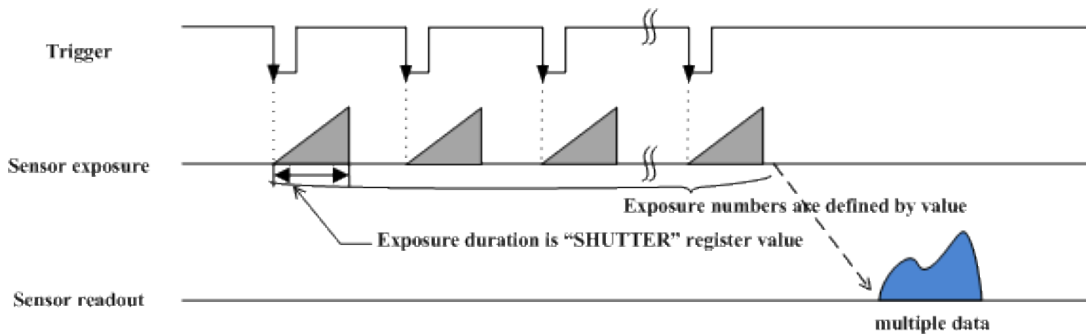
This is an internal trigger mode. The camera issues the trigger internally and cycle time is N times of the cycle time of the fastest frame rate. Integration

time of incoming light is described in the shutter register. Parameter N is required and must be 1 or greater ($N \geq 1$).

Trigger Mode 4

This mode is the “multiple shutter preset mode.” It is similar to mode 1, but the exposure time is governed by the shutter property. On each trigger, shutter property defines the exposure duration. When N triggers are received, a frame is acquired.

Parameter N is required and describes the number of triggers.

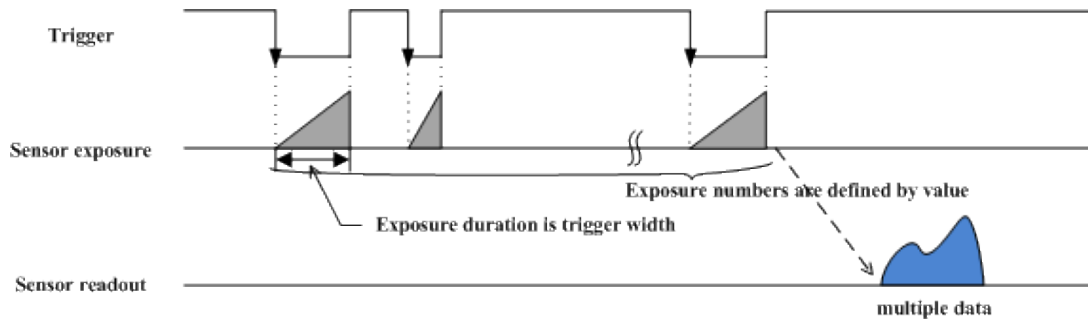


The camera starts integration of incoming light from the first external trigger input falling edge and exposes incoming light at shutter time. Repeat this sequence until the Nth external trigger input falling edge, then finish integration. Parameter N is required and must be 1 or greater ($N \geq 1$).

Trigger Mode 5

This mode is the “multiple shutter pulse width mode.” It is a combination of modes 1 and 2. The exposure time is governed by the duration of the trigger signal and a number of trigger signals can be integrated into a single readout. If the trigger parameter is 1, this mode is degenerate with mode 1.

A parameter is required. The parameter describes the number of triggers.



The camera starts integration of incoming light from first the external trigger input falling edge and exposes incoming light until the trigger is inactive. Repeat this sequence until the Nth external trigger input falling edge, then finish integration. Parameter N is required and must be 1 or greater ($N \geq 1$).

Trigger Mode 14

This is a vendor-specific mode and no information is available. Consult the documentation for your camera.

Trigger Mode 15

This is a vendor-specific mode and no information is available. Consult the documentation for your camera.

Controlling Logging Parameters

In this section...
“Data Logging” on page 5-26
“Specifying Logging Mode” on page 5-26
“Specifying the Number of Frames to Log” on page 5-27
“Determining How Much Data Has Been Logged” on page 5-29
“Determining How Many Frames Are Available” on page 5-31
“Delaying Data Logging After a Trigger” on page 5-34
“Specifying Multiple Triggers” on page 5-35

Data Logging

The following subsections describe how to control various aspects of data logging.

- Specifying the logging mode
- Specifying the number of frames to log
- Determining how many frames have been logged since the object was started
- Determining how many frames are currently available in the memory buffer
- Delaying data logging after a trigger executes
- Specifying multiple trigger executions

Specifying Logging Mode

Using the video input object `LoggingMode` property, you can control where the toolbox logs acquired frames of data.

The default value for the `LoggingMode` property is `'memory'`. In this mode, the toolbox logs data to a buffer in memory. If you want to bring image data into the MATLAB workspace, you must log frames to memory. The functions provided by the toolbox to move data into the workspace all work with the

memory buffer. For more information, see “Bringing Image Data into the MATLAB Workspace” on page 6-3.

You can also log data to a disk file by setting the `LoggingMode` property to `'disk'` or to `'disk&memory'`. By logging frames to a disk file, you create a permanent record of the frames you acquire. For example, this code sets the value of the `LoggingMode` property of the video input object `vid` to `'disk&memory'`.

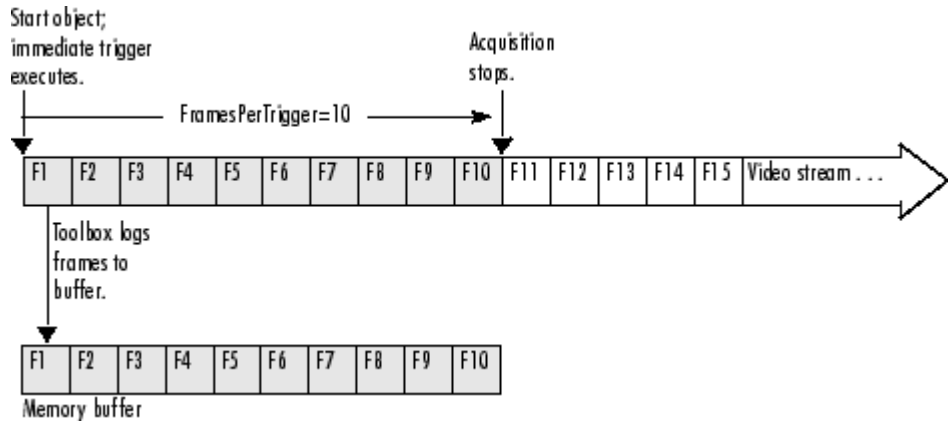
```
set(vid,'LoggingMode','disk&memory');
```

Because the toolbox stores the image frames in Audio Video Interleaved (AVI) format, you can view the logged frames in any standard media player. For more information, see “Logging Image Data to Disk” on page 5-46.

Specifying the Number of Frames to Log

In the Image Acquisition Toolbox software, you specify the amount of data you want to acquire as the number of frames per trigger.

You specify the desired size of your acquisition as the value of the video input object `FramesPerTrigger` property. By default, the value of this property is 10 frames per trigger, but you can specify any value. The following figure illustrates an acquisition using the default value for the `FramesPerTrigger` property. To see an example of an acquisition, see “Acquiring 100 Frames” on page 5-29.



Specifying the Amount of Data to Log

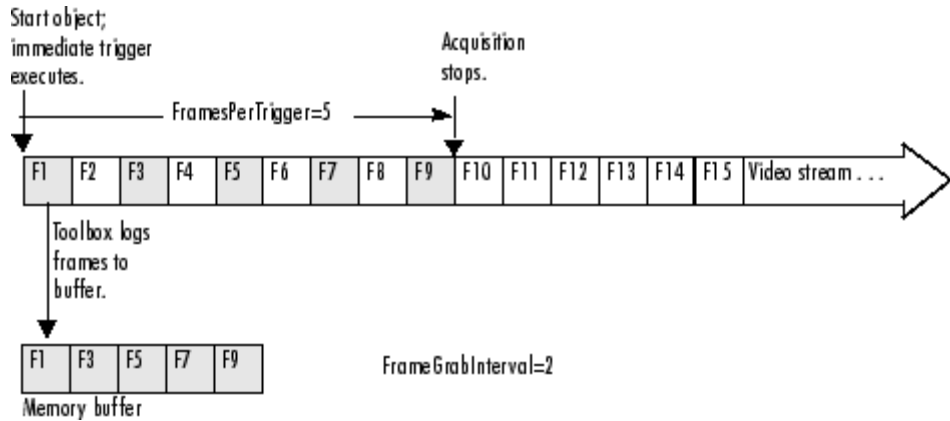
Note While you can specify any size acquisition, the number of frames you can acquire is limited by the amount of memory you have available on your system for image storage. A large acquisition can potentially fill all available system memory. For large acquisitions, you might want to remove frames from the buffer as they are logged. For more information, see “Moving Multiple Frames into the Workspace” on page 6-4. To learn how to empty the memory buffer, see “Freeing Memory” on page 5-43.

Specifying a Noncontiguous Acquisition

Although `FramesPerTrigger` specifies the number of frames to acquire, these frames do not have to be captured contiguously from the video stream. You can specify that the toolbox skip a certain number of frames between frames it acquires. To do this, set the value of the `FrameGrabInterval` property.

Note The `FrameGrabInterval` property controls the interval at which the toolbox acquires frames from the video stream (measured in frames). This property does not control the rate at which frames are provided by the device, otherwise known as the frame rate.

The following figure illustrates how the `FrameGrabInterval` property affects an acquisition.



Impact of `FrameGrabInterval` on Data Logging

Determining How Much Data Has Been Logged

To determine how many frames have been acquired by a video input object, check the value of the `FramesAcquired` property. This property tells how many frames the object has acquired since it was started. To determine how many frames are currently available in the memory buffer, see “Determining How Many Frames Are Available” on page 5-31.

Acquiring 100 Frames

This example illustrates how you can specify the amount of data to be acquired and determine how much data has been acquired. (For an example of configuring a time-based acquisition, see “Acquiring 10 Seconds of Image Data” on page 6-5.)

- 1 Create an image acquisition object** — This example creates a video input object for a Windows image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

- 2 Configure properties** — Specify the amount of data you want to acquire as the number of frames per trigger. By default, a video input object acquires 10 frames per trigger. For this example, set the value of this property to 100.

```
set(vid, 'FramesPerTrigger', 100)
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger and begins acquiring frames of data. To verify if the video input object is logging data, use the `islogging` function.

```
islogging(vid)  
ans =
```

```
1
```

The `start` function returns control to the command line immediately but the object continues logging the data to the memory buffer. After acquiring the specified number of frames, the object stops running and logging.

- 4 Check how many frames have been acquired** — To verify that the specified number of frames has been acquired, check the value of the `FramesAcquired` property. Note that the object continuously updates the value of the `FramesAcquired` property as the acquisition progresses. If you view the value of this property several times during an acquisition, you can see the number of frames acquired increase until logging stops.

```
vid.FramesAcquired  
ans =
```

```
100
```

- 5 Clean up** Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Determining How Many Frames Are Available

The `FramesAcquired` property tells how many frames the object has logged since it was started, described in “Determining How Much Data Has Been Logged” on page 5-29. Once you move frames from the memory buffer into the MATLAB workspace, the number of frames stored in the memory buffer will differ from the `FramesAcquired` value. To determine how many frames are currently available in the memory buffer, check the value of the `FramesAvailable` property.

Note The `FramesAvailable` property tells the number of frames in the memory buffer, *not* in the disk log, if `LoggingMode` is configured to `'disk'` or `'disk&memory'`. Because it takes longer to write frames to a disk file than to memory, the number of frames stored in the disk log might lag behind those stored in the memory buffer. To see how many frames are available in the disk log, look at the value of the `DiskLoggerFrameCount` property. See “Logging Image Data to Disk” on page 5-46 for more information.

This example illustrates the distinction between the `FramesAcquired` and the `FramesAvailable` properties:

1 Create an image acquisition object — This example creates a video input object for a Windows image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

2 Configure properties — For this example, configure an acquisition of 15 frames.

```
set(vid,'FramesPerTrigger',15)
```

3 Start the image acquisition object — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger and begins acquiring frames of data. The `start` function returns control to the command line immediately but the object continues logging the data to the memory buffer. After logging the specified number of frames, the object stops running.

- 4 Check how many frames have been acquired** — To determine how many frames the object has acquired and how many frames are available in the memory buffer, check the value of the `FramesAcquired` and `FramesAvailable` properties.

```
vid.FramesAcquired  
ans =
```

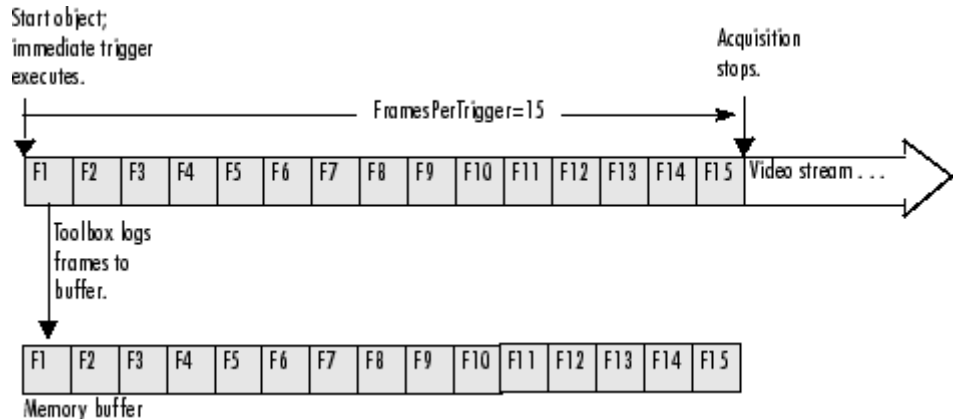
```
15
```

```
vid.FramesAvailable
```

```
ans =
```

```
15
```

The object updates the value of these properties continuously as it acquires frames of data. The following figure illustrates how the object puts acquired frames in the memory buffer as the acquisition progresses.



Frames Available After Initial Trigger Execution

5 Remove frames from the memory buffer — When you remove frames from the memory buffer, the object decrements the value of the `FramesAvailable` property by the number of frames removed.

To remove frames from the memory buffer, call the `getdata` function, specifying the number of frames to retrieve. For more information about using `getdata`, see “Bringing Image Data into the MATLAB Workspace” on page 6-3.

```
data = getdata(vid,5);
```

After you execute the `getdata` function, check the values of the `FramesAcquired` and `FramesAvailable` properties again. Notice that the `FramesAcquired` property remains unchanged but the object has decremented the value of the `FramesAvailable` property by the number of frames removed from the memory buffer.

```
vid.FramesAcquired
```

```
ans =
```

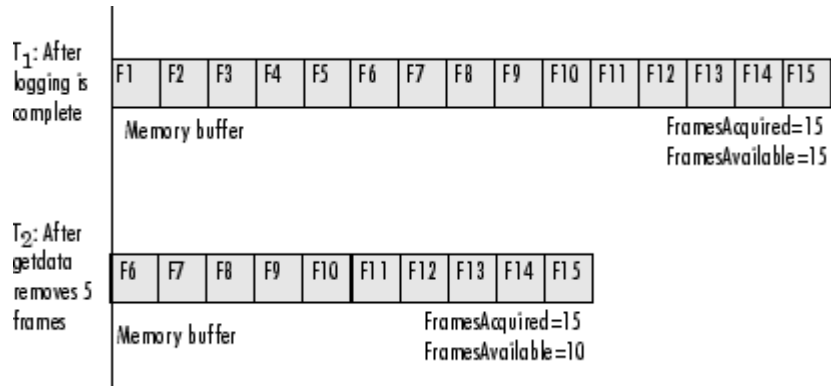
```
15
```

```
vid.FramesAvailable
```

```
ans =
```

```
10
```

The following figure illustrates the contents of the memory buffer after frames are removed.



Contents of Memory Buffer Before and After Removing Frames

6 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Delaying Data Logging After a Trigger

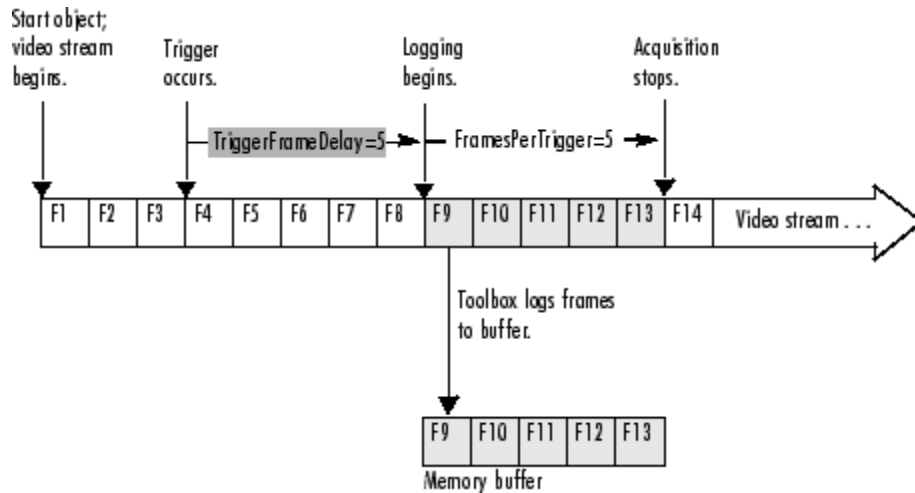
In some image acquisition setups, you might not want to log the first few frames returned from your camera or other imaging device. For example, some cameras require a short warmup time when activated. The quality of the first few images returned by these cameras might be too dark to be useful for your application.

To account for this characteristic of your setup, you can specify that the toolbox skip a specified number of frames after a trigger executes. You use the `TriggerFrameDelay` property to specify the number of frames you want to skip before logging begins.

For example, to specify a delay of five frames before data logging begins after a trigger executes, you would set the value of the `TriggerFrameDelay` property to 5. The number of frames captured is defined by the `FramesPerTrigger` property and is unaffected by the delay.

```
set(vid, 'TriggerFrameDelay', 5);
```

This figure illustrates this scenario.



Specifying a Delay Before Data Logging Begins

Specifying Multiple Triggers

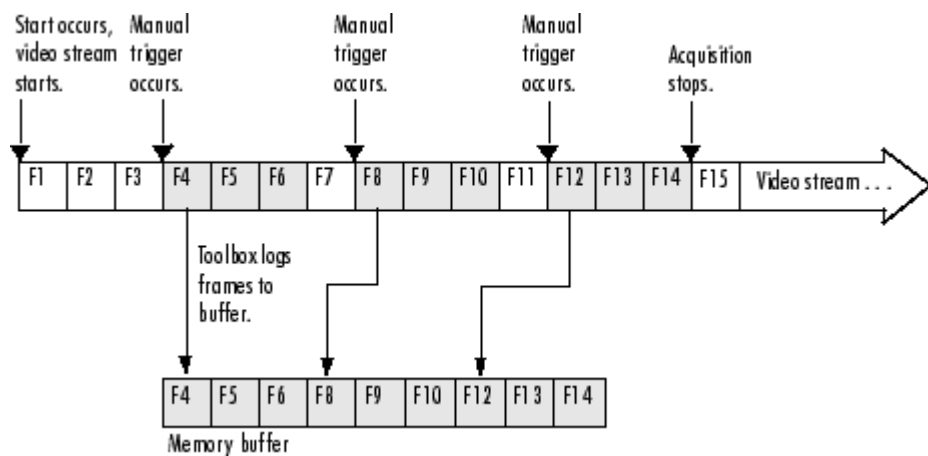
When a trigger occurs, a video input object acquires the number of frames specified by the `FramesPerTrigger` property and logs the data to a memory buffer, a disk file, or both.

When it acquires the specified number of frames, the video input object stops running. To execute another trigger, you must restart the video input object. Restarting an object causes it to delete all the data it has stored in the memory buffer from the previous trigger. To execute multiple triggers, retaining the data from each trigger, you must specify a value for the `TriggerRepeat` property.

Note that the `TriggerRepeat` property specifies the number of *additional* times a trigger executes. For example, to execute a trigger three times, you would set the value of the `TriggerRepeat` property to 2. In the following, `vid` is a video input object created with the `videoinput` function.

```
set(vid, 'TriggerRepeat', 2);
```

This figure illustrates an acquisition with three executions of a manual trigger. In the figure, the `FramesPerTrigger` property is set to 3.



Executing Multiple Triggers

Waiting for an Acquisition to Finish

In this section...
“Using the wait Function” on page 5-37
“Blocking the Command Line Until an Acquisition Completes” on page 5-38

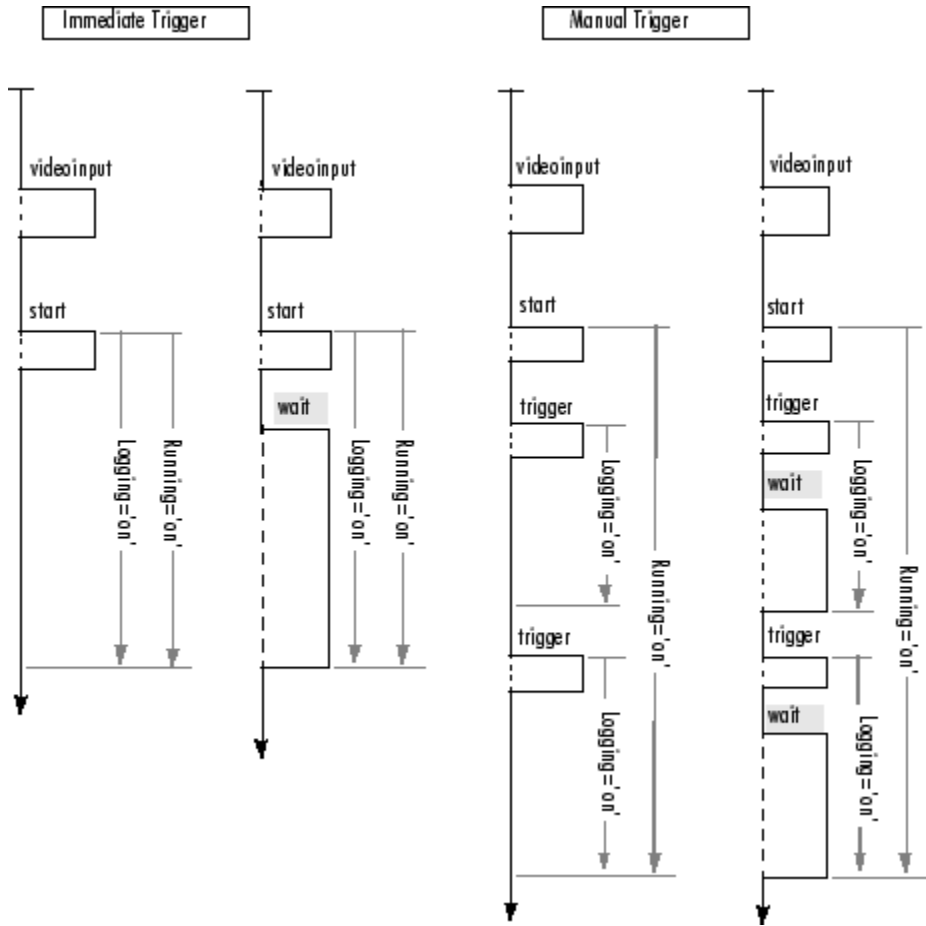
Using the wait Function

The `start` function and the `trigger` function are asynchronous functions. That is, they start the acquisition of frames and return control to the MATLAB command line immediately.

In some scenarios, you might want your application to wait until the acquisition completes before proceeding with other processing. To do this, call the `wait` function immediately after the `start` or `trigger` function returns. The `wait` function blocks the MATLAB command line until an acquisition completes or a timeout value expires, whichever comes first.

By default, `wait` blocks the command line until a video input object stops running. You can optionally specify that `wait` block the command line until the object stops logging. For acquisitions using an immediate trigger, video input objects always stop running and stop logging at the same time. However, with a manual trigger configured for multiple executions (`TriggerRepeat > 0`), you can use `wait` immediately after each call to the `trigger` function to block the command line while logging is in progress, even though the object remains in running state throughout the entire acquisition.

The following figure illustrates the flow of control at the MATLAB command line for a single execution of an immediate trigger and a manual trigger, with and without the `wait` function. A hardware trigger is similar to the manual trigger diagram, except that the acquisition is triggered by an external signal to the camera or frame grabber board, not by the `trigger` function. For an example, see “Blocking the Command Line Until an Acquisition Completes” on page 5-38.



Using wait to Block the MATLAB® Command Line

Blocking the Command Line Until an Acquisition Completes

The following example illustrates how to use the wait function to put a 60 second time limit on the execution of a hardware trigger. If the hardware trigger does not execute within the time limit, wait returns control to the MATLAB command line.

1 Create an image acquisition object — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

2 Configure a hardware trigger — Use the `triggerinfo` function to determine valid configurations of the `TriggerSource` and `TriggerCondition` properties. See “Determining Valid Configurations” on page 5-7 for more information. In this example, `triggerinfo` returns the following valid trigger configurations.

```
triggerinfo(vid)
Valid Trigger Configurations:

      TriggerType:   TriggerCondition:   TriggerSource:
      'immediate'   'none'                               'none'
      'manual'      'none'                               'none'
      'hardware'    'risingEdge'                         'TTL'
      'hardware'    'fallingEdge'                        'TTL'
```

Configure the video input object trigger properties to one of the valid combinations returned by `triggerinfo`. You can specify each property value as an argument to the `triggerconfig` function

```
triggerconfig(vid, 'hardware', 'risingEdge', 'TTL')
```

Alternatively, you can set these values by passing one of the structures returned by the `triggerinfo` function to the `triggerconfig` function.

```
configs = triggerinfo(vid);
triggerconfig(vid,configs(3));
```

3 Configure other object properties — This example also sets the value of the `FramesPerTrigger` property to configure an acquisition large enough to produce a noticeable duration. (The default is 10 frames per trigger.)

```
set(vid, 'FramesPerTrigger', 100)
```

- 4 Start the image acquisition object** — Call the start function to start the image acquisition object.

```
start(vid)
```

The start function sets the object running and returns control to the command line.

- 5 Block the command line until the acquisition finishes** — After the start function returns, call the wait function.

```
wait(vid,60)
```

The wait function blocks the command line until the hardware trigger fires and acquisition completes or until the amount of time specified by the timeout value expires.

- 6 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Managing Memory Usage

In this section...

“Memory Usage” on page 5-41

“Monitoring Memory Usage” on page 5-41

“Modifying the Frame Memory Limit” on page 5-42

“Freeing Memory” on page 5-43

Memory Usage

The first time it needs to allocate memory to store an image frame, the toolbox determines the total amount of memory it has available to store acquired image frames. By default, the toolbox sets this value, called the *frame memory limit*, to equal all the physical memory that is available when the toolbox is first accessed.

Image data can require a lot of memory. For example, even a relatively small (96-by-128) 24-bit color image requires almost 37 K bytes for each frame.

whos

Name	Size	Bytes	Class
rgb_image	96x128x3	36864	uint8 array

Monitoring Memory Usage

The toolbox includes a utility function, called `imaqmem`, that provides information about the toolbox’s current memory usage.

The `imaqmem` function returns a structure that contains several memory usage statistics including the total amount of physical memory available, the amount of physical memory currently in use, and a value, called the memory load, that characterizes the current memory usage.

To illustrate, this example calls `imaqmem` and then uses the frame memory limit and the current frame memory usage statistics to calculate how much memory is left for image frame storage.

```
out = imaqmem;  
mem_left = out.FrameMemoryLimit - out.FrameMemoryUsed;
```

To see an example of using a callback function to monitor memory usage, see “Monitoring Memory Usage” on page 7-18.

Modifying the Frame Memory Limit

To enable your image acquisition application to work with more image frames, you might want to increase the frame memory limit. Using the `imaqmem` function you can determine the current frame memory limit and specify a new one. The following example illustrates this process.

- 1 Determine the current frame memory limit** — This example calls the `imaqmem` function, requesting the value of the `FrameMemoryLimit` field.

```
out = imaqmem('FrameMemoryLimit')  
  
out =  
  
15425536
```

- 2 Set the frame memory limit to a new value** — When you call `imaqmem` with a numeric argument, it sets the `FrameMemoryLimit` field to the value.

```
imaqmem(36000000)
```

- 3 Verify the frame memory limit setting** — Call `imaqmem` again, requesting the value of the `FrameMemoryLimit` field.

```
out = imaqmem('FrameMemoryLimit')  
  
out =  
  
36000000
```


Freeing Memory

At times, while acquiring image data, you might want to delete some or all of the frames that are stored in memory. Using the `flushdata` function, you can delete all the frames currently stored in memory or only those frames associated with the execution of a trigger.

The following example illustrates how to use `flushdata` to delete all the frames in memory or one trigger's worth of frames.

- 1 Create an image acquisition object** — This example creates a video input object for a Windows image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

- 2 Configure properties** — For this example, configure an acquisition of five frames per trigger and, to show the effect of `flushdata`, configure multiple triggers using the `TriggerRepeat` property.

```
vid.FramesPerTrigger = 5  
vid.TriggerRepeat = 2;
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger, acquires five frames of data, and repeats this trigger two more times. After logging the specified number of frames, the object stops running.

To verify that the object acquired data, view the value of the `FramesAvailable` property. This property reports how many frames are currently stored in the memory buffer.

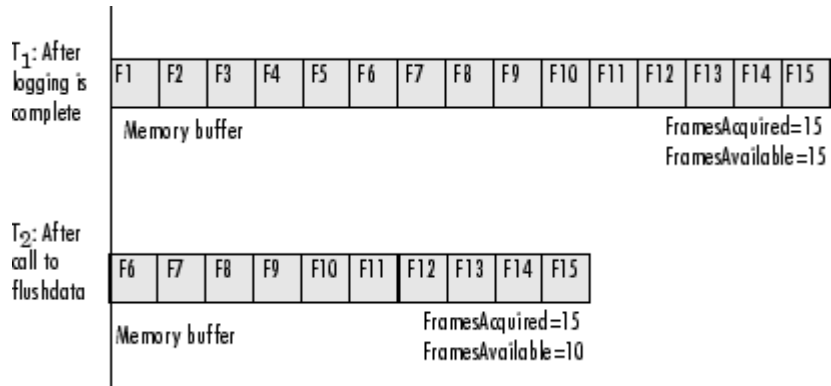
```
vid.FramesAvailable
ans =

    15
```

4 Delete a trigger's worth of image data — Call the `flushdata` function, specifying the mode `'triggers'`. This deletes the frames associated with the oldest trigger.

```
flushdata(vid,'triggers');
```

The following figure shows the frames acquired before and after the call to `flushdata`. Note how `flushdata` deletes the frames associated with the oldest trigger.



To verify that the object deleted the frames, view the value of the `FramesAvailable` property.

```
vid.FramesAvailable
ans =

    10
```

- 5 Empty the entire memory buffer** — Calling `flushdata` without specifying the mode deletes all the frames stored in memory.

```
flushdata(vid);
```

To verify that the object deleted the frames, view the value of the `FramesAvailable` property.

```
vid.FramesAvailable  
ans =  
  
    0
```

- 6 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Logging Image Data to Disk

In this section...
“Logging Data to Disk Using VideoWriter” on page 5-46
“Logging Data to Disk Using VideoWriter” on page 5-48
“Logging Data to Disk Using an AVI File” on page 5-49
“Creating an AVI File Object for Logging” on page 5-51
“Logging Data to Disk Using an AVI File” on page 5-53

Logging Data to Disk Using VideoWriter

While a video input object is running, you can log image data being acquired to a disk file. Logging image data to disk provides a record of your data. You can log data to several formats but VideoWriter is recommended, instead of using an AVI file.

For the best performance, logging to disk requires a MATLAB VideoWriter object, which is a MATLAB function, not an Image Acquisition Toolbox function. After you create and configure a VideoWriter object, provide it to the videoinput object's DiskLogger property.

VideoWriter provides a number of different profiles that log the data in different formats. The following example uses the Motion JPEG 2000 profile, which can log single-banded (grayscale) data as well as multi-byte data. Supported profiles are:

- 'Motion JPEG 2000' — Compressed Motion JPEG 2000 file.
- 'Archival' — Motion JPEG 2000 file with lossless compression.
- 'Motion JPEG AVI' — Compressed AVI file using Motion JPEG codec.
- 'Uncompressed AVI' — Uncompressed AVI file with RGB24 video.
- 'MPEG-4' — Compressed MPEG-4 file with H.264 encoding (systems with Windows 7 or Mac OS X 10.7 and later).
- 'Grayscale AVI' — Uncompressed AVI file with grayscale video. Only used for monochrome devices.

- 'Indexed AVI' — Uncompressed AVI file with indexed video. Only used for monochrome devices.

Logging Data to Disk Using VideoWriter

This example uses a GigE Vision device in a grayscale format (Mono10).

- 1** Create a video input object that accesses a GigE Vision image acquisition device and uses grayscale format at 10 bits per pixel.

```
vidobj = videoinput('gige', 1, 'Mono10');
```

- 2** You can log acquired data to memory, to disk, or both. By default, data is logged to memory. To change the logging mode to disk, configure the video input object's `LoggingMode` property.

```
set(vidobj, 'LoggingMode', 'disk')
```

- 3** Create a `VideoWriter` object with the profile set to Motion JPEG 2000.

```
logfile = VideoWriter('logfile.mj2', 'Motion JPEG 2000')
```

- 4** Configure the video input object to use the `VideoWriter` object.

```
vidobj.DiskLogger = logfile;
```

- 5** Now that the video input object is configured for logging data to a Motion JPEG 2000 file, initiate the acquisition.

```
start(vidobj)
```

- 6** Wait for the acquisition to finish.

```
wait(vidobj, 5)
```

- 7** When logging large amounts of data to disk, disk writing occasionally lags behind the acquisition. To determine whether all frames are written to disk, you can optionally use the `DiskLoggerFrameCount` property.

```
while (vidobj.FramesAcquired ~= vidobj.DiskLoggerFrameCount)  
    pause(.1)  
end
```

- 8 You can verify that the `FramesAcquired` and `DiskLoggerFrameCount` properties have identical values by using these commands and comparing the output.

```
vidobj.FramesAcquired  
vidobj.DiskLoggerFrameCount
```

- 9 When the video input object is no longer needed, delete it and clear it from the workspace.

```
delete(vidobj)  
clear vidobj
```

Guidelines for Using a VideoWriter Object to Log Image Data

Note the following when using `VideoWriter`.

- You should not delete the video input object until logging has been completed as indicated by the `DiskLoggerFrameCount` property equaling the `FramesAcquired` property. Doing so will cause disk logging to stop without all of the data being logged.
- If `START` is called multiple times without supplying a new `VideoWriter` object, the contents of the previous file will be erased when `START` is called.
- Once the `VideoWriter` object has been passed to the `DiskLogger` property, you should not modify it.

Logging Data to Disk Using an AVI File

While a video input object is running, you can log the image data being acquired to a disk file. Logging image data to disk provides a record of your data. You can log data to several formats but we recommend using `VideoWriter`, as described in the previous section. However, if you need to use an AVI file, this section describes how to do that.

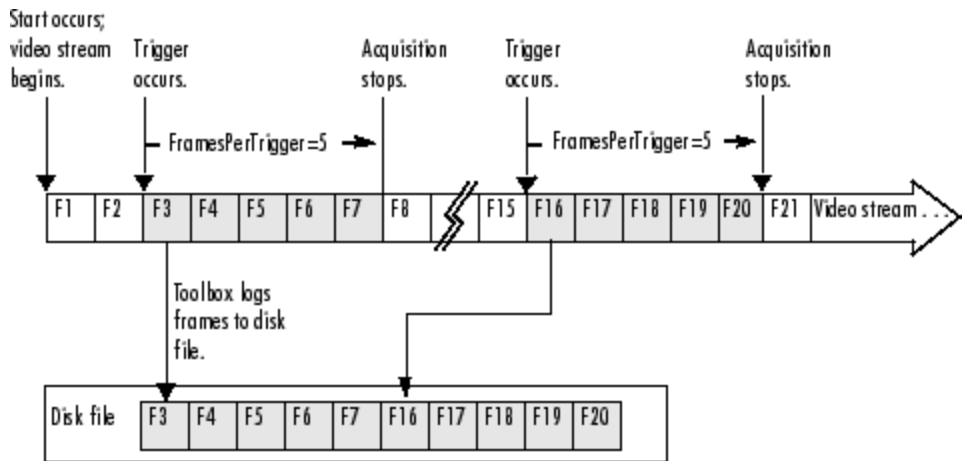
To set up data logging to disk:

- 1 Create a disk file to store the data. The toolbox logs the data to disk in Audio Video Interleave (AVI) format because this format provides data compression capabilities that allow for efficient storage. You must use the

MATLAB `avifile` function to create this log file. For more information, see “Creating an AVI File Object for Logging” on page 5-51.

- 2** Set the value of the video input object `LoggingMode` property to `'disk'` or `'disk&memory'`.
- 3** Set the value of the video input object `DiskLogger` property to the AVI file object created in step 1.

The following figure shows how the toolbox adds frames to the AVI file when a trigger occurs. With each subsequent trigger, the toolbox appends the acquired frames to the end of the AVI file. The frames must have the same dimensions. For an example of how to set up disk data logging, see “Logging Data to Disk Using an AVI File” on page 5-53.



Logging Data to a Disk File

Note AVI files are limited to a bit-depth of 8 bits per pixel for each band. If you have higher bit data, you should not log it to an AVI file since the AVI format is restricted to 8-bit data. If you do log higher bit data to an AVI file, it will be scaled and then logged as 8-bit data.

Creating an AVI File Object for Logging

To create an AVI file in the MATLAB environment, use the `avifile` function. You specify the name of the AVI file to the `avifile` function. For example, to create the AVI file named `my_datalog.avi`, enter this code at the MATLAB command prompt.

```
aviobj = avifile('my_datalog.avi');
```

The `avifile` function returns an AVI file object. You can use the AVI file object returned by the `avifile` function, `aviobj`, to modify characteristics of the AVI file by setting the values of the object's properties. For example, you can specify the codec used for data compression or specify the desired quality of the output.

For more information about AVI file objects, see the MATLAB `avifile` documentation. For more information about using AVI files to log image data, see the following topics.

- “Logging Grayscale Images Using an AVI File” on page 5-51
- “Guidelines for Using an AVI File Object to Log Image Data” on page 5-51
- “Closing the DiskLogger AVI file” on page 5-52

Logging Grayscale Images Using an AVI File

When logging images in grayscale format, such as RS170, you must set the value of the AVI object's `Colormap` property to be a grayscale colormap. Otherwise, the image data in the AVI file will not display correctly.

This example uses the MATLAB `gray` function to create a grayscale colormap and sets the value of the AVI file object's `Colormap` property with this colormap.

```
logfile = avifile('my_datalog.avi', 'Colormap', gray(256));
```

Guidelines for Using an AVI File Object to Log Image Data

When you specify the AVI file object as the value of the `DiskLogger` property, you are creating a copy of the AVI file object. Do not access the AVI file object using the original variable name, `aviobj`, while the video input object is using

the file for data logging. To avoid file access conflicts, keep in mind these guidelines when using an AVI file for data logging:

- Do not close an AVI file object while it is being used for data logging.
- Do not use the AVI file `addframe` function to add frames to the AVI file object while it is being used for data logging.
- Do not change the values of any AVI file object properties while it is being used for data logging.

Note AVI files are limited to a bit-depth of 8 bits per pixel for each band. If you have higher bit data, you should not log it to an AVI file since the AVI format is restricted to 8-bit data. If you do log higher bit data to an AVI file, it will be scaled and then logged as 8-bit data.

Closing the DiskLogger AVI file

When data logging has ended, close the AVI file to make it accessible outside the MATLAB environment. Use the value of the video input object `DiskLogger` property to reference the AVI file, rather than the variable returned when you created the AVI file object (`aviobj`). See “Logging Data to Disk Using an AVI File” on page 5-53 for an example.

Before you close the file, make sure that the video input object has finished logging frames to disk. Because logging to disk takes more time than logging to memory, the completion of disk logging can lag behind the completion of memory logging. To determine when logging to disk is complete, check the value of the `DiskLoggerFrameCount` property; this property tells how many frames have been logged to disk.

Note When you log frames to disk, the video input object queues the frames for writing but the operating system might not perform the write operation immediately. Closing an AVI file causes the data to be written to the disk.

Logging Data to Disk Using an AVI File

This example illustrates how to configure a video input object to log data to a disk file:

- 1 Create a MATLAB AVI file object** — Create the MATLAB AVI file that you want to use for data logging, using the `avifile` function. You specify the name of the AVI file when you create it.

```
my_log = 'my_datalog.avi';
aviobj = avifile(my_log);

aviobj

Adjustable parameters:
      Fps: 15.0000
  Compression: 'Indeo3'
      Quality: 75
KeyFramePerSec: 2.1429
      VideoName: 'my_datalog.avi'
```

```
Automatically updated parameters:
      Filename: 'my_datalog.avi'
  TotalFrames: 0
      Width: 0
      Height: 0
      Length: 0
      ImageType: 'Unknown'
  CurrentState: 'Open'
```

- 2 Configure properties of the AVI file object** — You can optionally configure the properties of the AVI file object. The AVI file object supports properties that control the data compression used, image quality, and other characteristics of the file. The example sets the quality property to a midlevel value. By lowering the quality, the AVI file object creates smaller log files.

```
aviobj.Quality = 50;
```

Because this example acquires image data in grayscale format (RS170), you must also specify the colormap used with the AVI object to ensure that the stored data displays correctly.

```
aviobj.Colormap = gray(256);
```

- 3 Create a video input object** — This example creates a video input object for a Matrox image acquisition device, using the default video format M_RS170. To run this example on your system, use the `imaqhwinfo` function to get the video input object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

- 4 Configure video input object properties** — Set up disk logging by setting the value of the `DiskLogger` property to be `aviobj`, the AVI file object created in step 1. Then, set the `LoggingMode` property to `'disk'` (or `'disk&memory'`). This example also sets the `TriggerRepeat` property.

```
vid.LoggingMode = 'disk&memory';  
vid.DiskLogger = aviobj;  
vid.TriggerRepeat = 3;
```

- 5 Start the video input object** — Start logging data to disk.

```
start(vid)
```

The object executes an immediate trigger, acquires frames of data, repeats the trigger three additional times, and then stops.

To verify that all the frames have been logged to the AVI file, check the value of the `DiskLoggerFrameCount` property. This property tells the number of frames that have been logged to disk.

```
vid.DiskLoggerFrameCount
```

```
ans =
```

```
40
```

Note Because it takes longer to write frames to a disk file than to memory, the value of the `DiskLoggerFrameCount` property can lag behind the value of the `FramesAvailable` property, which specifies the number of frames logged to memory.

To verify that a disk file was created, go to the directory in which the log file resides and make sure it exists. The `exist` function returns 2 if the file exists.

```
if(exist(my_log)==2)
    disp('AVI file created.')
end
```

- 6 Close the AVI file object** — Close the AVI file to make it available outside the MATLAB environment. Closing the AVI file object ensures that the logged data is written to the disk file. Be sure to use the value of the video input object `DiskLogger` property, `vid.DiskLogger`, to reference the AVI file object, not the original variable, `aviobj`, returned by the `avifile` function.

```
aviobj = close(vid.DiskLogger);
```

Use the original variable, `aviobj`, as the return value when closing an AVI file object.

- 7 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```


Working with Acquired Image Data

When you trigger an acquisition, the toolbox stores the image data in a memory buffer, a disk file, or both. To work with this data, you must bring it into the MATLAB workspace.

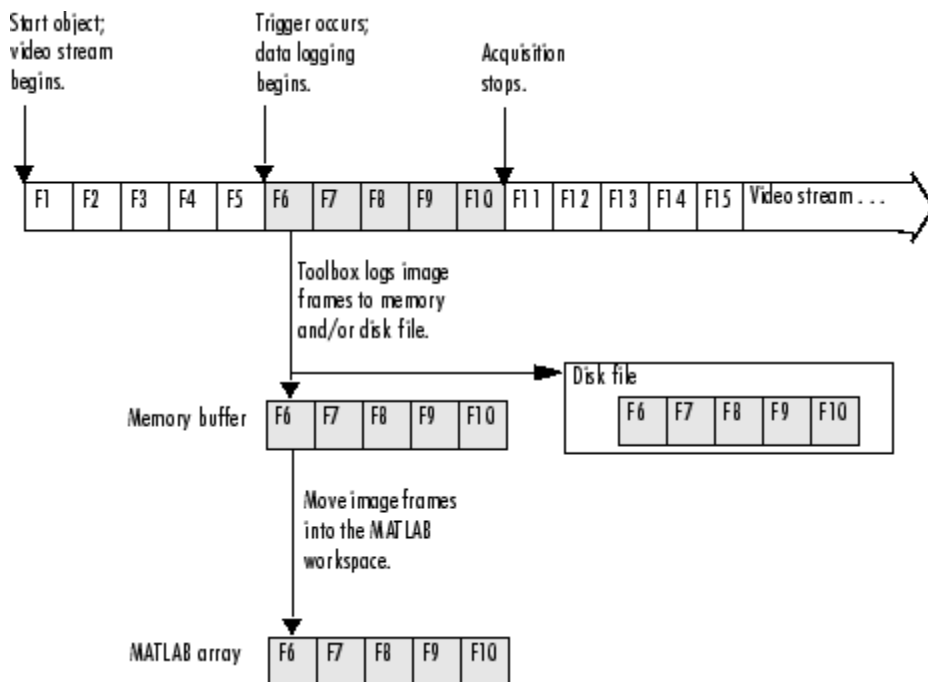
This chapter describes how you use video input object properties and toolbox functions to bring the logged data into the MATLAB workspace.

- “Image Acquisition Overview” on page 6-2
- “Bringing Image Data into the MATLAB Workspace” on page 6-3
- “Working with Image Data in MATLAB Workspace” on page 6-12
- “Retrieving Timing Information” on page 6-24

Image Acquisition Overview

When a trigger occurs, the toolbox acquires frames from the video stream and logs the frames to a buffer in memory, a disk file, or both, depending on the value of the `LoggingMode` property. To work with this logged image data, you must bring it into the MATLAB workspace.

The following figure illustrates a group of frames being acquired from the video stream, logged to memory and disk, and brought into the MATLAB workspace as a multidimensional numeric array. Note that when frames are brought into the MATLAB workspace, they are removed from the memory buffer.



Overview of Image Acquisition

Bringing Image Data into the MATLAB Workspace

In this section...

“Overview” on page 6-3

“Moving Multiple Frames into the Workspace” on page 6-4

“Viewing Frames in the Memory Buffer” on page 6-6

“Bringing a Single Frame into the Workspace” on page 6-10

Overview

The toolbox provides three ways to move frames from the memory buffer into the MATLAB workspace:

- **Removing multiple frames from the buffer** — To move a specified number of frames from the memory buffer into the workspace, use the `getdata` function. The `getdata` function removes the frames from the memory buffer as it moves them into the workspace. The function blocks the MATLAB command line until all the requested frames are available, or until a timeout value expires. For more information, see “Moving Multiple Frames into the Workspace” on page 6-4.
- **Viewing the most recently acquired frames in the buffer** — To bring the most recently acquired frames in the memory buffer into the workspace *without* removing them from the buffer, use the `peekdata` function. When returning frames, `peekdata` starts with the most recently acquired frame and works backward in the memory buffer. In contrast, `getdata` starts at the beginning of the buffer, returning the oldest acquired frame first. `peekdata` does not block the command line and is not guaranteed to return all the frames you request. For more information, see “Viewing Frames in the Memory Buffer” on page 6-6.
- **Bringing a single frame of data into the workspace** — As a convenience, the toolbox provides the `getsnapshot` function, which returns a single frame of data into the MATLAB workspace. Because the `getsnapshot` function does not require starting the object or triggering an acquisition, it is the easiest way to bring image data into the workspace. `getsnapshot` is independent of the memory buffer; it can return a frame even if the memory buffer is empty, and the frame returned does not

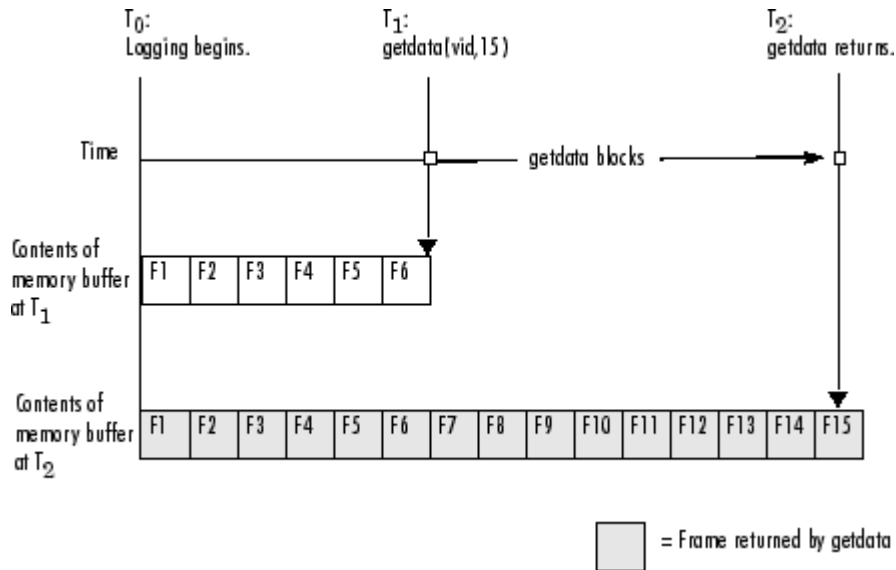
affect the value of the `FramesAvailable` property. For more information, see “Bringing a Single Frame into the Workspace” on page 6-10. For an example of using `getsnapshot`, see the Image Acquisition Toolbox example **Acquiring a Single Image in a Loop** in the **Examples** list at the top of the Image Acquisition Toolbox main Documentation Center page, or open the file `demoimaq_GetSnapshot.m` in the MATLAB Editor.

Moving Multiple Frames into the Workspace

To move multiple frames of data from the memory buffer into the MATLAB workspace, use the `getdata` function. By default, `getdata` retrieves the number of frames specified in the `FramesPerTrigger` property but you can specify any number. See the `getdata` reference page for complete information about this function.

Note When the `getdata` function moves frames from the memory buffer into the workspace, it removes the frames from the memory buffer.

In this figure, `getdata` is called at T_1 with a request for 15 frames but only six frames are available in the memory buffer. `getdata` blocks until the specified number of frames becomes available, at T_2 , at which point `getdata` moves the frames into the MATLAB workspace and returns control to the command prompt.



getdata Blocks Until Frames Become Available

Acquiring 10 Seconds of Image Data

This example shows how you can configure an approximate time-based acquisition using the `FramesPerTrigger` property:

- 1 Create an image acquisition object** — This example creates a video input object for a Windows image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

- 2 Configure properties** — To acquire 10 seconds of data, determine the frame rate of your image acquisition device and then multiply the frame rate by the number of seconds of data you want to acquire. The product of this multiplication is the value of the `FramesPerTrigger` property.

For this example, assume a frame rate of 30 frames per second (fps). Multiplying 30 by 10, you need to set the `FramesPerTrigger` property to the value 300.

```
set(vid, 'FramesPerTrigger', 300)
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger and begins acquiring frames of data. The `start` function returns control to the command line immediately but the object continues logging the data to the memory buffer. After logging the specified number of frames, the object stops running.

- 4 Bring the acquired data into the workspace** — To verify that you acquired the amount of data you wanted, use the optional `getdata` syntax that returns the timestamp of every frame acquired. The difference between the first timestamp and the last timestamp should approximate the amount of data you expected.

```
[data time] = getdata(vid, 300);  
  
elapsed_time = time(300) - time(1)
```

```
10.0467
```

- 5 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Viewing Frames in the Memory Buffer

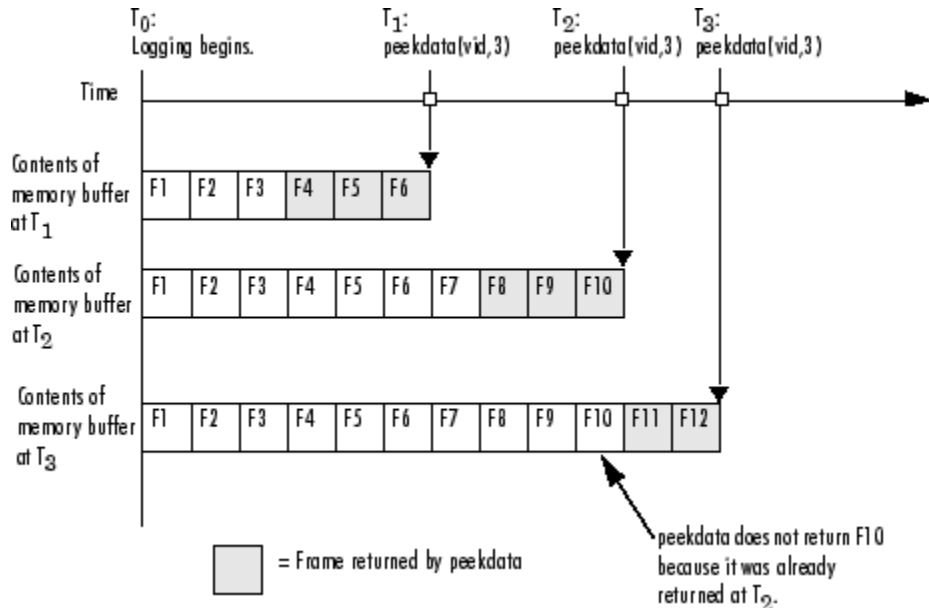
To view sample frames from the memory buffer without removing them, use the `peekdata` function.

The `peekdata` function always returns the most recently acquired frames in the memory buffer. For example, if you request three frames, `peekdata` returns the most recently acquired frame in the buffer at the time of the request and the two frames that immediately precede it.

The following figure illustrates this process. The command `peekdata(vid, 3)` is called at three different times (T_1 , T_2 , and T_3). The shaded frames indicate

the frames returned by `peekdata` at each call. (`peekdata` returns frames without removing them from the memory buffer.)

Note in the figure that, at T_3 , only two frames have become available since the last call to `peekdata. In this case, peekdata returns only the two frames, with a warning that it returned less data than was requested.`



Frames Returned by `peekdata`

Note The `peekdata` function does not return any data while running if in disk logging mode.

The following example illustrates how to use `peekdata`:

- 1 Create an image acquisition object** — This example creates a video input object for a Data Translation image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('dt',1);
```

- 2 Configure properties** — For this example, configure a manual trigger. You must use the `triggerconfig` function to specify the trigger type.

```
triggerconfig(vid,'manual')
```

In addition, configure a large enough acquisition to allow several calls to `peekdata` before it finishes.

```
set(vid,'FramesPerTrigger',300);
```

- 3 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The video object is now running but not logging.

```
isrunning(vid)
```

```
ans =
```

```
1
```

```
islogging(vid)
```

```
ans =
```

```
0
```

- 4 Use `peekdata` to view frames before a trigger** — If you call `peekdata` before you trigger the acquisition, `peekdata` can only return a single frame of data because data logging has not been initiated and the memory buffer is empty. If more than one frame is requested, `peekdata` issues a warning that it is returning fewer than the requested number of frames.

```
pdata = peekdata(vid,50);
```

```
Warning: PEEKDATA could not return all the frames requested.
```

Verify that `peekdata` returned a single frame. A single frame of data should have the same width and height as specified by the `ROIPosition`

property and the same number of bands, as specified by the `NumberOfBands` property. In this example, the video format of the data is RGB so the value of the `NumberOfBands` property is 3.

```
whos
  Name          Size          Bytes  Class

  pdata         96x128x3         36864  uint8 array
  vid           1x1             1060  videoinput object
```

Verify that the object has not acquired any frames.

```
get(vid, 'FramesAcquired')
ans =
    0
```

5 Trigger the acquisition — Call the `trigger` function to trigger an acquisition.

```
trigger(vid)
```

The object begins logging frames to the memory buffer.

6 View the most recently acquired frames — While the acquisition is in progress, call `peekdata` several times to view the latest frames in the memory buffer. Depending on the number of frames you request, and the timing of these requests, `peekdata` might return fewer than the number of frames you specify.

```
pdata = peekdata(vid,50);
```

To verify that `peekdata` returned the frames you requested, check the dimensions of `pdata`. `peekdata` returns a four-dimensional array of frames, where the last dimension indicates the number of frames returned.

```
whos
  Name          Size          Bytes  Class

  pdata         4-D             1843200  uint8 array
  vid           1x1             1060  videoinput object
```

```
size(pdata)
```

```
ans =  
  
    96    128     3    50
```

7 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Bringing a Single Frame into the Workspace

To bring a single frame of image data into the MATLAB workspace, use the `getsnapshot` function. You can call the `getsnapshot` function at any time after object creation.

This example illustrates how simple it is to use the `getsnapshot` function.

1 Create an image acquisition object — This example creates a video input object for a Matrox device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

2 Bring a frame into the workspace — Call the `getsnapshot` function to bring a frame into the workspace. Note that you do not need to start the video input object before calling the `getsnapshot` function.

```
frame = getsnapshot(vid);
```

The `getsnapshot` function returns an image of the same width and height as specified by the `ROIPosition` property and the same number of bands as specified by the `NumberOfBands` property. In this example, the video format of the data is RGB so the value of the `NumberOfBands` property is 3.

```
whos  
  
Name          Size          Bytes  Class  
  
frame        96x128x3      36864  uint8 array  
vid          1x1           1060  videoinput object
```


Note that the frame returned by `getsnapshot` is not removed from the memory buffer, if frames are stored there, and does not affect the value of the `FramesAvailable` property.

3 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

For an example of using `getsnapshot`, see the Image Acquisition Toolbox example **Acquiring a Single Image in a Loop** in the **Examples** list at the top of the Image Acquisition Toolbox main Documentation Center page, or open the file `demoimaq_GetSnapshot.m` in the MATLAB Editor.

Working with Image Data in MATLAB Workspace

In this section...

“Understanding Image Data” on page 6-12

“Determining the Dimensions of Image Data” on page 6-13

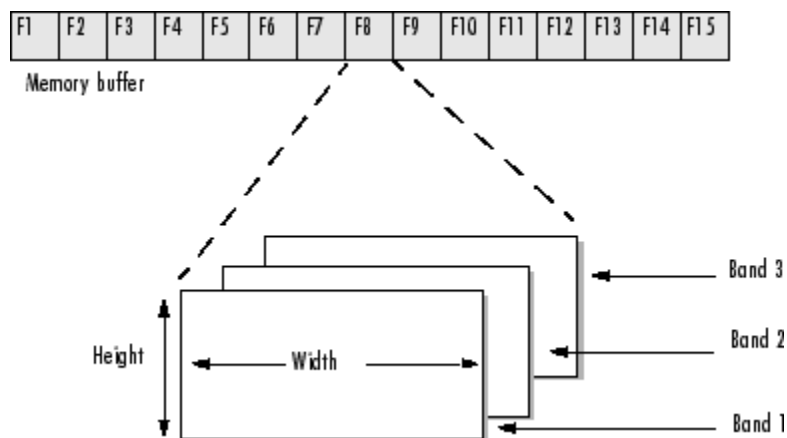
“Determining the Data Type of Image Frames” on page 6-16

“Specifying the Color Space” on page 6-17

“Viewing Acquired Data” on page 6-23

Understanding Image Data

The illustrations in this documentation show the video stream and the contents of the memory buffer as a sequence of individual frames. In reality, each frame is a multidimensional array. The following figure illustrates the format of an individual frame.



Format of an Individual Frame

The following sections describes how the toolbox

- Determines the dimensions of the data returned
- Determines the data type used for the data

- Determines the color space of the data

This section also describes several ways to view acquired image data.

Determining the Dimensions of Image Data

The video format used by the image acquisition device is the primary determinant of the width, height, and the number of bands in each image frame. Image acquisition devices typically support multiple video formats. You select the video format when you create the video input object (described in “Specifying the Video Format” on page 4-12). The video input object stores the video format in the `VideoFormat` property.

Industry-standard video formats, such as RS170 or PAL, include specifications of the image frame width and height, referred to as the *image resolution*. For example, the RS170 standard defines the width and height of the image frame as 640-by-480 pixels. Other devices, such as digital cameras, support the definition of many different, nonstandard image resolutions. The video input object stores the video resolution in the `VideoResolution` property.

Each image frame is three dimensional; however, the video format determines the number of bands in the third dimension. For color video formats, such as RGB, each image frame has three bands: one each for the red, green, and blue data. Other video formats, such as the grayscale RS170 standard, have only a single band. The video input object stores the size of the third dimension in the `NumberOfBands` property.

Note Because devices typically express video resolution as width-by-height, the toolbox uses this convention for the `VideoResolution` property. However, when data is brought into the MATLAB workspace, the image frame dimensions are listed in reverse order, height-by-width, because MATLAB expresses matrix dimensions as row-by-column.

ROIs and Image Dimensions

When you specify a region-of-interest (ROI) in the image being captured, the dimensions of the ROI determine the dimensions of the image frames returned. The `VideoResolution` property specifies the dimensions of the

image data being provided by the device; the `ROIPosition` property specifies the dimensions of the image frames being logged. See the `ROIPosition` property reference page for more information.

Video Format and Image Dimensions

The following example illustrates how video format affects the size of the image frames returned.

- 1 Select a video format** — Use the `imaqhwinfo` function to view the list of video formats supported by your image acquisition device. This example shows the video formats supported by a Matrox Orion frame grabber. The formats are industry standard, such as RS170, NTSC, and PAL. These standards define the image resolution.

```
info = imaqhwinfo('matrox');  
  
info.DeviceInfo.SupportedFormats  
  
ans =  
Columns 1 through 4  
  
    'M_RS170'    'M_RS170_VIA_RGB'    'M_CCIR'    'M_CCIR_VIA_RGB'  
  
Columns 5 through 8  
  
    'M_NTSC'    'M_NTSC_RGB'    'M_NTSC_YC'    'M_PAL'  
  
Columns 9 through 10  
  
    'M_PAL_RGB'    'M_PAL_YC'
```

- 2 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device using the default video format, RS170. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

- 3 View the video format and video resolution properties** — The toolbox creates the object with the default video format. This format defines the video resolution.

```
get(vid,'VideoFormat')  
  
ans =  
  
    M_RS170  
  
get(vid,'VideoResolution')  
  
ans =  
  
    [640 480]
```

- 4 Bring a single frame into the workspace** — Call the `getsnapshot` function to bring a frame into the workspace.

```
frame = getsnapshot(vid);
```

The dimensions of the returned data reflect the image resolution and the value of the `NumberOfBands` property.

```
vid.NumberOfBands  
ans =  
  
    1  
  
size(frame)  
  
ans =  
  
    480 640
```

- 5 Start the image acquisition object** — Call the `start` function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger and begins acquiring frames of data.

- 6 Bring multiple frames into the workspace** — Call the `getdata` function to bring multiple image frames into the MATLAB workspace.

```
data = getdata(vid,10);
```

The `getdata` function brings 10 frames of data into the workspace. Note that the returned data is a four-dimensional array: each frame is three-dimensional and the n th frame is indicated by the fourth dimension.

```
size(data)
```

```
ans =
```

```
480 640 1 10
```

- 7 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
```

```
clear vid
```

Determining the Data Type of Image Frames

By default, the toolbox returns image frames in the data type used by the image acquisition device. If there is no MATLAB data type that matches the object's native data type, `getdata` chooses a MATLAB data type that preserves numerical accuracy. For example, in RGB 555 format, each color component is expressed in 5-bits. `getdata` returns each color as a `uint8` value.

You can specify the data type you want `getdata` to use for the returned data. For example, you can specify that `getdata` return image frames as an array of class `double`. To see a list of all the data types supported, see the `getdata` reference page.

The following example illustrates the data type of returned image data.

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

- 2 Bring a single frame into the workspace** — Call the `getsnapshot` function to bring a frame into the workspace.

```
frame = getsnapshot(vid);
```

- 3 View the class of the returned data** — Use the `class` function to determine the data type used for the returned image data.

```
class(frame)
```

```
ans =
```

```
uint8
```

- 4 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
```

```
clear vid
```

Specifying the Color Space

For most image acquisition devices, the video format of the video stream determines the color space of the acquired image data, that is, the way color information is represented numerically.

For example, many devices represent colors as RGB values. In this color space, colors are represented as a combination of various intensities of red, green, and blue. Another color space, widely used for digital video, is the YCbCr color space. In this color space, luminance (brightness or intensity) information is stored as a single component (Y). Chrominance (color) information is stored as two color-difference components (Cb and Cr). Cb represents the difference between the blue component and a reference value. Cr represents the difference between the red component and a reference value.

The toolbox can return image data in grayscale, RGB, and YCbCr. To specify the color representation of the image data, set the value of the `ReturnedColorSpace` property. To display image frames using the `image`, `imagesc`, or `imshow` functions, the data must use the RGB color space.

Another MathWorks® product, the Image Processing Toolbox software, includes functions that convert YCbCr data to RGB data, and vice versa.

Note Some devices that claim to support the YUV color space actually support the YCbCr color space. YUV is similar to YCbCr but not identical. The difference between YUV and YCbCr is the scaling factor applied to the result. YUV refers to a particular scaling factor used in composite NTSC and PAL formats. In most cases, you can specify the YCbCr color space for devices that support YUV.

You can determine your device's default color space by using the `get` function: `get(vid, 'ReturnedColorSpace')`, where `vid` is the name of the video object. An example of this is shown in step 2 in the example below. There may be situations when you wish to change the color space. The example below shows a case where the default color space is `rgb`, and you change it to `grayscale` (step 3).

The following example illustrates how to specify the color space of the returned image data.

1 Create an image acquisition object — This example creates a video input object for a generic Windows image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('winvideo',1);
```

2 View the default color space used for the data — The value of the `ReturnedColorSpace` property indicates the color space of the image data.

```
get(vid, 'ReturnedColorSpace')
```

```
ans =
```

```
rgb
```


- 3 Modify the color space used for the data** — To change the color space of the returned image data, set the value of the `ReturnedColorSpace` property.

```
set(vid, 'ReturnedColorSpace', 'grayscale')
```

```
ans =
```

```
grayscale
```

- 4 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
```

```
clear vid
```

Converting Bayer Images

You can use the `ReturnedColorSpace` and `BayerSensorAlignment` properties to control Bayer demosaicing.

If your camera uses Bayer filtering, the toolbox supports the Bayer pattern and can return color if desired. By setting the `ReturnedColorSpace` property to `'bayer'`, the Image Acquisition Toolbox software will demosaic Bayer patterns returned by the hardware. This color space setting will interpolate Bayer pattern encoded images into standard RGB images.

In order to perform the demosaicing, the toolbox needs to know the pixel alignment of the sensor. This is the order of the red, green, and blue sensors and is normally specified by describing the four pixels in the upper-left corner of the sensor. It is the band sensitivity alignment of the pixels as interpreted by the camera's internal hardware. You must get this information from the camera's documentation and then specify the value for the alignment.

If your camera can return Bayer data, the toolbox can automatically convert it to RGB data for you, or you can specify it to do so. The following two examples illustrate both use cases.

Manual Conversion

The camera in this example has a Bayer sensor. The GigE Vision™ standard allows cameras to inform applications that the data is Bayer encoded and provides enough information for the application to convert the Bayer pattern into a color image. In this case the toolbox automatically converts the Bayer pattern into an RGB image.

- 1** Create a video object `vid` using the GigE Vision adaptor and the designated video format.

```
vid = videoinput('gige', 1, 'BayerGB8_640x480');
```

- 2** View the default color space used for the data.

```
vid.ReturnedColorSpace
```

```
ans =
```

```
rgb
```

- 3** Create a one-frame image `img` using the `getsnapshot` function.

```
img = getsnapshot(vid);
```

- 4** View the size of the acquired image.

```
size(img)
```

```
ans =
```

```
480 640 3
```

- 5** Sometimes you might not want the toolbox to automatically convert the Bayer pattern into a color image. For example, there are a number of different algorithms to convert from a Bayer pattern into an RGB image and you might wish to specify a different one than the toolbox uses or you might want to further process the raw data before converting it into a color image.

```
% Set the color space to grayscale.
```

```
vid.ReturnedColorSpace = 'grayscale';
```

```
% Acquire another image frame.
img = getsnapshot(vid);

% Now check the size of the new frame acquired using grayscale.
size(img)
```

```
ans =
```

```
480 640
```

Notice how the size changed from the `rgb` image to the `grayscale` image by comparing the `size` output in steps 4 and 5.

- 6 You can optionally use the `demosaic` function in the Image Processing Toolbox to convert Bayer patterns into color images.

```
% Create an image colorImage by using the demosaic function on the
% image img and convert it to color.
colorImage = demosaic(img, 'gbgr');
```

```
% Now check the size of the new color image.
size(colorImage)
```

```
ans =
```

```
480 640 3
```

- 7 Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Automatic Conversion

The camera in this example returns data that is a Bayer mosaic, but the toolbox doesn't know it since the DCAM standard doesn't have any way for the camera to communicate that to software applications. You need to know that by reading the camera specifications or manual. The toolbox can automatically convert the Bayer encoded data to RGB data, but it must be programmed to do so.

- 1 Create a video object `vid` using the DCAM adaptor and the designated video format for raw data.

```
vid = videoinput('dcam', 1, 'F7_RAW8_640x480');
```

- 2 View the default color space used for the data.

```
vid.ReturnedColorSpace
```

```
ans =
```

```
grayscale
```

- 3 Create a one-frame image `img` using the `getsnapshot` function.

```
img = getsnapshot(vid);
```

- 4 View the size of the acquired image.

```
size(img)
```

```
ans =
```

```
480 640
```

- 5 The value of the `ReturnedColorSpace` property is `grayscale` because Bayer data is single-banded and the toolbox doesn't yet know that it needs to decode the data. Setting the `ReturnedColorSpace` property to `'bayer'` indicates that the toolbox should decode the data.

```
% Set the color space to Bayer.
```

```
vid.ReturnedColorSpace = 'bayer';
```

- 6 In order to properly decode the data, the toolbox also needs to know the alignment of the Bayer filter array. This should be in the camera documentation. You can then use the `BayerSensorAlignment` property to set the alignment.

```
% Set the alignment.
```

```
vid.BayerSensorAlignment = 'grbg';
```

The `getdata` and `getsnapshot` functions will now return color data.

```
% Acquire another image frame.
img = getsnapshot(vid);

% Now check the size of the new frame acquired returning color data.
size(img)

ans =

480 640 3

Remove the image acquisition object from memory.

delete(vid)
clear vid
```

Viewing Acquired Data

Once you bring the data into the MATLAB workspace, you can view it as you would any other image in MATLAB.

The Image Acquisition Toolbox software includes a function, `imaqmontage`, that you can use to view all the frames of a multiframe image array in a single MATLAB image object. `imaqmontage` arranges the frames so that they roughly form a square. `imaqmontage` can be useful for visually comparing multiple frames.

MATLAB includes two functions, `image` and `imagesc`, that display images in a figure window. Both functions create a MATLAB image object to display the frame. You can use image object properties to control aspects of the display. The `imagesc` function automatically scales the input data.

The Image Processing Toolbox software includes an additional display routine called `imshow`. Like `image` and `imagesc`, this function creates a MATLAB image object. However, `imshow` also automatically sets various image object properties to optimize the display.

Retrieving Timing Information

In this section...
“Introduction” on page 6-24
“Determining When a Trigger Executed” on page 6-24
“Determining When a Frame Was Acquired” on page 6-25
“Determining the Frame Delay Duration” on page 6-26

Introduction

The following sections describe how the toolbox provides acquisition timing information, particularly,

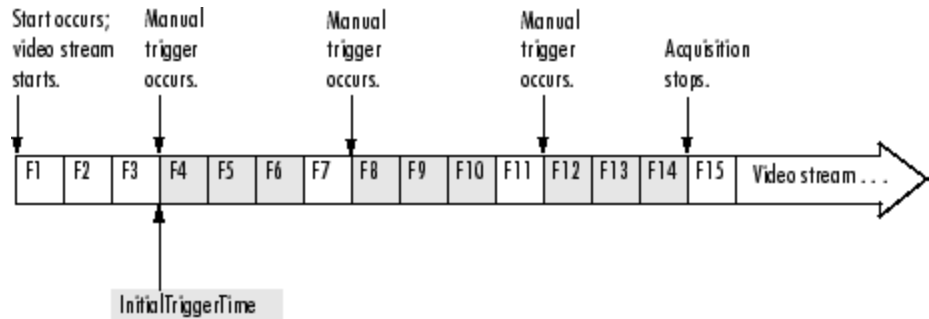
- Determining when a trigger executed
- Determining when a particular frame was acquired

To see an example of retrieving timing information, see “Determining the Frame Delay Duration” on page 6-26.

Determining When a Trigger Executed

To determine when a trigger executed, check the information returned by a trigger event in the object’s event log. You can also get access to this information in a callback function associated with a trigger event. For more information, see “Retrieving Event Information” on page 7-8.

As a convenience, the toolbox returns the time of the *first* trigger execution in the video input object’s `InitialTriggerTime` property. This figure indicates which trigger is returned in this property when multiple triggers are configured.



InitialTriggerTime Records First Trigger Execution

The trigger timing information is stored in MATLAB clock vector format. The following example displays the time of the first trigger for the video input object `vid`. The example uses the MATLAB `datestr` function to convert the information into a form that is more convenient to view.

```
datestr(vid.InitialTriggerTime)
```

```
ans =
```

```
02-Mar-2007 13:00:24
```

Determining When a Frame Was Acquired

The toolbox provides two ways to determine when a particular frame was acquired:

- By the absolute time of the acquisition
- By the elapsed time relative to the execution of the trigger

You can use the `getdata` function to retrieve both types of timing information.

Getting the Relative Acquisition Time

When you use the `getdata` function, you can optionally specify two return values. One return value contains the image data; the other return value contains a vector of timestamps that measure, in seconds, the time when the frame was acquired relative to the first trigger.

```
[data time] = getdata(vid);
```

To see an example, see “Determining the Frame Delay Duration” on page 6-26.

Getting the Absolute Acquisition Time

When you use the `getdata` function, you can optionally specify three return values. The first contains the image data, the second contains a vector of relative acquisition times, and the third is an array of structures where each structure contains metadata associated with a particular frame.

```
[data time meta ] = getdata(vid);
```

Each structure in the array contains the following four fields. The `Abstime` field contains the absolute time the frame was acquired. You can also retrieve this metadata by using event callbacks. See “Retrieving Event Information” on page 7-8 for more information.

Frame Metadata

Field Name	Description
<code>Abstime</code>	Absolute time the frame was acquired, returned in MATLAB clock format [year month day hour minute seconds]
<code>FrameNumber</code>	Frame number relative to when the object was started
<code>RelativeFrame</code>	Frame number relative to trigger execution
<code>TriggerIndex</code>	Trigger the event is associated with. For example, when the object starts, the associated trigger is 0. Upon stop, it is equivalent to the <code>TriggersExecuted</code> property.

Determining the Frame Delay Duration

To illustrate, this example calculates the duration of the delay specified by the `TriggerFrameDelay` property.

- 1 Create an image acquisition object** — This example creates a video input object for a Data Translation image acquisition device using the default video format. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.


```
vid = videoinput('dt',1);
```

- 2 Configure properties** — For this example, configure a trigger frame delay large enough to produce a noticeable duration.

```
set(vid, 'TriggerFrameDelay', 50)
```

- 3 Start the image acquisition object** — Call the start function to start the image acquisition object.

```
start(vid)
```

The object executes an immediate trigger and begins acquiring frames of data. The `start` function returns control to the command line immediately but data logging does not begin until the trigger frame delay expires. After logging the specified number of frames, the object stops running.

- 4 Bring the acquired data into the workspace** — Call the `getdata` function to bring frames into the workspace. Specify a return value to accept the timing information returned by `getdata`.

```
[data time ] = getdata(vid);
```

The variable `time` is a vector that contains the time each frame was logged, measured in seconds, relative to the execution of the first trigger. Check the first value in the time vector. It should reflect the duration of the delay before data logging started.

```
time
```

```
time =
```

```
4.9987  
5.1587  
5.3188  
5.4465  
5.6065  
5.7665  
5.8945  
6.0544  
6.2143  
6.3424
```

5 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Using Events and Callbacks

Using Events and Callbacks

You can enhance the power and flexibility of your image acquisition application by using *event callbacks*. An event is a specific occurrence that can happen while an image acquisition object is running. The toolbox defines a set of events that include starting, stopping, or acquiring frames of data.

When a particular event occurs, the toolbox can execute a function that you specify. This is called a *callback*. Certain events can result in one or more callbacks. You can use callbacks to perform processing tasks while your image acquisition object continues running. For example, you can display a message, analyze data, or perform other tasks. The start and stop callbacks, however, execute synchronously; the object does not perform any further processing until the callback function finishes.

Callbacks are controlled through video input object properties. Each event type has an associated property. You specify the function that you want executed as the value of the property.

The following topics describe using events and callbacks.

- “Using the Default Callback Function” on page 7-3
- “Event Types” on page 7-5
- “Retrieving Event Information” on page 7-8
- “Creating and Executing Callback Functions” on page 7-13

Using the Default Callback Function

To illustrate how to use callbacks, this section presents a simple example that creates an image acquisition object and associates a callback function with the start event, trigger event, and stop event. For information about all the event callbacks supported by the toolbox, see “Event Types” on page 7-5.

The example uses the default callback function provided with the toolbox, `imaqcallback`. The default callback function displays the name of the object along with information about the type of event that occurred and when it occurred. To learn how to create your own callback functions, see “Creating and Executing Callback Functions” on page 7-13.

This example illustrates how to use the default callback function.

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

- 2 Configure properties** — Set the values of three callback properties. The example uses the default callback function `imaqcallback`.

```
set(vid,'StartFcn',@imaqcallback)
set(vid,'TriggerFcn',@imaqcallback)
set(vid,'StopFcn',@imaqcallback)
```

For this example, specify the amount of data to log.

```
set(vid, 'FramesPerTrigger',100);
```

- 3 Start the image acquisition object** — Start the image acquisition object. The object executes an immediate trigger, acquires 100 frames of data, and then stops. With the three callback functions enabled, the object outputs information about each event as it occurs.

```
start(vid)
Start event occurred at 14:38:46 for video input object: M_RS170-matrox-1.
```

```
Trigger event occurred at 14:38:46 for video input object: M_RS170-matrox-1.  
Stop event occurred at 14:38:49 for video input object: M_RS170-matrox-1.
```

4 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Event Types

The Image Acquisition Toolbox software supports several different types of events. Each event type has an associated video input object property that you can use to specify the function that executes when the event occurs.

This table lists the supported event types, the name of the video input object property associated with the event, and a brief description of the event. For detailed information about these callback properties, see the property reference list in “Image Acquisition Toolbox Properties” on page 4-31.

The toolbox generates a specific set of information for each event and stores it in an event structure. To learn more about the contents of these event structures and how to retrieve this information, see “Retrieving Event Information” on page 7-8.

Note Callbacks, including `ErrorFcn`, are executed only when the video object is in a running state. If you need to use the `ErrorFcn` callback for error handling during previewing, you must start the video object before previewing. To do that without logging data, use a manual trigger.

Events and Callback Function Properties

Event	Callback Property	Description
Error	<code>ErrorFcn</code>	<p>The toolbox generates an error event when a run-time error occurs, such as a hardware error or timeout. Run-time errors do not include configuration errors such as setting an invalid property value.</p> <p>When an error event occurs, the toolbox executes the function specified by the <code>ErrorFcn</code> property. By default, the toolbox executes the default callback function for this event, <code>imaqcallback</code>,</p>

Events and Callback Function Properties (Continued)

Event	Callback Property	Description
		which displays the error message at the MATLAB command line.
Frames Acquired	FramesAcquiredFcn	<p>The toolbox generates a frames acquired event when a specified number of frames have been acquired. You use the <code>FramesAcquiredFcnCount</code> property to specify this number.</p> <p>When a frames acquired event occurs, the toolbox executes the function specified by the <code>FramesAcquiredFcn</code> property.</p>
Start	StartFcn	<p>The toolbox generates a start event when an object is started. You use the <code>start</code> function to start an object.</p> <p>When a start event occurs, the toolbox executes the function specified by the <code>StartFcn</code> property.</p> <hr/> <p>Note The <code>StartFcn</code> callback executes synchronously. If you specify a <code>StartFcn</code> callback function, the toolbox waits for the function to finish executing before performing any other processing. If an error occurs in the start callback function, the object never starts.</p> <hr/>

Events and Callback Function Properties (Continued)

Event	Callback Property	Description
Stop	StopFcn	<p>The toolbox generates a stop event when the object stops running. An object stops running when the stop function is called, the specified number of frames is acquired, or a run-time error occurs.</p> <p>When a stop event occurs, the toolbox executes the function specified by the StopFcn property.</p> <hr/> <p>Note The StopFcn callback executes synchronously. If you specify a StopFcn callback function, the toolbox waits for the function to finish executing before performing any other processing.</p> <hr/>
Timer	TimerFcn	<p>The toolbox generates a timer event when a specified amount of time expires. Time is measured relative to when the object starts running. You use the TimerPeriod property to specify the amount of time.</p> <hr/> <p>Note Some timer events might not execute if your system is significantly slowed or if the TimerPeriod is set too small.</p> <p>When a timer event occurs, the toolbox executes the function specified by the TimerFcn property.</p> <hr/>
Trigger	TriggerFcn	<p>The toolbox generates a trigger event when a trigger executes. The video input object executes immediate triggers. You execute manual triggers by calling the trigger function. The image acquisition device executes hardware triggers when a specified condition is met.</p> <p>When a trigger event occurs, the toolbox executes the function specified by the TriggerFcn property.</p>

Retrieving Event Information

In this section...
“Introduction” on page 7-8
“Event Structures” on page 7-8
“Accessing Data in the Event Log” on page 7-10

Introduction

Each event has associated with it a set of information, generated by the toolbox and stored in an event structure. This information includes the event type, the time the event occurred, and other event-specific information. While a video input object is running, the toolbox records event information in the object's `EventLog` property. You can also access the event structure associated with an event in a callback function.

This section

- Defines the information in an event structure for all event types
- Describes how to retrieve information from the `EventLog` property

For information about accessing event information in a callback function, see “Creating and Executing Callback Functions” on page 7-13.

Event Structures

An event structure contains two fields: `Type` and `Data`. For example, this is an event structure for a trigger event:

```
Type: 'Trigger'  
Data: [1x1 struct]
```

The `Type` field is a text string that specifies the event type. For a trigger event, this field contains the text string `'Trigger'`.

The `Data` field is a structure that contains information about the event. The composition of this structure varies depending on which type of event

occurred. For information about the information associated with specific events, see the following sections:

- “Data Fields for Start, Stop, Frames Acquired, and Trigger Events” on page 7-9
- “Data Fields for Error Events” on page 7-9
- “Data Fields for Timer Events” on page 7-10

Data Fields for Start, Stop, Frames Acquired, and Trigger Events

For start, stop, frames acquired, and trigger events, the Data structure contains these fields.

Field Name	Description
AbsTime	Absolute time the event occurred, returned in MATLAB clock format [year month day hour minute seconds]
FrameMemoryLimit	Amount of memory allotted for frame storage. You can specify this value using the <code>imaqmem</code> function.
FrameMemoryUsed	Amount of frame memory that is currently in use
FrameNumber	Frame number relative to when the object was started
RelativeFrame	Frame number relative to the execution of a trigger
TriggerIndex	Trigger the event is associated with. For example, upon start, the associated trigger is 0. Upon stop, it is equivalent to the <code>TriggersExecuted</code> property.

Data Fields for Error Events

For error events, the Data structure contains these fields.

Field Name	Description
AbsTime	Absolute time the event occurred, returned in MATLAB clock format [year month day hour minute seconds]
FrameMemoryLimit	Amount of memory allotted for frame storage. You can specify this value using the <code>imaqmem</code> function.
FrameMemoryUsed	Amount of frame memory that is currently in use
Message	Text message associated with the error
MessageID	MATLAB message identifier associated with the error

Data Fields for Timer Events

For timer events, the Data structure contains these fields.

Field Name	Description
AbsTime	Absolute time the event occurred, returned in MATLAB clock format [year month day hour minute seconds]
FrameMemoryLimit	Amount of memory allotted for frame storage. You can specify this value using the <code>imaqmem</code> function.
FrameMemoryUsed	Amount of frame memory that is currently in use

Accessing Data in the Event Log

While a video input object is running, the toolbox stores event information in the object's `EventLog` property. The value of this property is an array of event structures. Each structure represents one event. For detailed information about the composition of an event structure for each type of event, see "Event Structures" on page 7-8.

The toolbox adds event structures to the `EventLog` array in the order in which the events occur. The first event structure reflects the first event recorded, the second event structure reflects the second event recorded, and so on.

Note Only start, stop, error, and trigger events are recorded in the `EventLog` property. Frames-acquired events and timer events are not included in the `EventLog`. Event structures for these events (and all the other events) are available to callback functions. For more information, see “Creating and Executing Callback Functions” on page 7-13.

To illustrate the event log, this example creates a video input object, runs it, and then examines the object’s `EventLog` property:

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

- 2 Start the image acquisition object** — Start the image acquisition object. By default, the object executes an immediate trigger, acquires 10 frames of data, and then stops.

```
start(vid)
```

- 3 View the event log** — Access the `EventLog` property of the video input object. The execution of the video input object generated three events: start, trigger, and stop. Thus the value of the `EventLog` property is a 1x3 array of event structures.

```
events = vid.EventLog  
events =
```

```
1x3 struct array with fields:  
    Type  
    Data
```

To list the events that are recorded in the `EventLog` property, examine the contents of the `Type` field.

```
{events.Type}
ans =
    'Start'    'Trigger'    'Stop'
```

To get information about a particular event, access the `Data` field in that event structure. The example retrieves information about the trigger event.

```
trigdata = events(2).Data

trigdata =

        AbsTime: [2004 12 29 16 40 52.5990]
    FrameMemoryLimit: 139427840
    FrameMemoryUsed: 0
        FrameNumber: 0
        RelativeFrame: 0
        TriggerIndex: 1
```

4 Clean up — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Creating and Executing Callback Functions

In this section...
“Introduction” on page 7-13
“Creating Callback Functions” on page 7-13
“Specifying Callback Functions” on page 7-15
“Viewing a Sample Frame” on page 7-17
“Monitoring Memory Usage” on page 7-18

Introduction

The power of using event callbacks is the processing that you can perform in response to events. You decide which events you want to associate callbacks with and the functions these callbacks execute.

This section

- Describes how to create a callback function
- Describes how to specify the function as the value of a callback property
- Provides two examples of using event callbacks:
 - Shows how to use callbacks to view a sample frame from the frames being acquired
 - Uses callback to implement a simple memory monitoring function

Note Callback function execution might be delayed if the callback involves a CPU-intensive task such as updating a figure.

Creating Callback Functions

This section explains how to create callback functions for the `TimerFcn`, `FramesAcquiredFcn`, `StartFcn`, `StopFcn`, `TriggerFcn`, and `ErrorFcn` callbacks.

Callback functions require at least two input arguments:

- The image acquisition object
- The event structure associated with the event

The function header for this callback function illustrates this basic syntax.

```
function mycallback(obj,event)
```

The first argument, `obj`, is the image acquisition object itself. Because the object is available, you can use in your callback function any of the toolbox functions, such as `getdata`, that require the object as an argument. You can also access all object properties.

The second argument, `event`, is the event structure associated with the event. This event information pertains only to the event that caused the callback function to execute. For a complete list of supported event types and their associated event structures, see “Event Structures” on page 7-8.

In addition to these two required input arguments, you can also specify additional, application-specific arguments for your callback function.

Note To receive the object and event arguments, and any additional arguments, you must use a cell array when specifying the name of the function as the value of a callback property. For more information, see “Specifying Callback Functions” on page 7-15.

Writing a Callback Function

To illustrate, this example implements a callback function for a frames-acquired event. This callback function enables you to monitor the frames being acquired by viewing a sample frame periodically.

To implement this function, the callback function acquires a single frame of data and displays the acquired frame in a MATLAB figure window. The function also accesses the event structure passed as an argument to display the timestamp of the frame being displayed. The `drawnow` command in the callback function forces MATLAB to update the display.


```
function display_frame(obj,event)

sample_frame = peekdata(obj,1);

imagesc(sample_frame);

drawnow; % force an update of the figure window

abstime = event.Data.AbsTime;

t = fix(abstime);

sprintf('%s %d:%d:%d', 'timestamp', t(4),t(5),t(6))
```

To see how this function can be used as a callback, see “Viewing a Sample Frame” on page 7-17.

Specifying Callback Functions

You associate a callback function with a specific event by setting the value of the event’s callback property. The video input object supports callback properties for all types of events.

You can specify the callback function as the value of the property in any of three ways:

- Text string
- Cell array
- Function handle

The following sections provide more information about each of these options.

Note To access the object or event structure passed to the callback function, you must specify the function as a cell array or as a function handle.

Using a Text String to Specify Callback Functions

You can specify the callback function as a string. For example, this code specifies the callback function `mycallback` as the value of the start event callback property `StartFcn` for the video input object `vid`.

```
vid.StartFcn = 'mycallback';
```

In this case, the callback is evaluated in the MATLAB workspace.

Using a Cell Array to Specify Callback Functions

You can specify the callback function as a text string inside a cell array.

For example, this code specifies the callback function `mycallback` as the value of the start event callback property `StartFcn` for the video input object `vid`.

```
vid.StartFcn = {'mycallback'};
```

To specify additional parameters, include them as additional elements in the cell array.

```
time = datestr(now,0);  
vid.StartFcn = {'mycallback',time};
```

The first two arguments passed to the callback function are still the video input object (`obj`) and the event structure (`event`). Additional arguments follow these two arguments.

Using Function Handles to Specify Callback Functions

You can specify the callback function as a function handle.

For example, this code specifies the callback function `mycallback` as the value of the start event callback property `StartFcn` for the video input object `vid`.

```
vid.StartFcn = @mycallback;
```

To specify additional parameters, include the function handle and the parameters as elements in the cell array.

```
time = datestr(now,0);  
vid.StartFcn = {@mycallback,time};
```

If you are executing a local callback function from within a MATLAB file, you must specify the callback as a function handle.

Specifying a Toolbox Function as a Callback

In addition to specifying callback functions of your own creation, you can also specify the `start`, `stop`, or `trigger` toolbox functions as callbacks. For example, this code sets the value of the stop event callback to Image Acquisition Toolbox `start` function.

```
vid.StopFcn = @start;
```

Disabling Callbacks

If an error occurs in the execution of the callback function, the toolbox disables the callback and displays a message similar to the following.

```
start(vid)
??? Error using ==> frames_cb
Too many input arguments.
```

Warning: The FramesAcquiredFcn callback is being disabled.

To enable a callback that has been disabled, set the value of the property associated with the callback or restart the object.

Viewing a Sample Frame

This example creates a video input object and sets the frames acquired event callback function property to the `display_frame` function, created in “Writing a Callback Function” on page 7-14.

The example sets the `TriggerRepeat` property of the object to 4 so that 50 frames are acquired. When run, the example displays a sample frame from the acquired data every time five frames have been acquired.

- 1 Create an image acquisition object** — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox', 1);
```

- 2 Configure property values** — This example sets the `FramesPerTrigger` value to 30 and the `TriggerRepeat` property to 4. The example also specifies as the value of the `FramesAcquiredFcn` callback the event callback function `display_frame`, created in “Writing a Callback Function” on page 7-14. The object will execute the `FramesAcquiredFcn` every five frames, as specified by the value of the `FramesAcquiredFcnCount` property.

```
set(vid, 'FramesPerTrigger', 30);  
set(vid, 'TriggerRepeat', 4);  
set(vid, 'FramesAcquiredFcnCount', 5);  
set(vid, 'FramesAcquiredFcn', {'display_frame'});
```

- 3 Acquire data** — Start the video input object. Every time five frames are acquired, the object executes the `display_frame` callback function. This callback function displays the most recently acquired frame logged to the memory buffer.

```
start(vid)
```

- 4 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)  
clear vid
```

Monitoring Memory Usage

This example creates a callback function for a timer event that displays the toolbox’s current memory usage and stops the acquisition when the available memory for frame storage falls below a specified amount.

Creating the Memory Monitor Callback Function

This callback function implements a simple memory usage monitoring function. The callback function uses the `imaqmem` function to retrieve two memory usage statistics, `FrameMemoryLimit` and `FrameMemoryUsed`, and then calculates the amount of memory that is currently left for allocating frames. When the amount of memory available falls below a specified value, the function outputs a message and stops the object.

```
function mem_mon(obj,event)

out = imaqmem;

mem_left = out.FrameMemoryLimit - out.FrameMemoryUsed;

msg = 'Memory left for frames';
msg2 = 'Memory load';
low_limit = 2000000;

if(mem_left > low_limit)
    sprintf('%s: %d \n%s: %d',msg, mem_left,msg2, out.MemoryLoad)
else
    disp('Memory available for frames getting low.');
```

```
    disp('Stopping acquisition.')
```

```
    stop(obj);
end
```

Running the Example

The example acquires frames until the amount of memory left for frame storage reaches a lower limit specified in the callback function.

1 Create an image acquisition object — This example creates a video input object for a Matrox image acquisition device. To run this example on your system, use the `imaqhwinfo` function to get the object constructor for your image acquisition device and substitute that syntax for the following code.

```
vid = videoinput('matrox',1);
```

2 Configure property values — This example sets up a continuous acquisition by setting the `FramesPerTrigger` value to `Inf`. The example also specifies the timer event callback function `mem_mon`, created in “Creating the Memory Monitor Callback Function” on page 7-18, as the value of the `TimerFcn` callback. The object will execute the `TimerFcn` every five seconds, as specified by the value of the `TimerPeriod` property.

```
set(vid,'FramesPerTrigger',Inf);
set(vid,'TimerPeriod',5);
set(vid,'TimerFcn',{'mem_mon'});
```

- 3 Acquire data** — Start the video input object. Every 5 seconds, the object executes the callback function associated with the timer event. This function outputs the current memory available for frame storage and the memory load statistic. When the amount of memory reaches the specified lower limit, the callback function stops the acquisition.

```
start(vid)
ans =

ans =

Memory left for frames: 27791360
Memory load: 88

ans =

Memory left for frames: 26316800
Memory load: 88

ans =

Memory left for frames: 24842240
Memory load: 89

.
.
.

Memory left for frames: 2969600
Memory load: 97

Memory available for frames getting low.
Stopping acquisition.
```

- 4 Clean up** — Always remove image acquisition objects from memory, and the variables that reference them, when you no longer need them.

```
delete(vid)
clear vid
```

Using the From Video Device Block in Simulink

The Image Acquisition Toolbox software includes a block that can be used in Simulink to bring live video data into models.

- “Simulink Image Acquisition Overview” on page 8-2
- “Opening the Image Acquisition Toolbox Block Library” on page 8-3
- “Using Code Generation” on page 8-5
- “Saving Video Data to a File” on page 8-6

Simulink Image Acquisition Overview

The Image Acquisition Toolbox software includes a block that can be used in Simulink to bring live video data into models.

The topics in this section describe how to use the Image Acquisition Toolbox block library. The toolbox block library contains one block called the From Video Device block. You can use this block to acquire live video data in a Simulink model. You can connect this block with blocks in other Simulink libraries to create sophisticated models.

Use of the Image Acquisition Toolbox From Video Device block requires Simulink, a tool for simulating dynamic systems. If you are new to Simulink, read the Getting Started section of the Simulink documentation to better understand its functionality.

For full details about the block in the Image Acquisition Toolbox software, see the reference page for the From Video Device block.

Opening the Image Acquisition Toolbox Block Library

In this section...

“Using the imaqlib Command” on page 8-3

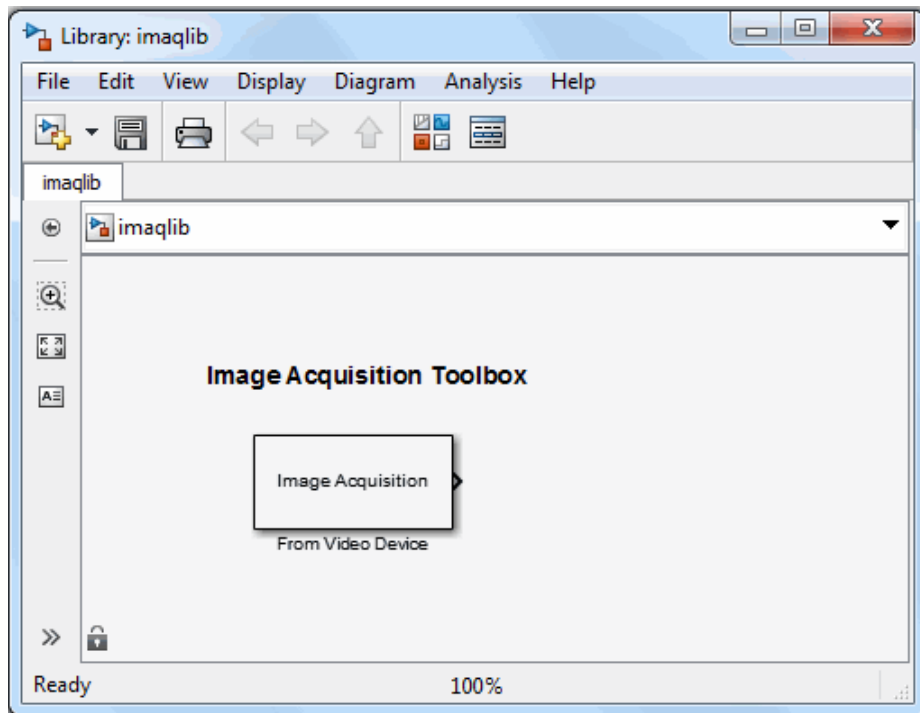
“Using the Simulink Library Browser” on page 8-4

Using the imaqlib Command

To open the Image Acquisition Toolbox block library, enter

```
imaqlib
```

at the MATLAB prompt. MATLAB displays the contents of the library in a separate window.



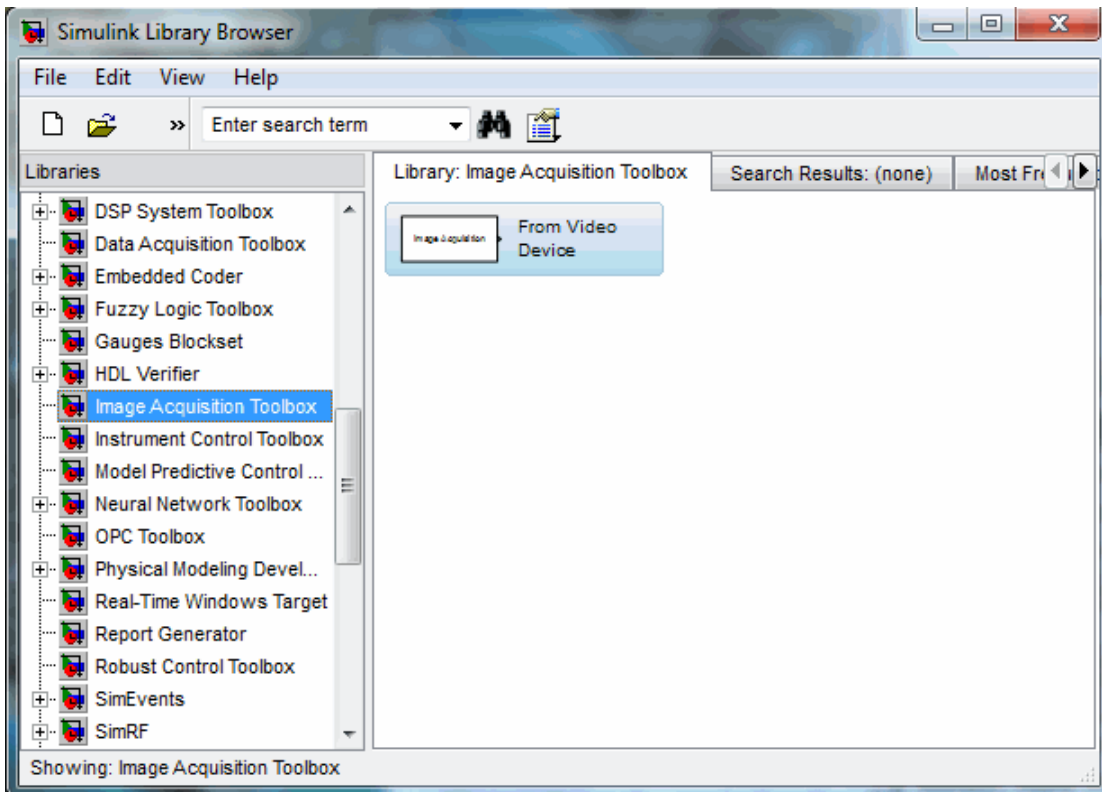
Using the Simulink Library Browser

To open the Image Acquisition Toolbox block library, start the Simulink Library Browser and select the library from the list of available block libraries.

To start the Simulink Library Browser, enter

```
simulink
```

at the MATLAB prompt. MATLAB opens the browser window. The left pane lists available block libraries in alphabetical order. To open the Image Acquisition Toolbox block library, click its icon.



Using Code Generation

The From Video Device block supports the use of code generation. You can generate code from the block. This enables models containing the From Video Device block to run successfully in Accelerator, Rapid Accelerator, External, and Deployed modes.

Here is a typical workflow for code generation.

- 1** Develop a model using the From Video Device block and blocks from the Computer Vision System Toolbox™.
- 2** Run the simulation to verify that your device is working.
- 3** Build the model to generate code and create the executable.

The deployed application can then be used on a machine that does not have MATLAB and Simulink.

The block supports use of the `packNGo` function from Simulink Coder™. Source-specific properties for your device are honored when code is generated. The generated code compiles with both C and C++ compilers.

For more information, see “Code Generation” on page 16-3 on the block reference page.

Saving Video Data to a File

In this section...

“Introduction” on page 8-6

“Step 1: Open the Image Acquisition Toolbox Library” on page 8-6

“Step 2: Open a Model or Create a New Model” on page 8-7

“Step 3: Drag the From Video Device Block into the Model” on page 8-8

“Step 4: Drag Other Blocks to Complete the Model” on page 8-9

“Step 5: Connect the Blocks” on page 8-10

“Step 6: Specify From Video Device Block Parameter Values” on page 8-11

“Step 7: Run the Simulation” on page 8-13

Introduction

The best way to learn about the From Video Device block is to see an example. This section provides a step-by-step example that builds a simple model using the block in conjunction with blocks from other blockset libraries.

Step 1: Open the Image Acquisition Toolbox Library

To use the From Video Device block, you must open the Image Acquisition Toolbox block library. To open it, start the Simulink Library Browser and select the Image Acquisition Toolbox entry from the list.

To start the Simulink Library Browser, enter

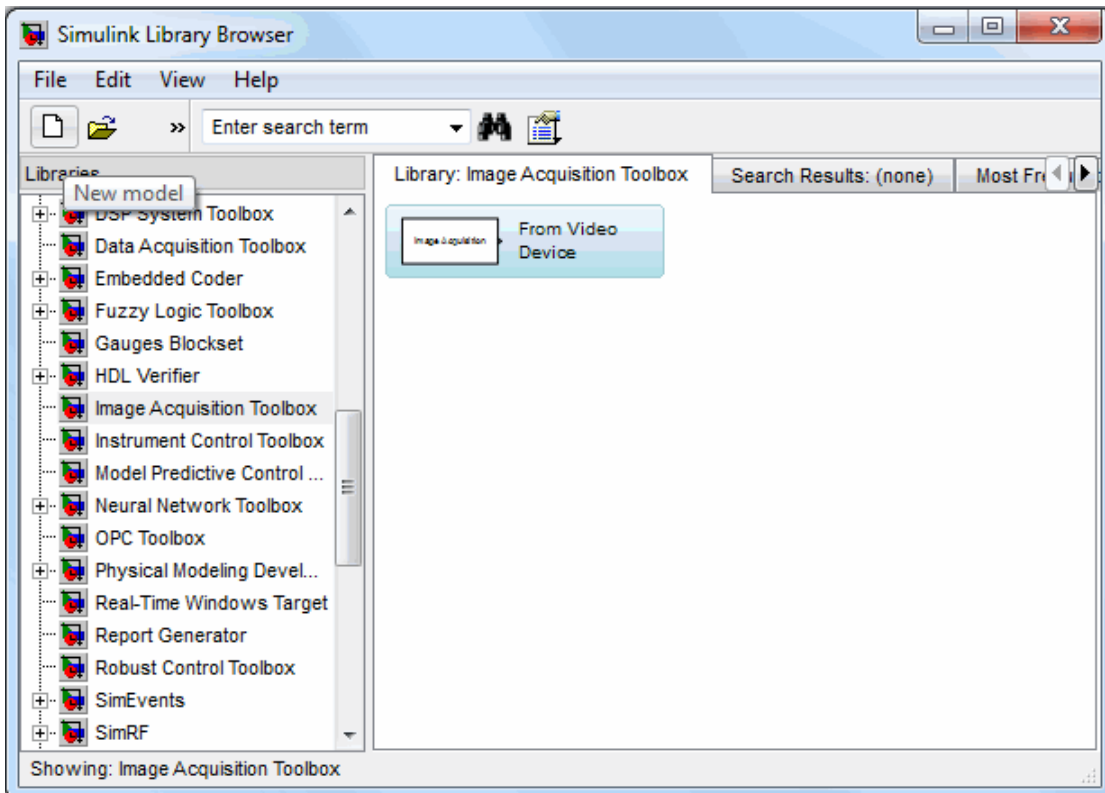
```
simulink
```

at the MATLAB prompt. (For more information about opening the library, see “Opening the Image Acquisition Toolbox Block Library” on page 8-3.)

Step 2: Open a Model or Create a New Model

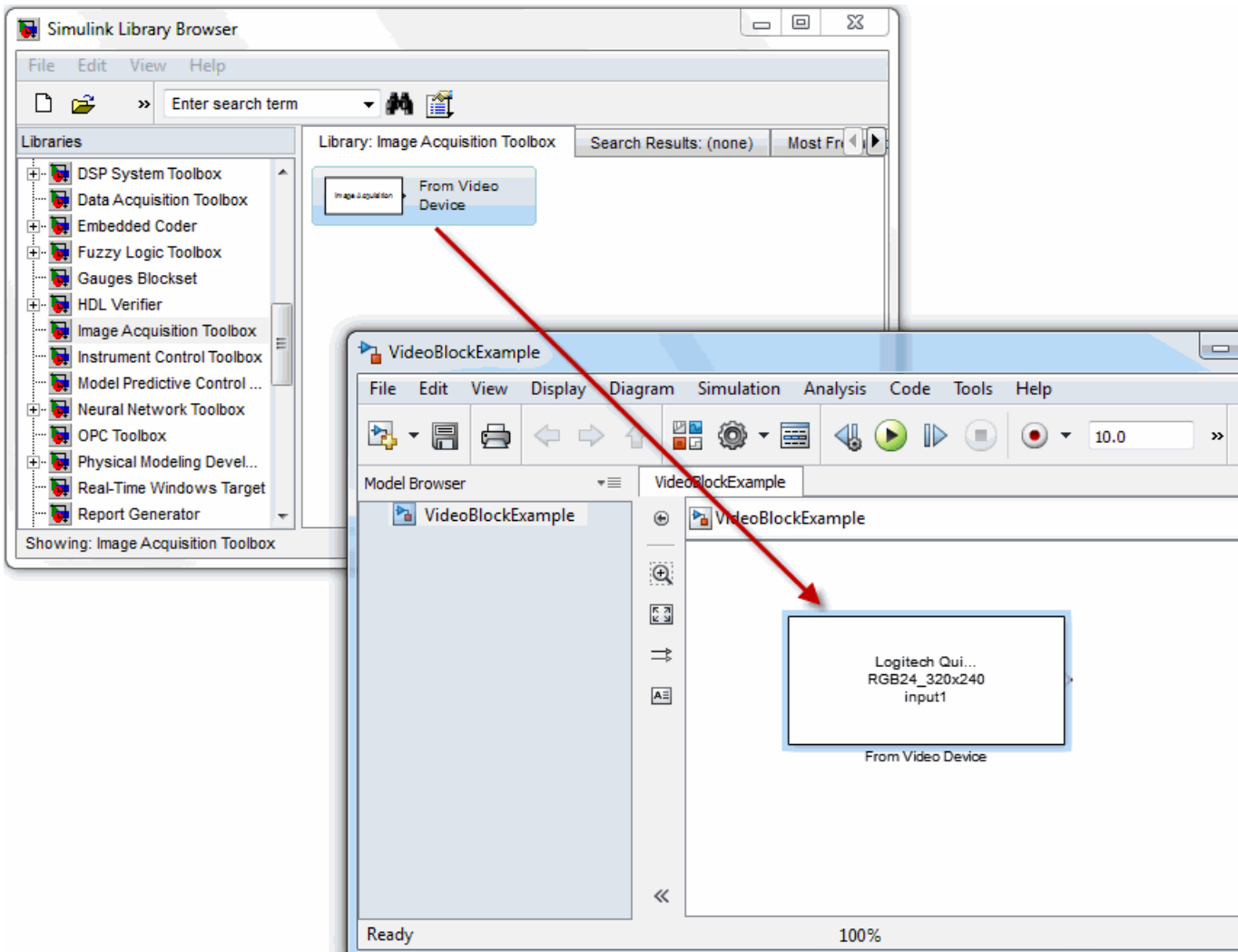
To use a block, you must add it to an existing model or create a new model.

To create a new model, click the **New model** button on the Simulink Library Browser toolbar. Simulink opens an empty model. To assign the new model a name, use the **Save** option.



Step 3: Drag the From Video Device Block into the Model

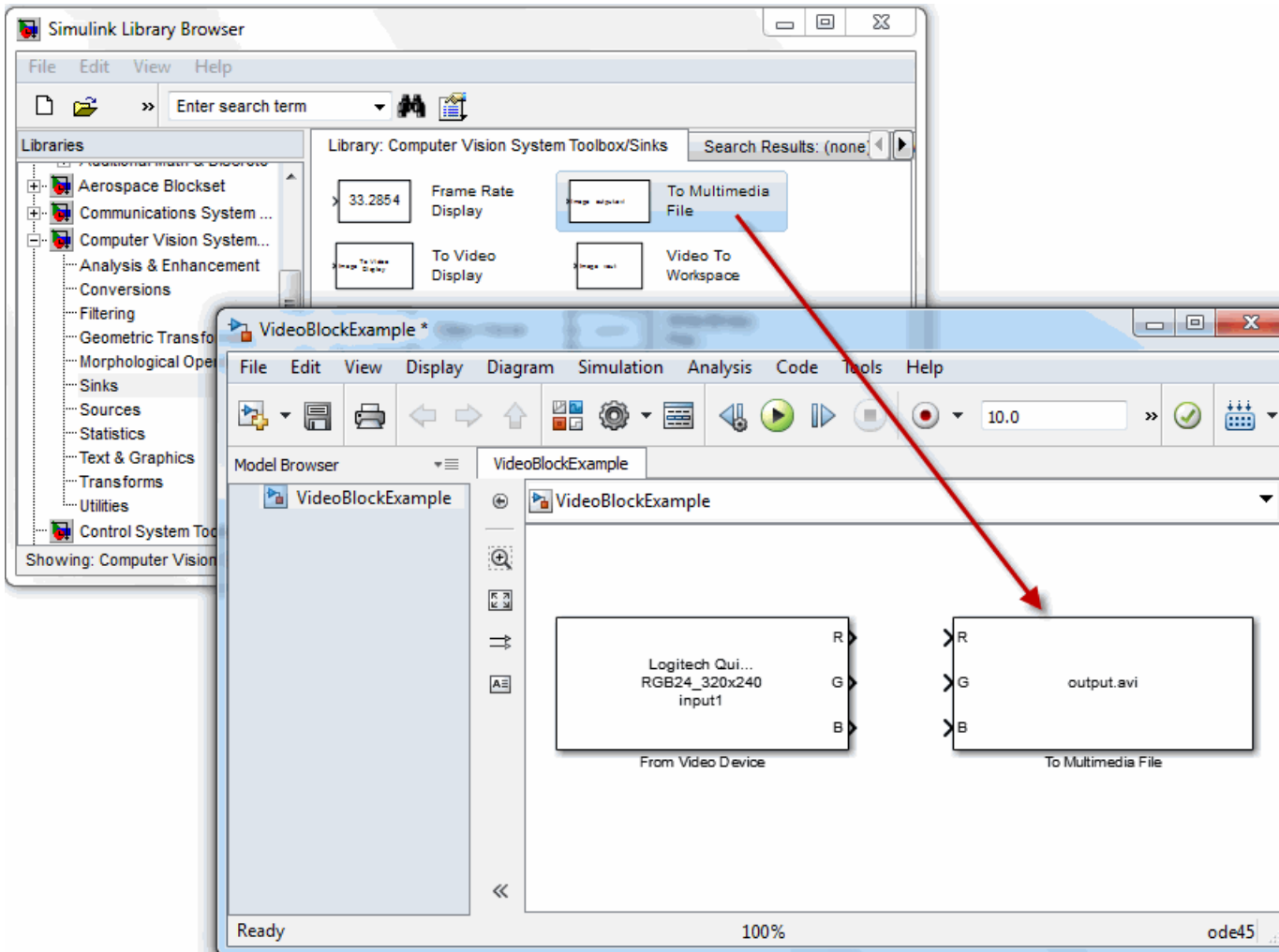
To use the From Video Device block in a model, click the block in the library and, holding the mouse button down, drag it into the Simulink Editor. Note how the name on the block changes to reflect the device connected to your system that is associated with the block. If you have multiple devices connected, you can choose the device to use in the Source Block Parameters dialog box by double-clicking the block.



Step 4: Drag Other Blocks to Complete the Model

To illustrate using the block, this example creates a simple model that acquires data and then outputs the data to a file in Audio Video Interleave (AVI) format. To create this model, this example uses a block from Computer Vision System Toolbox.

Open the Computer Vision System Toolbox library. In the library window, open the **Sinks** subsystem. From this subsystem, click the To Multimedia File block in the library and, holding the mouse button down, drag the block into the Simulink Editor.



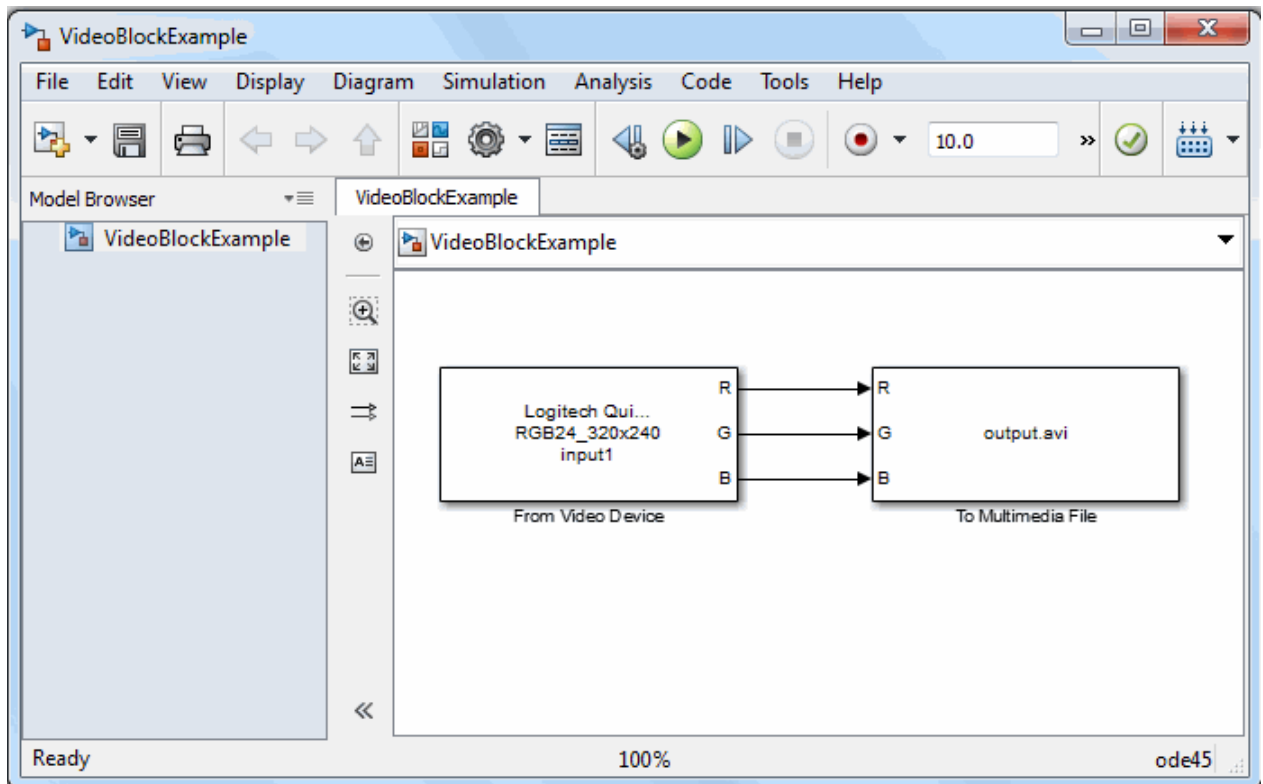
Drag Output Block to Model

Step 5: Connect the Blocks

Connect the three outputs from the From Video Device block to the three corresponding inputs on the To Multimedia File block. If the ports are not displayed, you can choose the option to display them in the Source Block Parameters dialog box by double-clicking the block. One quick way to make

all three connections at once is to select the From Video Device block, press and hold the **Ctrl** key, and then click the To Multimedia File block.

Note that your camera might have output ports that are Y, Cb, Cr and the input ports on the To Multimedia File block are R, G, B. Some devices designate color band by YCbCr and some devices designate it by RGB. Both are valid and will work together.



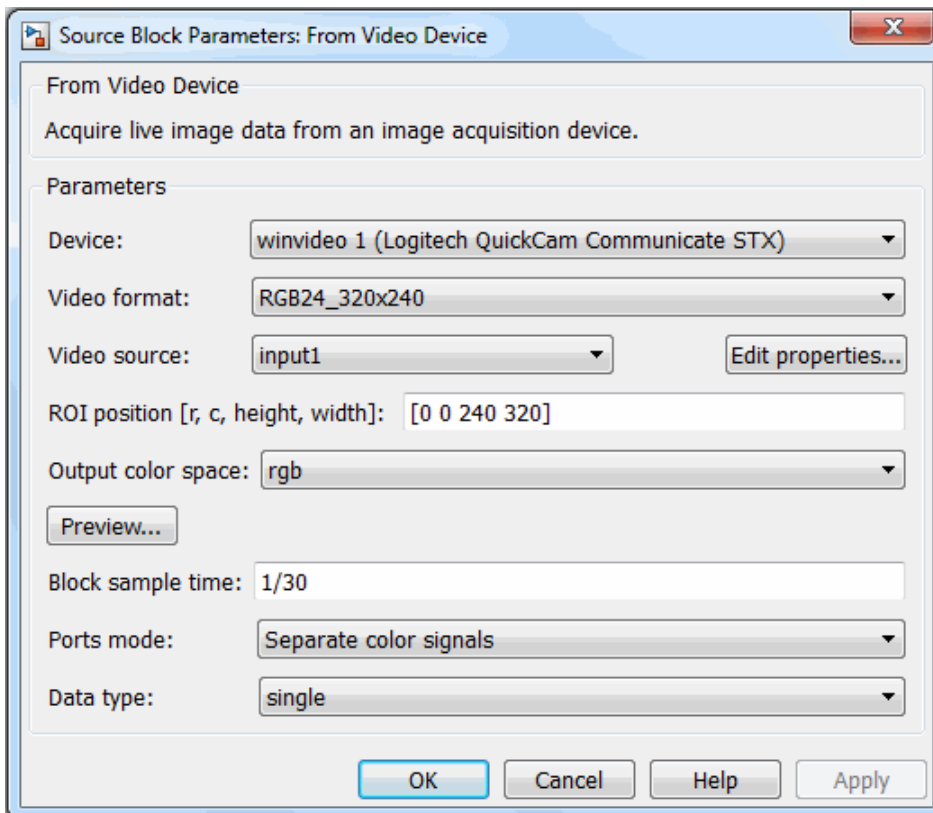
Connect the From Video Device Block to the To Multimedia File Block

Step 6: Specify From Video Device Block Parameter Values

To check From Video Device block parameter settings, double-click the block's icon in the Simulink Editor. This opens the Source Block Parameters dialog

box for the From Video Device block, shown in the following figure. Use the various fields in the dialog box to determine the current values of From Video Device block parameters or change the values.

For example, using this dialog box, you can specify the device you want to use, select the video format you want to use with the device, or specify the block sample time. For more details, see the From Video Device block reference page.

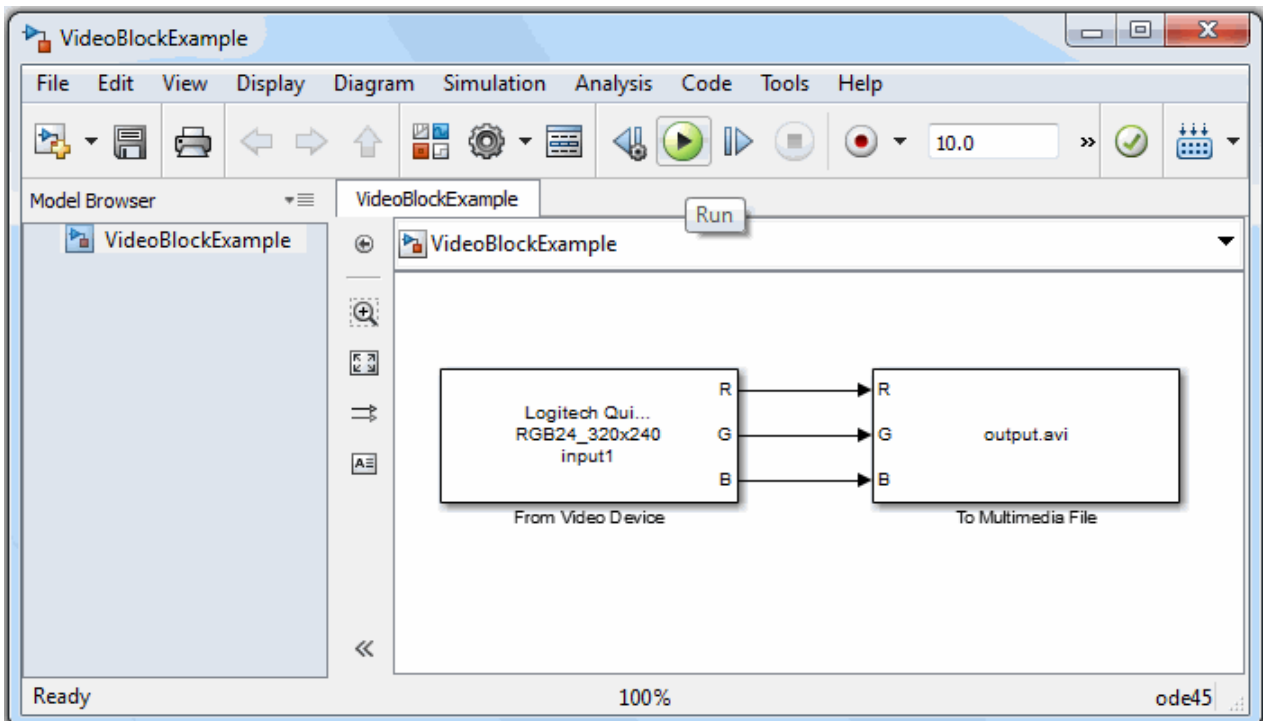


You can set parameters for any of the blocks you include in your model. For example, to specify the name of the AVI file, double-click the To Multimedia File block. Make sure that you have write permission to the directory into which the block writes the AVI file.

Step 7: Run the Simulation

To run the simulation, click the green **Run** button on the Simulink Editor toolbar. You can use toolbar options to specify how long to run the simulation and to stop it. You can also start the simulation by selecting **Simulation > Run**.

While the simulation is running, the status bar at the bottom of the Simulink Editor indicates the progress of the simulation. After the simulation finishes, check the directory in which you ran the simulation to verify that an AVI file was created.



Configuring GigE Vision Devices

- “Types of Setups” on page 9-2
- “Network Hardware Configuration Notes” on page 9-3
- “Network Adaptor Configuration Notes” on page 9-4
- “Software Configuration” on page 9-12
- “Setting Preferences” on page 9-14
- “Troubleshooting” on page 9-17

Types of Setups

The Image Acquisition Toolbox software supports GigE Vision devices. The following sections describe information on installing and configuring the devices to work with the Image Acquisition Toolbox software. Separate troubleshooting information is found in “Troubleshooting GigE Vision Devices on Windows” on page 13-26.

Note Not all cameras that use Ethernet are GigE Vision. A camera must have the GigE Vision logo appearing on it or its data sheet to be a GigE Vision device.

There are five different setups you can use for GigE Vision cameras.

- Direct to a PC not on a network — PC is connected to camera with a Cat 5e or 6 Ethernet cable. PC is not on a network. This is one of the setups that offers the best acquisition speed.
- Direct to a PC on a network, using two Ethernet cards — PC is connected to camera with a Cat 5e or 6 Ethernet cable. PC is connected to a network. This is one of the setups that offers the best acquisition speed.
- Indirect to a PC on a network, with PC and camera on same subnet — PC is connected to a network with a Cat 5e or 6 Ethernet cable. Camera is connected to the same network with a Cat 5e or 6 Ethernet cable. You may connect multiple cameras to the network using separate cables.
- Multiple cameras to a PC directly, using multiple Ethernet cards — PC is connected to camera 1 with a Cat 5e or 6 Ethernet cable. PC is connected to camera 2 with a separate Cat 5e or 6 Ethernet cable. PC is optionally connected to a network. This is one of the setups that offers the best acquisition speed.
- Multiple cameras to a PC directly, using switch or hub — PC is connected to a switch or hub directly with a Cat 5e or 6 Ethernet cable. Camera 1 is connected to switch/hub with a Cat 5e or 6 Ethernet cable. Camera 2 is connected to the switch/hub with a separate Cat 5e or 6 Ethernet cable. PC is optionally connected to a network. Alternatively, switch/hub is optionally connected to a network.

Network Hardware Configuration Notes

The following notes apply to network connections and hardware.

Using the same network as the PC on a shared network connection — Plug the camera into the network that the PC is plugged into. They must be on the same subnet. A system administrator can configure a VLAN if necessary.

Using a private network connection — You can connect the camera through the main/only Ethernet card, or through a second Ethernet card. In either scenario, a switch can be used to connect multiple cameras.

Ethernet cards — Ethernet cards must be 1000 Mbps. If direct connection or PC network allows, use a card that supports jumbo frames for larger packet sizes. Also, on Windows, increase the number of receive buffers if reception is poor.

Switches for connecting multiple cameras — Use a switch that has full duplex 1000 Gbps per port capacity. It can be a managed switch, but does not have to be.

Network Adaptor Configuration Notes

In this section...
“Windows Configuration” on page 9-4
“Linux Configuration” on page 9-6
“Mac Configuration” on page 9-7

Windows Configuration

Important Note: When you install your vendor software that came with your device, do not install your vendor’s filtering or performance networking driver.

Let Windows automatically determine the IP if you are using a single direct connection to the PC, instead of attempting to use static IP. Otherwise, leave organizational IP configuration settings in place.

Use your vendor software to configure the camera for DHCP/LLA.

If you have multiple cameras connected to multiple Ethernet cards, you cannot have them all set to automatic IP configuration. You must specify the IP address for each card and each card must be on a different subnet.

Enable large frame support if your Ethernet card, and switch if present, supports it and you are using a direct connection. If you are not using a direct connection, you can enable large frame support if all switches and routers in your organization’s network support it.

Set the Receive Buffers high, 2048 for example.

Installation of GigE Vision Cameras and Drivers on Windows

Follow these steps to install a GigE Vision camera on a Windows machine.

- 1 It is not necessary to install your vendor software that came with your device, but you may want to in order to verify that the device is running outside of MATLAB.

Important Note: Do not install your vendor’s filtering or performance networking driver.

- 2** In the Windows Network Connections dialog box (part of Control Panel), if using a second network adaptor, you can optionally rename your second network adaptor to “GigE Vision” to help distinguish it from your primary adaptor.

If the **Status** column says “Limited or no connectivity,” it will not impact your camera, as that status applies to the Internet.

- 3** Open the Properties dialog box of the Ethernet card by double-clicking it in Network Connections. If you are using a separate Ethernet card for the GigE camera, make sure that in the **This connection uses the following items** section on the **General** tab you have nothing selected except for **Internet Protocol (TCP/IP)**. Be sure to use TCP/IP version 4, and not version 6.

Make sure that any vendor drivers are unchecked and that anti-virus program drivers are unchecked. If you cannot uncheck the anti-virus software from the adaptor due to organization restrictions, you may need to purchase a second gigabit Ethernet card. In this case, leave all of the options as is for the network card for your PC, and configure the second card as described here, which will only connect to your camera.

- 4** In Windows Device Manager, make sure your network cards show up as using the correct network card vendor driver.

For example, in the Device Manager window, under **Network adapters**, you should see **Intel PRO/1000 PT Desktop Adapter** if you use that particular Ethernet card.

Check your adaptor properties. If your situation allows, as described in the next section, make sure that **Jumbo Frames** is enabled in the **Settings** on the **Advanced** tab. Make sure that **Receive Descriptors** is enabled in the **Settings > Performance Options** on the **Advanced** tab. Make sure that the correct adaptor is listed in the **Driver** tab and that it has not been replaced with a vendor-specific driver instead of the driver of the Ethernet card.

Note You do not need to install GenICam™ to use the GigE adaptor, because it is now included in the installation of the toolbox. However, if you are using the From Video Device block and doing code generation, you would need to install GenICam to run the generated application outside of MATLAB.

Linux Configuration

You will not need any drivers from your vendor and we recommend that you do not install any that may have come with your device.

We recommend that you have your system administrator help with the following setup tasks:

- Getting the Ethernet card recognized by the kernel.

- Getting the IP and MTU configuration set up for direct connection.

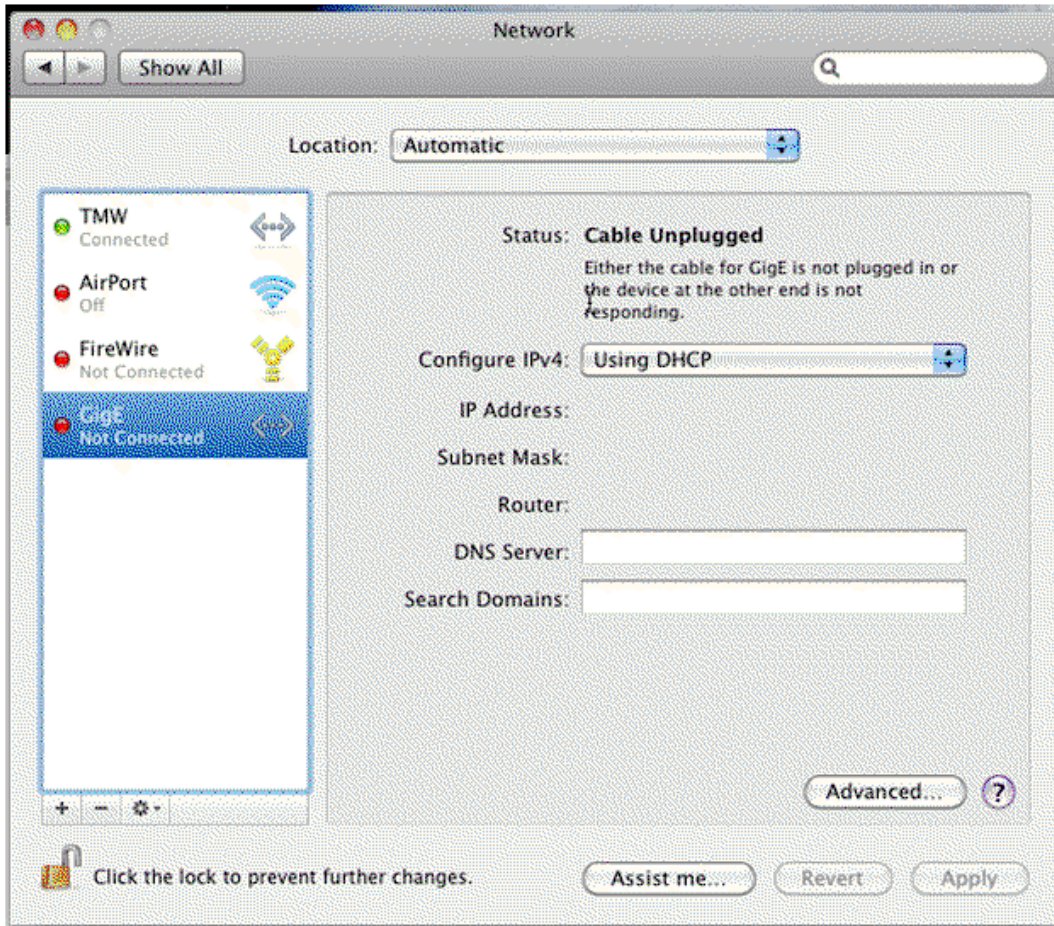
For dynamic IP configuration of a camera and Ethernet card not connected to an organizational network, avahi-autoipd can be used. However, we recommend that each direct connection to a camera have an interface with a static IP such as 10.10.x.y or 192.168.x.y.

If you want to use jumbo frames and your Ethernet card and switches (if present) allow, configure the MTU accordingly.

Mac Configuration

You will not need any drivers from your vendor and we recommend that you do not install any that may have come with your device.

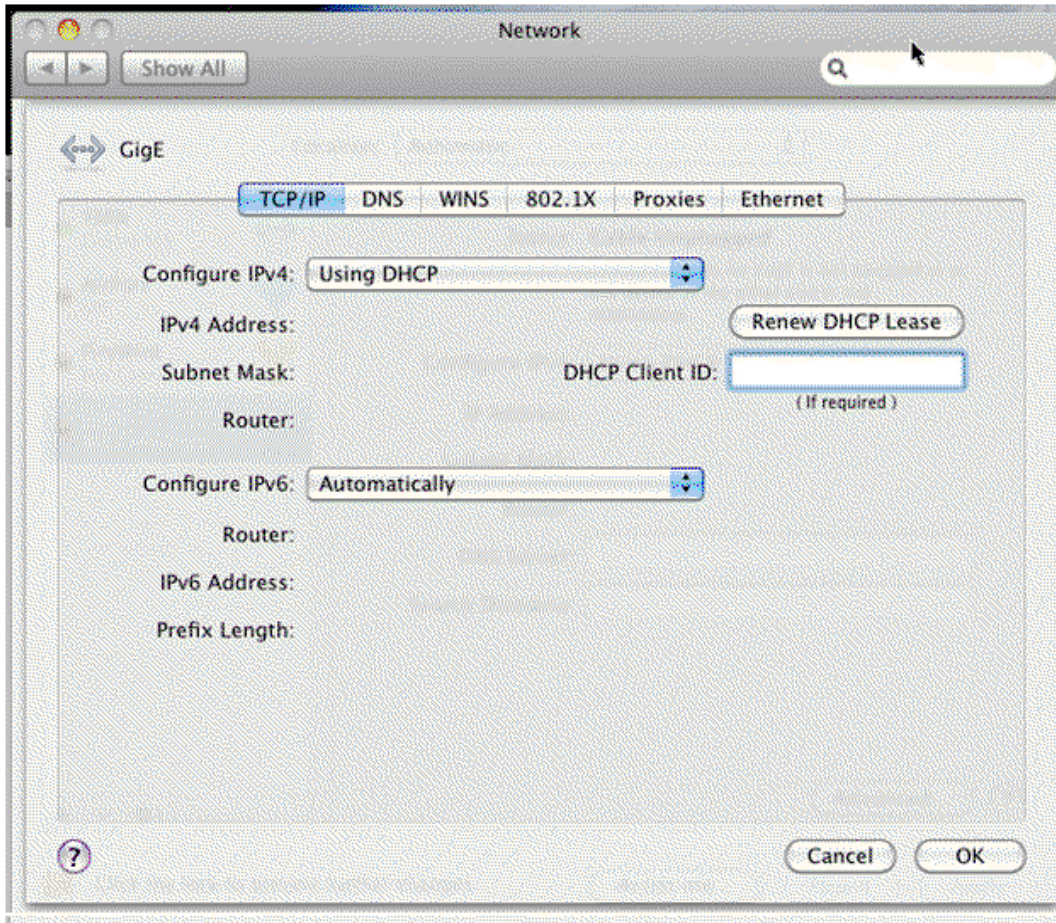
You should configure your Ethernet connection as shown:



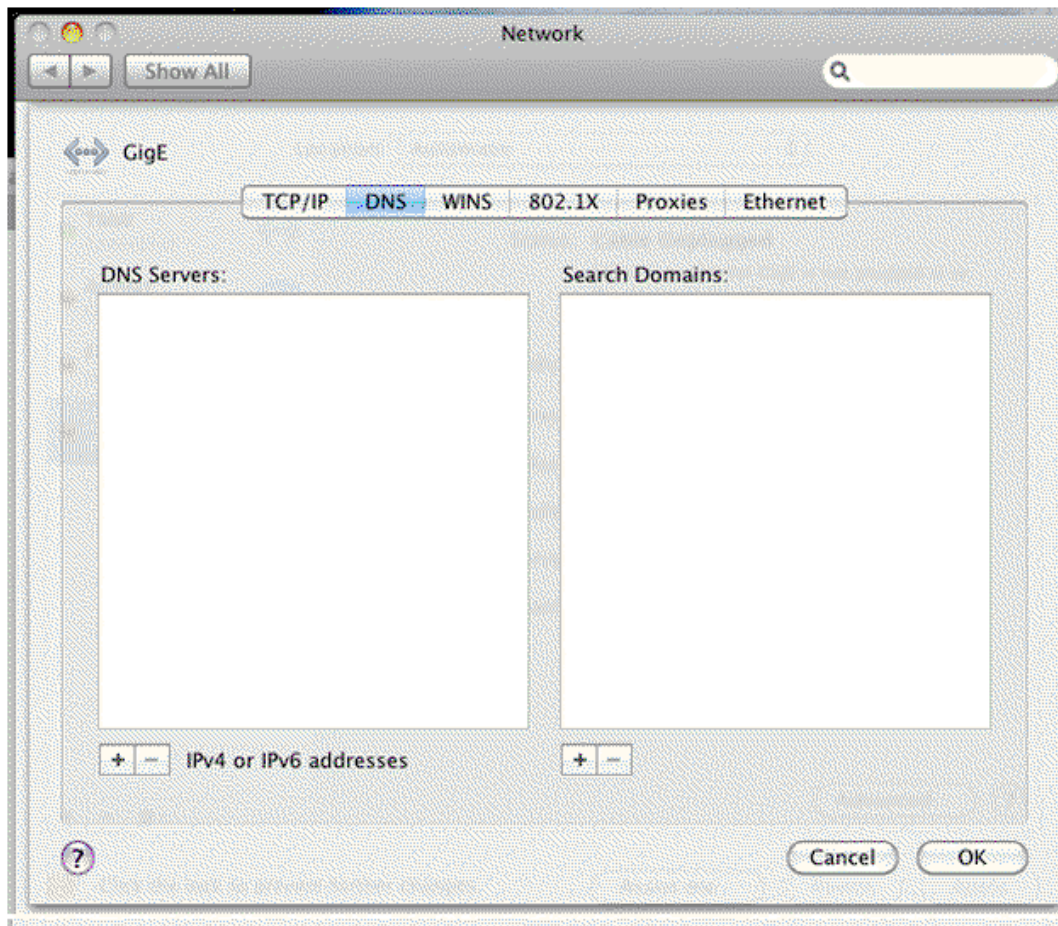
In the configuration shown here, the Mac Pro has two Ethernet connections, one to an internal network, and one for GigE Vision. The GigE Vision connection is set to use DHCP.

Advanced settings are set as shown in the following diagrams.

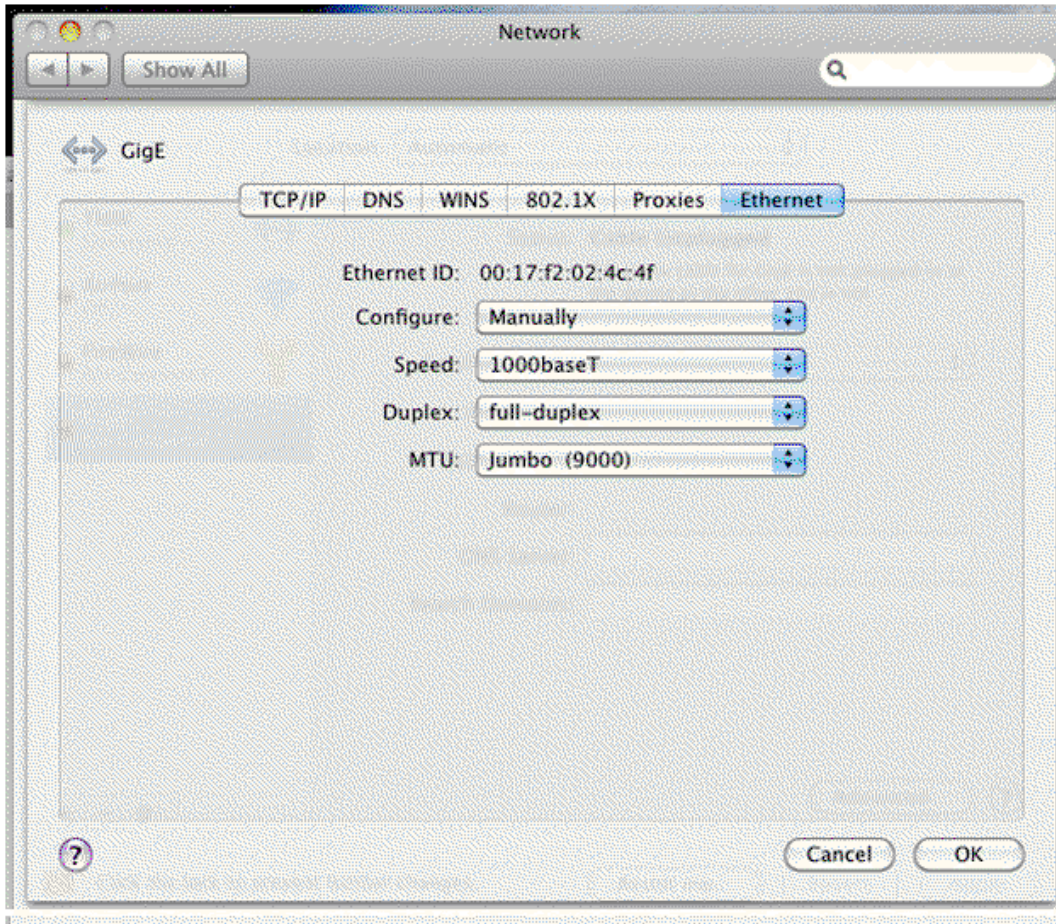
The **TCP/IP** tab.



The DNS tab.



The **Ethernet** tab.



If you are using a MacBook, you may not have the option of Jumbo frames in the **MTU**.

Software Configuration

You need to have GenICam installed, but that is done for you by the Image Acquisition Toolbox. The necessary environment variables should automatically be set as part of the installation. You can optionally check to verify the following environment variables. See the examples below.

Note If you have a camera that requires a GenICam XML file on a local drive (most cameras do not), you should set `MWIMAQ_GENICAM_XML_FILES` environment variable to the directory of your choice, and then install the camera's XML file in that directory. However, most cameras do not require or use local XML files.

Windows Example

```
MWIMAQ_GENICAM_XML_FILES=C:\cameraXML
```

You can test the installation by using the following command:

```
imaqhwinfo('gige')
```

and by looking at the relevant sections of the output when you run the `imaqsupport` function.

Linux Example

```
MWIMAQ_GENICAM_XML_FILES=/local/cameraXML
```

You can test the installation by using the following command:

```
imaqhwinfo('gige')
```

Mac Example

```
MWIMAQ_GENICAM_XML_FILES=/local/cameraXML
```

You can test the installation by using the following command:

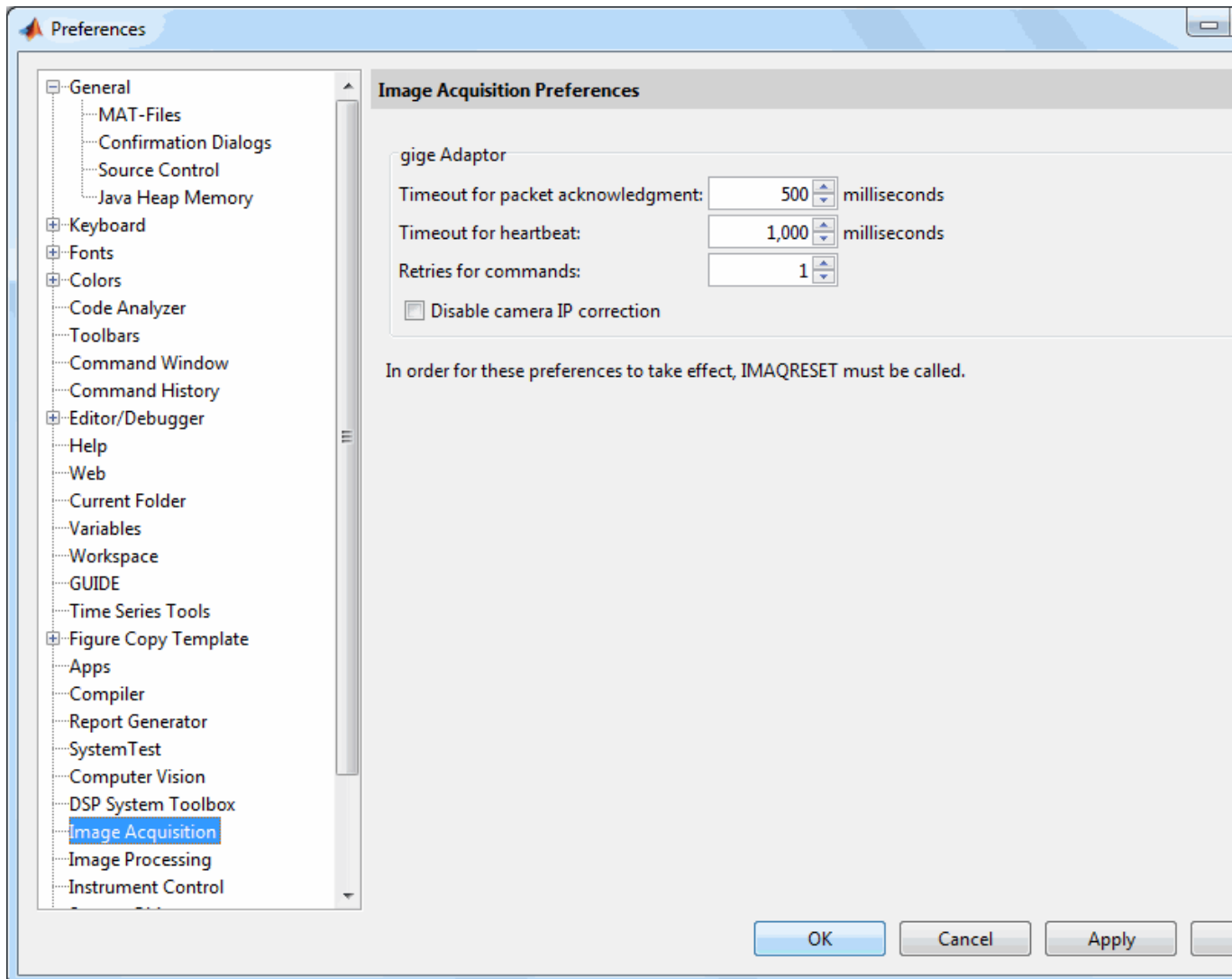
```
imaqhwinfo('gige')
```


and by looking at the relevant sections of the output when you run the `imaqsupport` function.

Note You do not need to install GenICam to use the GigE adaptor, because it is now included in the installation of the toolbox. However, if you are using the From Video Device block and doing code generation, you would need to install GenICam to run the generated application outside of MATLAB.

Setting Preferences

There are three GigE Vision related preferences in the Image Acquisition Preferences. In MATLAB, on the **Home** tab, in the **Environment** section, click **Preferences > Image Acquisition**.



Timeout for packet acknowledgement – this is a timeout value for the time between the sending of a command (for camera discovery or control) and the time that the acknowledgement is received from the camera.

Timeout for heartbeat – the camera requires that the application send a packet every so often (like a heartbeat) to keep the control connection alive. This is the setting for that packet period. Setting it too low can add unnecessary load to the computer and to the camera. Setting it too high can cause the camera to remain in use too long beyond when the toolbox attempts to relinquish control, leading to a failure to obtain control to start another acquisition.

Retries for commands – this is the number of attempts that the toolbox will make to send a command to the camera before deciding that the send has failed. The time between retries is set by the **Timeout for packet acknowledgement** setting.

Disable camera IP correction – check if you want to disable automatic IP correction for your camera. Clear the check mark to re-enable IP correction.

Troubleshooting

For troubleshooting information for GigE Vision devices on Windows, see “Troubleshooting GigE Vision Devices on Windows” on page 13-26.

For troubleshooting information for GigE Vision devices on Linux[®], see “Troubleshooting GigE Vision Devices on Linux” on page 13-29.

For troubleshooting information for GigE Vision devices on Mac, see “Troubleshooting GigE Vision Devices on Mac” on page 13-31.

Using the Kinect for Windows Adaptor

- “Important Information About the Kinect Adaptor” on page 10-2
- “Data Streams Returned by the Kinect” on page 10-4
- “Detecting the Kinect Devices” on page 10-8
- “Acquiring Image and Skeletal Data Using Kinect” on page 10-10
- “Acquiring from Color and Depth Devices Simultaneously” on page 10-26
- “Using Skeleton Viewer for Kinect Skeletal Data” on page 10-28
- “Installing the Kinect for Windows Runtime” on page 10-31
- “Support Packages and Support Package Installer” on page 10-37
- “Install This Support Package on Other Computers” on page 10-39
- “Open Examples for This Support Package” on page 10-41

Important Information About the Kinect Adaptor

The Kinect Adaptor lets you acquire images using a Kinect® for Windows device. Kinects are often used in automotive IVS, robotics, human-computer interaction (HCI), security systems, entertainment systems, game design, and civil engineering. They can be used for analyzing skeletons, 3D mapping, gesture recognition, human travel patterns, sports and games, etc.

The Kinect adaptor is supported on 32-bit and 64-bit Windows.

Doing image acquisition with a Kinect for Windows camera is similar to using other cameras and adaptors, but with several key differences:

- The Kinect for Windows device has two separate physical sensors, and each one uses a different DeviceID in the `videoinput` object. The Kinect color sensor returns color image data. The Kinect depth sensor returns depth and skeletal data. For information about Kinect device discovery and the use of two device IDs, see “Detecting the Kinect Devices” on page 10-8.
- The Kinect for Windows device returns four data streams. The image stream is returned by the color sensor and contains color data in various color formats. The depth stream is returned by the depth sensor and returns depth information in pixels. The skeletal stream is returned by the depth sensor and returns metadata about the skeletons. There is also an audio stream, but this is unused by Image Acquisition Toolbox. For details on the streams, see “Data Streams Returned by the Kinect” on page 10-4.
- The Kinect for Windows can track up to six people. It can provide full tracking on two people, and position tracking on up to four more.
- In Image Acquisition Toolbox, skeletal metadata is accessed through the depth sensor object. For an example showing how to access the skeletal metadata, see “Acquiring Image and Skeletal Data Using Kinect” on page 10-10.

Note The Kinect adaptor is intended for use only with the Kinect for Windows sensor.

Note In order to use the Kinect for Windows support in the Image Acquisition Toolbox, you must have version 1.6 or later of the Kinect for Windows Runtime installed on your system. If you already have it installed, you do not need to do anything more. If you do not have it installed, you need to install it following the procedure in “Installing the Kinect for Windows Runtime” on page 10-31.

Data Streams Returned by the Kinect

The Kinect for Windows device returns these data streams.

- Image stream (returned by the color sensor)
- Depth stream (returned by the depth sensor)
- Skeletal stream (returned by the depth sensor)
- Audio stream (not used by the Image Acquisition Toolbox, but could be used with MATLAB audiorecorder)

Image Stream

The image stream returns color image data and other formats using the Kinect color sensor. It supports the following formats.

Format	Description
RawYUV_640x480	Raw YUV format. Resolution of 640 x 480, frame rate of 15 frames per second, which is the maximum allowed.
RGB_1280x960	RGB format. Resolution of 1280 x 960, frame rate of 12 frames per second, which is the maximum allowed.
RGB_640x480	RGB format. Resolution of 640 x 480, frame rate of 30 frames per second, which is the maximum allowed.
YUV_640x480	YUV format. Resolution of 640 x 480, frame rate of 15 frames per second, which is the maximum allowed.

Format	Description
Infrared_640x480	<p>Infrared format. MONO16 frame type with resolution of 640 x 480, frame rate of 30 frames per second, which is the maximum allowed.</p> <p>The infrared stream allows you to capture frames in low light situations.</p>
RawBayer_1280x960	<p>Raw Bayer format. MONO8 frame type with resolution of 1280 x 960, frame rate of 12 frames per second, which is the maximum allowed.</p> <p>This format returns the raw Bayer pattern, so you can use your own algorithm to reconstruct the color image.</p>
RawBayer_640x480	<p>Raw Bayer format. MONO8 frame type with resolution of 640 x 480, frame rate of 30 frames per second, which is the maximum allowed.</p> <p>This format returns the raw Bayer pattern, so you can use your own algorithm to reconstruct the color image.</p>

Depth Stream

The depth stream returns person segmentation data using the Kinect depth sensor. The depth map is distance in meters from the camera plane. For Skeletal Tracking only two people can be tracked at a given time, although six people can be segmented at a time. This means it can provide full tracking on two skeletons, and partial position tracking on up to four more. The tracking ranges are a default range of 50 cm to 400 cm and a near range of 40 cm to 300 cm.

The depth stream supports the following formats.

Format	Description
Depth_640x480	Resolution of 640 x 480, frame rate of 30 frames per second
Depth_320x240	Resolution of 320 x 240, frame rate of 30 frames per second
Depth_80x60	Resolution of 80 x 60, frame rate of 30 frames per second

Skeletal Stream

The skeletal stream returns skeletal data using the Kinect depth device. The skeleton frame returned contains data on the ground plane position and a time stamp. It contains the overall position of the skeleton and the 3-D position of all 20 joints (position in meters). Two skeletons are actively tracked, and another four are tracked passively.

Note To understand the differences in using the Kinect adaptor compared to other toolbox adaptors, see “Important Information About the Kinect Adaptor” on page 10-2. For information about Kinect device discovery and the use of two device IDs, see “Detecting the Kinect Devices” on page 10-8. For an example that shows how to access the skeletal metadata, see “Acquiring Image and Skeletal Data Using Kinect” on page 10-10.

Detecting the Kinect Devices

Typically in the Image Acquisition Toolbox, each camera or image device has one DeviceID. Because the Kinect for Windows camera has two separate sensors, the color sensor and the depth sensor, the toolbox lists two DeviceIDs. If you use `imaqhwinfo` on the adaptor, you can see this.

```
info = imaqhwinfo('kinect');
info

info =

    AdaptorDllName: '<matlabroot>\toolbox\imaq\imaqadaptors\win64\mwkinectimaq.dll'
    AdaptorDllVersion: '4.6 (R2013b)'
    AdaptorName: 'kinect'
    DeviceIDs: {[1] [2]}
    DeviceInfo: [1x2 struct]
```

You can see the two device IDs in the output.

If you look at each device, you can see that they represent the color sensor and the depth sensor. The following shows the color sensor.

```
info.DeviceInfo(1)

ans =

    DefaultFormat: 'RGB_640x480'
    DeviceFileSupported: 0
    DeviceName: 'Kinect Color Sensor'
    DeviceID: 1
    VideoInputConstructor: 'videoinput('kinect', 1)''
    VideoDeviceConstructor: 'imaq.VideoDevice('kinect', 1)''
    SupportedFormats: {'RGB_1280x960' 'RGB_640x480' 'RawYUV_640x480' 'YUV_640x480'
    'Infrared_640x480' 'RawBayer_1280x960' 'RawBayer_640x480'}
```

In the output, you can see that Device 1 is the color sensor.

The following shows the depth sensor, which is Device 2.

```
info.DeviceInfo(2)

ans =

    DefaultFormat: 'Depth_640x480'
    DeviceFileSupported: 0
    DeviceName: 'Kinect Depth Sensor'
    DeviceID: 2
    VideoInputConstructor: 'videoinput('kinect', 2)''
    VideoDeviceConstructor: 'imaq.VideoDevice('kinect', 2)''
    SupportedFormats: {'Depth_640x480' 'Depth_320x240' 'Depth_80x60'}
```

You can use multiple Kinect cameras together. Multiple Kinect sensors are enumerated as DeviceIDs [1] [2] [3] [4] and so on. For example, if you had two Kinect cameras, the first one would have Kinect Color Sensor with DeviceID 1 and Kinect Depth Sensor with DeviceID 2 and the second Kinect camera would have Kinect Color Sensor with DeviceID 3 and Kinect Depth Sensor with DeviceID 4.

Note To understand the differences in using the Kinect adaptor compared to other toolbox adaptors, see “Important Information About the Kinect Adaptor” on page 10-2. For more information on the Kinect streams, see “Data Streams Returned by the Kinect” on page 10-4. For an example that shows how to access the skeletal metadata, see “Acquiring Image and Skeletal Data Using Kinect” on page 10-10.

Acquiring Image and Skeletal Data Using Kinect

In “Detecting the Kinect Devices” on page 10-8, you could see that the two sensors on the Kinect for Windows are represented by two device IDs, one for the color sensor and one of the depth sensor. In that example, Device 1 is the color sensor and Device 2 is the depth sensor. This example shows how to create a `videoinput` object for the color sensor to acquire RGB images and then for the depth sensor to acquire skeletal data.

- 1 Create the `videoinput` object for the color sensor. DeviceID 1 is used for the color sensor.

```
vid = videoinput('kinect',1,'RGB_640x480');
```

- 2 Look at the device-specific properties on the source device, which is the color sensor on the Kinect camera.

```
src = getselectedsource(vid);
```

```
src
```

```
Display Summary for Video Source Object:
```

```
General Settings:
```

```
Parent = [1x1 videoinput]  
Selected = on  
SourceName = ColorSource  
Tag =  
Type = videosource
```

```
Device Specific Properties:
```

```
Accelerometer = [0.0 -1.0 0.0]  
AutoExposure = on  
AutoWhiteBalance = on  
BacklightCompensation = AverageBrightness  
Brightness = 0.2156  
CameraElevationAngle = 3  
Contrast = 1  
ExposureTime = 1.0  
FrameInterval = 0
```



```

FrameRate = 30
Gain = 0
Gamma = 2.2
Hue = 0
PowerLineFrequency = Disabled
Saturation = 1
Sharpness = 0.5
WhiteBalance = 2700

```

As you can see in the output, the color sensor has a set of device-specific properties.

Device-Specific Property – Color Sensor	Description
Accelerometer	<p>Returns 3D vector of acceleration data for both the color and depth sensors. The data is updated while the device is running or previewing.</p> <p>This 1 x 3 double represents the x, y, and z values of acceleration in gravity units g (9.81m/s^2). For example,</p> <p>[0.06 -1.00 -0.09]</p> <p>represents values of x as 0.06 g, y as -1.00 g, and z as -0.09 g.</p>
AutoExposure	<p>Use to set the exposure automatically. This control whether other related properties are activated. Values are on (default) and off.</p> <p>on means that exposure is set automatically, and these properties are not able to be set and will throw a warning: FrameInterval, ExposureTime, and Gain.</p> <p>off means that these properties are not able to be set and will throw a warning: PowerLineFrequency, BacklightCompensation, and Brightness.</p>

Device-Specific Property – Color Sensor	Description
AutoWhiteBalance	<p>Use to enable or disable automatic white balance setting.</p> <p>on (default) means that it will automatically configure white balance and the WhiteBalance property cannot be set.</p> <p>off means that the WhiteBalance property is settable.</p>
BacklightCompensation	<p>Configures backlight compensation modes to adjust the camera to capture images dependent on environmental conditions.</p> <p>Note that this property is only valid if AutoExposure is set to Enabled. The default is AverageBrightness.</p> <p>Values are:</p> <p>AverageBrightness favors an average brightness level</p> <p>CenterPriority favors the center of the scene</p> <p>LowLightsPriority favors a low light level</p> <p>CenterOnly favors the center only</p>
Brightness	<p>Indicates the brightness level. The value range is 0.0 to 1.0, and the default value is 0.2156.</p> <p>Note that this property is only valid if AutoExposure is set to Enabled.</p>

Device-Specific Property – Color Sensor	Description
CameraElevationAngle	Controls the angle of the sensor lens. This is the camera angle relative to the ground. The value must be an integer property with range of -27 to 27 degrees. The default value is the last set value, since this is a sticky setting. Only set it if you want to change the angle of the camera. This property is shared with the depth sensor also.
Contrast	Indicates contrast level. Values must be in the range 0.5 to 2, with a default value of 1.
ExposureTime	Indicates the exposure time in increments of 1/10,000 of a second. The value range is 0 to 4000, and the default is 0. Note that this property is only valid if AutoExposure is set to Disabled.
FrameInterval	Indicates the frame interval in units of 1/10,000 of a second. The value range is 0 to 4000, and the default is 0. Note that this property is only valid if AutoExposure is set to Disabled.
FrameRate	Frames per second for the acquisition. This property is read only and the possible values for the color sensor are 12, 15, and 30 (default). It reflects the actual frame rate when running.
Gain	Indicates a multiplier for the RGB color values. The value range is 1.0 to 16.0, and the default is 1.0. Note that this property is only valid if AutoExposure is set to Disabled.

Device-Specific Property – Color Sensor	Description
Gamma	Indicates gamma measurement. Values must be in the range 1 to 2.8, with a default value of 2.2.
Hue	Indicates hue setting. Values must be in the range -22 to 22, with a default value of 0.
PowerLineFrequency	<p>Option for reducing flicker caused by the frequency of a power line. Values are Disabled, FiftyHertz, and SixtyHertz. The default is Disabled.</p> <p>Note that this property is only valid if AutoExposure is set to Enabled.</p>
Saturation	Indicates saturation level. Values must be in the range 0 to 2, with a default value of 1.
Sharpness	Indicates sharpness level. Values must be in the range 0 to 1, with a default value of 0.5.
WhiteBalance	<p>Indicates color temperature in degrees Kelvin. The value range is 2700 to 6500 and the default is 2700.</p> <p>Note that this property is only valid if AutoWhiteBalance is set to Disabled.</p>

- 3** You can optionally set some of these properties shown in the previous step. For example, you might be acquiring images in a low light situation. You could adjust the acquisition for this by setting the `BacklightCompensation` property to `LowLightsPriority`, which favors a low light level.

```
set(src, 'BacklightCompensation' , 'LowLightsPriority');
```

- 4** Preview the color stream by calling `preview` on the color sensor object created in step 1.

```
preview(vid);
```

When you are done previewing, close the preview window.

```
closepreview(vid);
```

- 5** Create the `videoinput` object for the depth sensor. Note that a second object is created (`vid2`), and `DeviceID 2` is used for the depth sensor.

```
vid2 = videoinput('kinect',2,'Depth_640x480');
```

- 6** Look at the device-specific properties on the source device, which is the depth sensor on the Kinect.

```
src = getselectedsource(vid2);
```

```
src
```

Display Summary for Video Source Object:

General Settings:

```
Parent = [1x1 videoinput]  
Selected = on  
SourceName = DepthSource  
Tag =  
Type = videosource
```

Device Specific Properties:

```
Accelerometer = [0.0 -1.0 0.0]  
BodyPosture = Standing  
CameraElevationAngle = 4  
DepthMode = Default
```

```

FrameRate = 30
IREmitter = on
SkeletonsToTrack = [1x0 double]
TrackingMode = off
    
```

As you can see in the output, the depth sensor has a set of device-specific properties associated with skeletal tracking. These properties are specific to the depth sensor.

Device-Specific Property – Depth Sensor	Description
Accelerometer	<p>Returns 3D vector of acceleration data for both the color and depth sensors. The data is updated while the device is running or previewing.</p> <p>This 1 x 3 double represents the x, y, and z values of acceleration in gravity units g (9.81m/s²). For example,</p> <p>[0.06 -1.00 -0.09]</p> <p>represents values of x as 0.06 g, y as -1.00 g, and z as -0.09 g.</p>
BodyPosture	<p>Indicates whether the tracked skeletons are standing or sitting. Values are Standing (gives 20 point skeleton data) and Seated (gives 10 point skeleton data, using joint indices 2 - 11). Standing is the default.</p> <p>Note that if BodyPosture is set to Seated mode, and TrackingMode is set to Position, no position is returned, since Position is the location of the hip joint and the hip joint is not tracked in Seated mode.</p> <p>See the subsection “BodyPosture Joint Indices” at the end of this example for the list of indices of the 20 skeletal joints.</p>

Device-Specific Property – Depth Sensor	Description
CameraElevationAngle	Controls the angle of the sensor lens. This is the camera angle relative to the ground. The value must be an integer property with range of -27 to 27 degrees. The default value is the last set value, since this is a sticky setting. Only set it if you want to change the angle of the camera. This property is shared with the color sensor also.
DepthMode	Indicates the range of depth in the depth map. Values are Default (range of 50 to 400 cm) and Near (range of 40 to 300 cm).
FrameRate	Frames per second for the acquisition. This property is read only and is fixed at 30 for the depth sensor for all formats. It reflects the actual frame rate when running.
IREmitter	Controls whether the IR emitter is on or off. Values are on and off. Initially, the default value is on. However, this is a sticky property, so the default value is the last set value. If you set it to off, it will remain off in future uses until you change the setting. An advantage of this property is that it is useful when using multiple Kinect devices to avoid interference.

Device-Specific Property – Depth Sensor	Description
SkeletonsToTrack	<p>Indicates the Skeleton Tracking ID returned as part of the metadata. Values are:</p> <p>[] Default tracking</p> <p>[TrackingID1] Track 1 skeleton with Tracking ID = TrackingID1</p> <p>[TrackingID1 TrackingID2] Track 2 skeletons with Tracking IDs = TrackingID1 and TrackingID2</p>
TrackingMode	<p>Indicates tracking state. Values are:</p> <p>Skeleton tracks full skeleton with joints</p> <p>Position tracks hip joint position only</p> <p>Off disables skeleton position tracking (default)</p> <p>Note that if BodyPosture is set to Seated mode, and TrackingMode is set to Position, no position is returned, since Position is the location of the hip joint and the hip joint is not tracked in Seated mode.</p>

7 Start the second videoinput object (the depth stream).

```
start(vid2);
```

8 Skeletal data is accessed as metadata on the depth stream. You can use `getdata` to access it.

```
% Get the data on the object.
```

```
[frame, ts, metaData] = getdata(vid2);
```

```
% Look at the metadata to see the parameters in the skeletal data.
metaData
```

```
metaData =
```



```

10x1 struct array with fields:
  AbsTime: [1x1 double]
  FrameNumber: [1x1 double]
  IsPositionTracked: [1x6 logical]
  IsSkeletonTracked: [1x6 logical]
  JointDepthIndices: [20x2x6 double]
  JointImageIndices: [20x2x6 double]
  JointTrackingState: [20x6 double]
  JointWorldCoordinates: [20x3x6 double]
  PositionDepthIndices: [2x6 double]
  PositionImageIndices: [2x6 double]
  PositionWorldCoordinates: [3x6 double]
  RelativeFrame: [1x1 double]
  SegmentationData: [640x480 double]
  SkeletonTrackingID: [1x6 double]
  TriggerIndex: [1x1 double]

```

These metadata fields are related to tracking the skeletons.

MetaData	Description
AbsTime	This is a 1 x 1 double and represents the full timestamp, including date and time, in MATLAB clock format.
FrameNumber	This is a 1 x 1 double and represents the frame number.
IsPositionTracked	This is a 1 x 6 Boolean matrix of true/false values for the tracking of the position of each of the six skeletons. A 1 indicates the position is tracked and a 0 indicates it is not.
IsSkeletonTracked	This is a 1 x 6 Boolean matrix of true/false values for the tracked state of each of the six skeletons. A 1 indicates it is tracked and a 0 indicates it is not.

MetaData	Description
JointDepthIndices	<p>If the BodyPosture property is set to Standing, this is a 20 x 2 x 6 double matrix of x-and y-coordinates for 20 joints in pixels relative to the depth image, for the six possible skeletons. If BodyPosture is set to Seated, this would be a 10 x 2 x 6 double for 10 joints.</p>
JointImageIndices	<p>If the BodyPosture property is set to Standing, this is a 20 x 2 x 6 double matrix of x-and y-coordinates for 20 joints in pixels relative to the color image, for the six possible skeletons. If BodyPosture is set to Seated, this would be a 10 x 2 x 6 double for 10 joints.</p>
JointTrackingState	<p>This 20 x 6 integer matrix contains enumerated values for the tracking accuracy of each joint for all six skeletons. Values include:</p> <ul style="list-style-type: none"> 0 not tracked 1 position inferred 2 position tracked
JointWorldCoordinates	<p>This is a 20 x 3 x 6 double matrix of x-, y- and z-coordinates for 20 joints, in meters from the sensor, for the six possible skeletons, if the BodyPosture is set to Standing. If it is set to Seated, this would be a 10 x 3 x 6 double for 10 joints.</p> <p>See step 9 for the syntax on how to see this data.</p>

MetaData	Description
PositionDepthIndices	A 2 x 6 double matrix of X and Y coordinates of each skeleton in pixels relative to the depth image.
PositionImageIndices	A 2 x 6 double matrix of X and Y coordinates of each skeleton in pixels relative to the color image.
PositionWorldCoordinates	A 3 x 6 double matrix of the X, Y and Z coordinates of each skeleton in meters relative to the sensor.
RelativeFrame	This 1 x 1 double represents the frame number relative to the execution of a trigger if triggering is used.
SegmentationData	Image size double array with each pixel mapped to a tracked/detected skeleton, represented by numbers 1 to 6. This segmentation map is a bitmap with pixel values corresponding to the index of the person in the field-of-view who is closest to the camera at that pixel position. A value of 0 means there is no tracked skeleton.
SkeletonTrackingID	<p>This 1 x 6 integer matrix contains the tracking IDs of all six skeletons. These IDs track specific skeletons using the <code>SkeletonsToTrack</code> property in step 5.</p> <p>Tracking IDs are generated by the Kinect and change from acquisition to acquisition.</p>
TriggerIndex	This is a 1 x 1 double and represents the trigger the event is associated with if triggering is used.

- 9 You can look at any individual property by drilling into the metadata. For example, look at the `IsSkeletonTracked` property.

```
metaData.IsSkeletonTracked
```

```
ans =
```

```
1 0 0 0 0 0
```

In this case it means that of the six possible skeletons, there is one skeleton being tracked and it is in the first position. If you have multiple skeletons, this property is useful to confirm which ones are being tracked.

- 10** Get the joint locations for the first person in world coordinates using the `JointWorldCoordinates` property. Since this is the person in position 1, the index uses 1.

```
metaData.JointWorldCoordinates(:, :, 1)
```

```
ans =
```

```
-0.1408  -0.3257  2.1674
-0.1408  -0.2257  2.1674
-0.1368  -0.0098  2.2594
-0.1324   0.1963  2.3447
-0.3024  -0.0058  2.2574
-0.3622  -0.3361  2.1641
-0.3843  -0.6279  1.9877
-0.4043  -0.6779  1.9877
 0.0301  -0.0125  2.2603
 0.2364   0.2775  2.2117
 0.3775   0.5872  2.2022
 0.4075   0.6372  2.2022
-0.2532  -0.4392  2.0742
-0.1869  -0.8425  1.8432
-0.1869  -1.2941  1.8432
-0.1969  -1.3541  1.8432
-0.0360  -0.4436  2.0771
 0.0382  -0.8350  1.8286
 0.1096  -1.2114  1.5896
 0.1196  -1.2514  1.5896
```

The columns represent the X, Y, and Z coordinates in meters of the 20 points on skeleton 1.

- 11** You can optionally view the segmentation data as an image.

```
% View the segmentation data as an image.
imagesc(metaDataDepth.SegmentationData);
% Set the color map to jet to color code the people detected.
colormap(jet);
```

BodyPosture Joint Indices

The `BodyPosture` property, in step 5, indicates whether the tracked skeletons are standing or sitting. Values are `Standing` (gives 20 point skeleton data) and `Seated` (gives 10 point skeleton data, using joint indices 2 - 11).

This is the order of the joints returned by the Kinect adaptor:

```
Hip_Center = 1;  
Spine = 2;  
Shoulder_Center = 3;  
Head = 4;  
Shoulder_Left = 5;  
Elbow_Left = 6;  
Wrist_Left = 7;  
Hand_Left = 8;  
Shoulder_Right = 9;  
Elbow_Right = 10;  
Wrist_Right = 11;  
Hand_Right = 12;  
Hip_Left = 13;  
Knee_Left = 14;  
Ankle_Left = 15;  
Foot_Left = 16;  
Hip_Right = 17;  
Knee_Right = 18;  
Ankle_Right = 19;  
Foot_Right = 20;
```

When `BodyPosture` is set to `Standing`, all 20 indices are returned, as shown above. When `BodyPosture` is set to `Seated`, numbers 2 through 11 are returned, since this represents the upper body of the skeleton.

Note To understand the differences in using the Kinect adaptor compared to previous toolbox adaptors, see “Important Information About the Kinect Adaptor” on page 10-2. For information about Kinect device discovery and the use of two device IDs, see “Detecting the Kinect Devices” on page 10-8. For an example of simultaneous acquisition, see “Acquiring from Color and Depth Devices Simultaneously” on page 10-26.

Acquiring from Color and Depth Devices Simultaneously

You can synchronize the data from the Kinect for Windows color stream and the depth stream using software manual triggering.

This synchronization method example triggers both objects manually.

- 1** Create the objects for the color and depth sensors. Device 1 is the color sensor and Device 2 is the depth sensor.

```
vid = videoinput('kinect',1);  
vid2 = videoinput('kinect',2);
```

- 2** Get the source properties for the depth device.

```
srcDepth = getselectedsource(vid2);
```

- 3** Set the frames per trigger for both devices to 1.

```
vid.FramesPerTrigger = 1;  
vid2.FramesPerTrigger = 1;
```

- 4** Set the trigger repeat for both devices to 200, in order to acquire 201 frames from both the color sensor and the depth sensor.

```
vid.TriggerRepeat = 200;  
vid2.TriggerRepeat = 200;
```

- 5** Configure the camera for manual triggering for both sensors.

```
triggerconfig([vid vid2], 'manual');
```

- 6** Start both video objects.

```
start([vid vid2]);
```


7 Trigger the devices, then get the acquired data.

```
% Trigger 200 times to get the frames.
for i = 1:201
    % Trigger both objects.
    trigger([vid vid2])
    % Get the acquired frames and metadata.
    [imgColor, ts_color, metaData_Color] = getdata(vid);
    [imgDepth, ts_depth, metaData_Depth] = getdata(vid2);
end
```

Using Skeleton Viewer for Kinect Skeletal Data

If you do an acquisition with a Kinect for Windows and get skeletal data, you can view the skeleton joints in this viewer. This example function displays one RGB image with skeleton joint locations overlaid on the image.

- 1** Create the Kinect objects and acquire image and skeletal data, as shown in “Acquiring Image and Skeletal Data Using Kinect” on page 10-10.
- 2** Use the `skeletonViewer` function to view the skeletal data.

In this code, `skeleton` is the joint image locations returned by the Kinect depth sensor, and `image` is the RGB image corresponding to the skeleton frame. `nSkeleton` is the number of skeletons.

```
function [] = skeletonViewer(skeleton, image, nSkeleton)
```

This is the order of the joints returned by the Kinect adaptor:

```
Hip_Center = 1;  
Spine = 2;  
Shoulder_Center = 3;  
Head = 4;  
Shoulder_Left = 5;  
Elbow_Left = 6;  
Wrist_Left = 7;  
Hand_Left = 8;  
Shoulder_Right = 9;  
Elbow_Right = 10;  
Wrist_Right = 11;  
Hand_Right = 12;  
Hip_Left = 13;  
Knee_Left = 14;  
Ankle_Left = 15;  
Foot_Left = 16;  
Hip_Right = 17;  
Knee_Right = 18;  
Ankle_Right = 19;  
Foot_Right = 20;
```

3 Show the RGB image.

```
imshow(image);
```

4 Create a skeleton connection map to link the joints.

```
SkeletonConnectionMap = [[1 2]; % Spine
                        [2 3];
                        [3 4];
                        [3 5]; %Left Hand
                        [5 6];
                        [6 7];
                        [7 8];
                        [3 9]; %Right Hand
                        [9 10];
                        [10 11];
                        [11 12];
                        [1 17]; % Right Leg
                        [17 18];
                        [18 19];
                        [19 20];
                        [1 13]; % Left Leg
                        [13 14];
                        [14 15];
                        [15 16]];
```

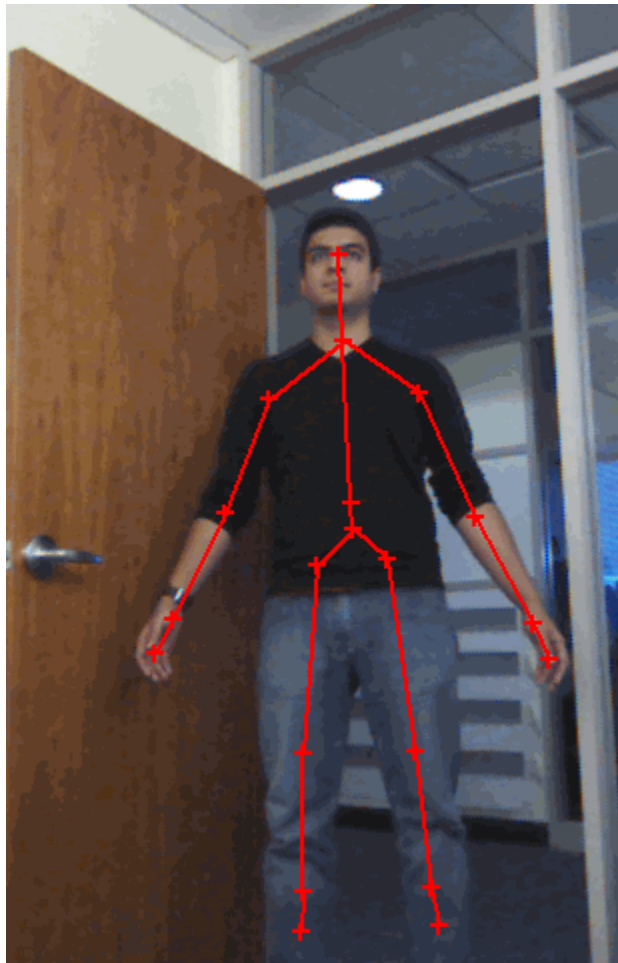
5 Draw the skeletons on the RGB image.

```
for i = 1:19

    if nSkeleton > 0
        X1 = [skeleton(SkeletonConnectionMap(i,1),1,1) skeleton(SkeletonConnectionMap(i,2),1,1)
            Y1 = [skeleton(SkeletonConnectionMap(i,1),2,1) skeleton(SkeletonConnectionMap(i,2),2,1)
            line(X1,Y1, 'LineWidth', 1.5, 'LineStyle', '-', 'Marker', '+', 'Color', 'r');
        end
    if nSkeleton > 1
        X2 = [skeleton(SkeletonConnectionMap(i,1),1,2) skeleton(SkeletonConnectionMap(i,2),1,2)
            Y2 = [skeleton(SkeletonConnectionMap(i,1),2,2) skeleton(SkeletonConnectionMap(i,2),2,2)
            line(X2,Y2, 'LineWidth', 1.5, 'LineStyle', '-', 'Marker', '+', 'Color', 'g');
        end
    end
hold on;
```

```
end  
hold off;
```

The viewer will show the following for this example, which contains the color image of one person, with the skeletal data overlaid on the image.



Installing the Kinect for Windows Runtime

In order to use the Kinect for Windows support in the Image Acquisition Toolbox, you must have version 1.6 or higher of the Kinect for Windows Runtime installed on your system. If you already have it installed, you do not need to follow the instructions in this section. If you do not have it installed, you need to install it following the procedure in this section. After you complete this process, you can acquire images using the Kinect for Windows with the Image Acquisition Toolbox, as described in the sections referred to in “Important Information About the Kinect Adaptor” on page 10-2.

Using this installation process, you download and install the following file(s) on your host computer:

- Kinect for Windows Runtime

Note You can use this support package only on a host computer running a version of 32-bit or 64-bit Windows that Image Acquisition Toolbox supports.

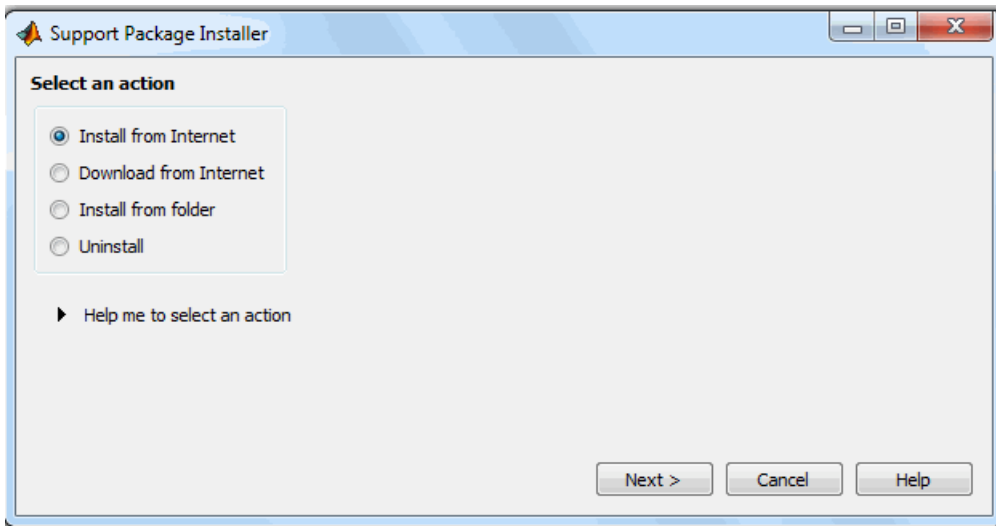
1 In MATLAB type:

```
supportPackageInstaller
```

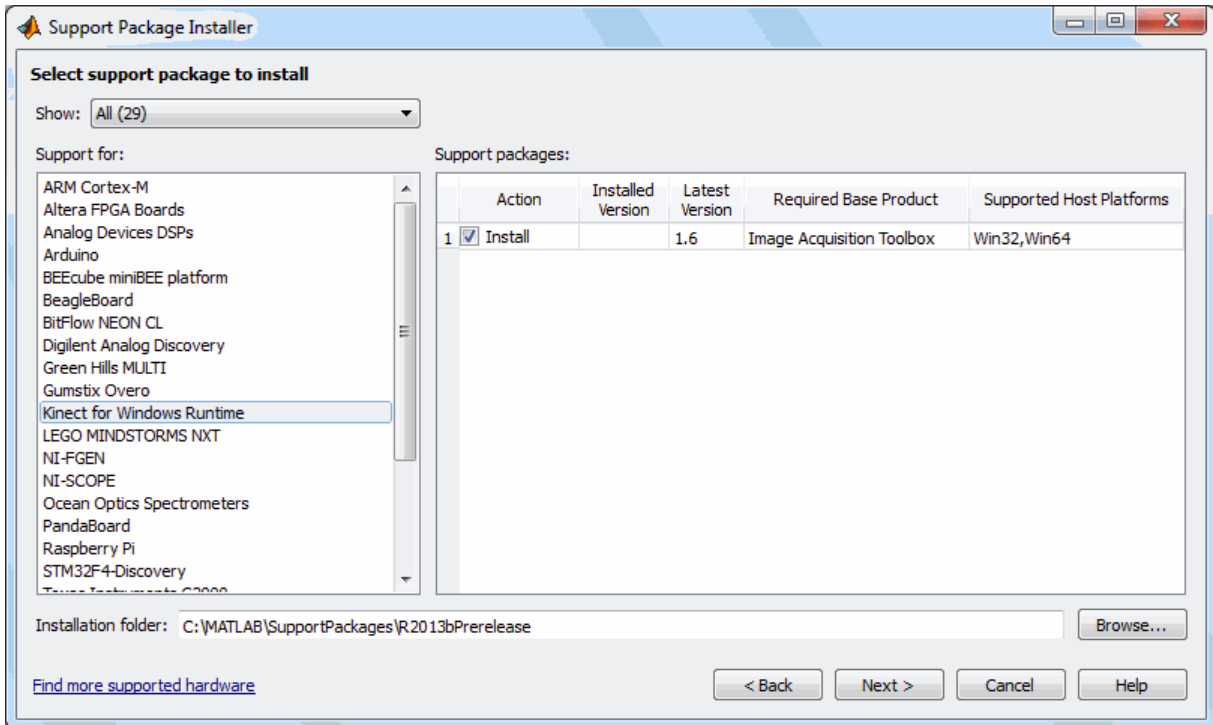
to open the Support Package Installer.

You can also open the installer from MATLAB: **Home > Resources > Add-Ons > Get Hardware Support Packages.**

- 2 On the **Select an action** screen, select **Install from Internet** then click **Next**. This option is selected by default. Support Package Installer downloads and installs the support package and third-party software from the Internet.



- 3** On the **Select support package to install** screen, select Kinect for Windows Runtime from the list.

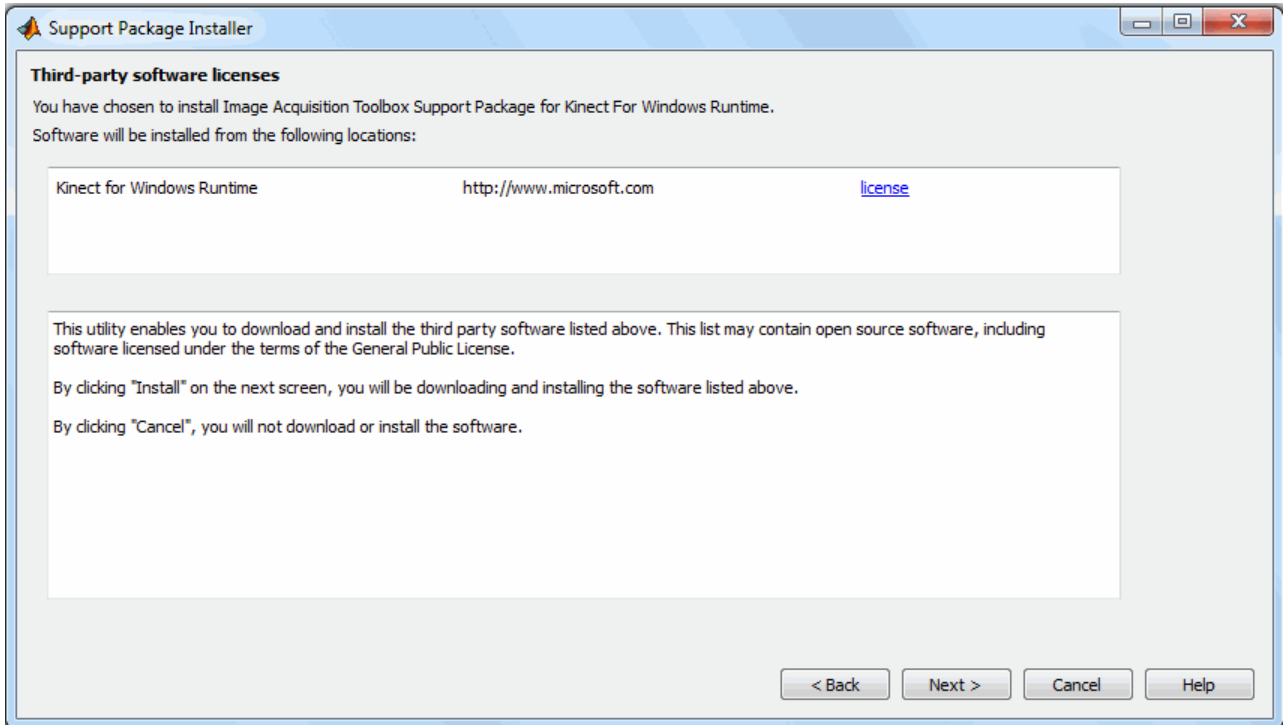


Accept or change the **Installation folder** and click **Next**.

Note You must have write privileges for the Installation folder.

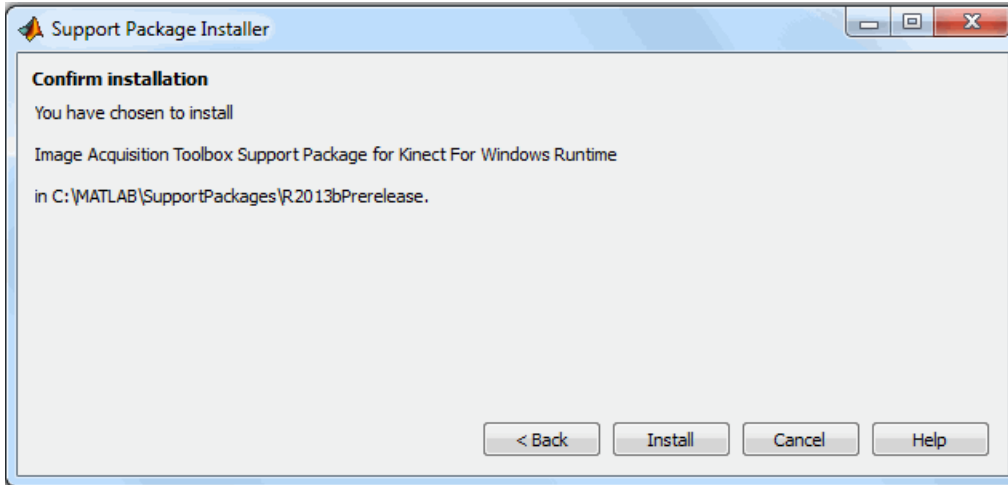
- 4** On the **MATHWORKS AUXILIARY SOFTWARE LICENSE AGREEMENT** screen, select the **I accept** checkbox and click **Next**.

5 The **Third-party software licenses** screen displays your choice of Image Acquisition Toolbox Support Package for Kinect for Windows Runtime.



Review the information, including the license agreements, and click **Next**.

- 6 On the **Confirm installation** screen, Support Package Installer confirms that you are installing the support package, and lists the installation location. Confirm your selection and click **Install**.



- 7 Support Package Installer displays a progress bar while it downloads and installs the Image Acquisition Toolbox support package and third-party software.

Note If you installed the support package previously, Support Package Installer removes the files from that installation before installing the current support package. If Support Package Installer cannot remove those files automatically, it instructs you to delete the files manually. Close MATLAB before removing the files. Then, restart MATLAB and run Support Package Installer again.

- 8 Toward the end of the installation process, a Kinect for Windows End User License Agreement dialog appears. Follow the prompts to accept the license agreement.
- 9 After the installation is complete you will see a confirmation message on the **Install/update complete** screen. Click **Finish** to close the Support Package Installer.

Troubleshooting

If the setup fails, it could be caused by an internet security setting. If you get an error message such as “KINECT Setup Failed – An error occurred while installing,” try the following and then run the installer again.

- 1 In Internet Explorer, go to **Tools > Internet Options**.
- 2 In Internet Options, select the **Advanced** tab.
- 3 Under the **Security** subsection, uncheck **Check for publisher’s certificate revocation** to temporarily disable it, and click **OK**.
- 4 Run the installer again.
- 5 After you have installed the support package, re-enable the security option in Internet Explorer.

Support Packages and Support Package Installer

What Is a Support Package?

A *support package* is an add-on that enables you to use a MathWorks product with specific third-party hardware and software.

Support packages can include:

- Simulink block libraries
- MATLAB functions, classes, and methods
- Firmware updates for the third-party hardware
- Automatic installation of third-party software
- Examples and tutorials

A *support package file* has a *.zip extension. This type of file contains MATLAB files, MEX files, and other supporting files required to install the support package. Use Support Package Installer to install these support package files.

A *support package installation file* has a *.mlpkginstall extension. You can double click this type of file to start Support Package Installer, which preselects a specific support package for installation. You can download these files from MATLAB Central File Exchange and use them to share support packages with others.

What Is Support Package Installer?

Support Package Installer is a wizard that guides you through the process of installing support packages.

You can use Support Package Installer to:

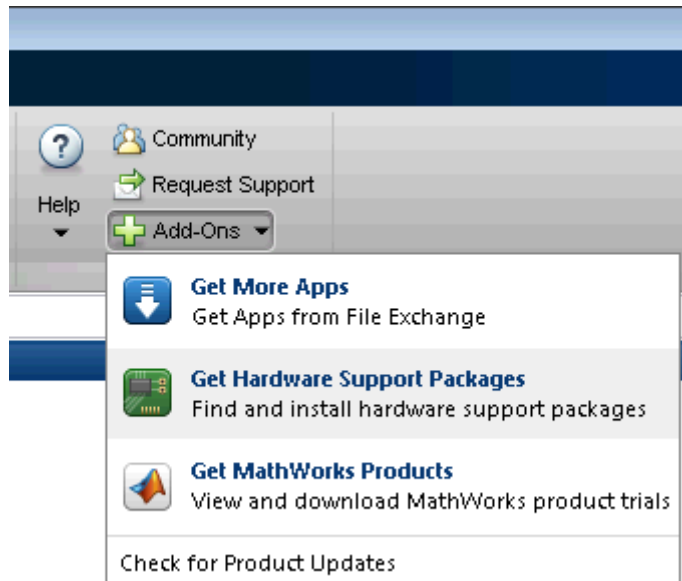
- Display a list of available, installable, installed, or updatable support packages
- Install, update, download, or uninstall a support package.
- Update the firmware on specific third-party hardware.

- Provide your MathWorks software with information about required third-party software.

If third-party software is included, Support Package Installer displays a list of the software and licenses for you to review before continuing.

You can start Support Package Installer in one of the following ways:

- On the MATLAB toolstrip, click **Add-Ons > Get Hardware Support Packages**.



- In the MATLAB Command Window, enter `supportPackageInstaller`.
- Double-click a support package installation file (*.mlpkginstall).

Install This Support Package on Other Computers

You can download a support package to one computer, and then install it on other computers. You can use this approach to:

- Save time when installing support packages on multiple computers.
- Install support packages on computers that are not connected to the Internet.

Before starting, select a computer to use for downloading. This computer must have the same base product license and platform as the computers upon which you are installing the support package. For example, suppose you want to install a Simulink support package on a group of computers that are running 64-bit Windows. To do so, you must first download the support package using a computer that has a Simulink license and is running 64-bit Windows.

Download the support package to one computer:

- 1** In the MATLAB Command Window, enter `supportPackageInstaller`.
- 2** In Support Package Installer, on the **Select an action** screen, choose **Install from Internet** or **Download from Internet**. Click **Next**.
- 3** On the following screen, select only one support package.

Notice the path of the **Download folder**. For example,
C:\MATLAB\SupportPackages\R2013b\downloads.

- 4** Using the file manager on your computer, open the downloads folder and observe its contents.
- 5** Using Support Package Installer, complete the installation or download process.

This process creates a folder within the **Download folder**. In some cases, if the support package requires another support package, this process creates an additional folder.

Prepare and share the support package files:

- 1 In the file manager, check how many folders were created during the installation or download process.
- 2 If more than one folder was created, combine the contents of the folders into the folder named after the support package.

For example,

C:\MATLAB\SupportPackages\R2013b\downloads*support_package_name*.

- 3 Make that folder available to other computers by sharing it on the network, or copying it to portable media, such as a USB flash drive.

Note Some support packages require that you install third-party software separately before completing the support package installation process. In that case, also make the third-party software available for installation on the other computers.

Install the support package on the other computers:

- 1 Run Support Package Installer on the other computer or computers.
- 2 On the **Install or update support package** screen, select the **Folder** option.
- 3 Use **Browse** to specify the location of the support package folder on the network or portable media.
- 4 Complete the instructions provided by Support Package Installer.

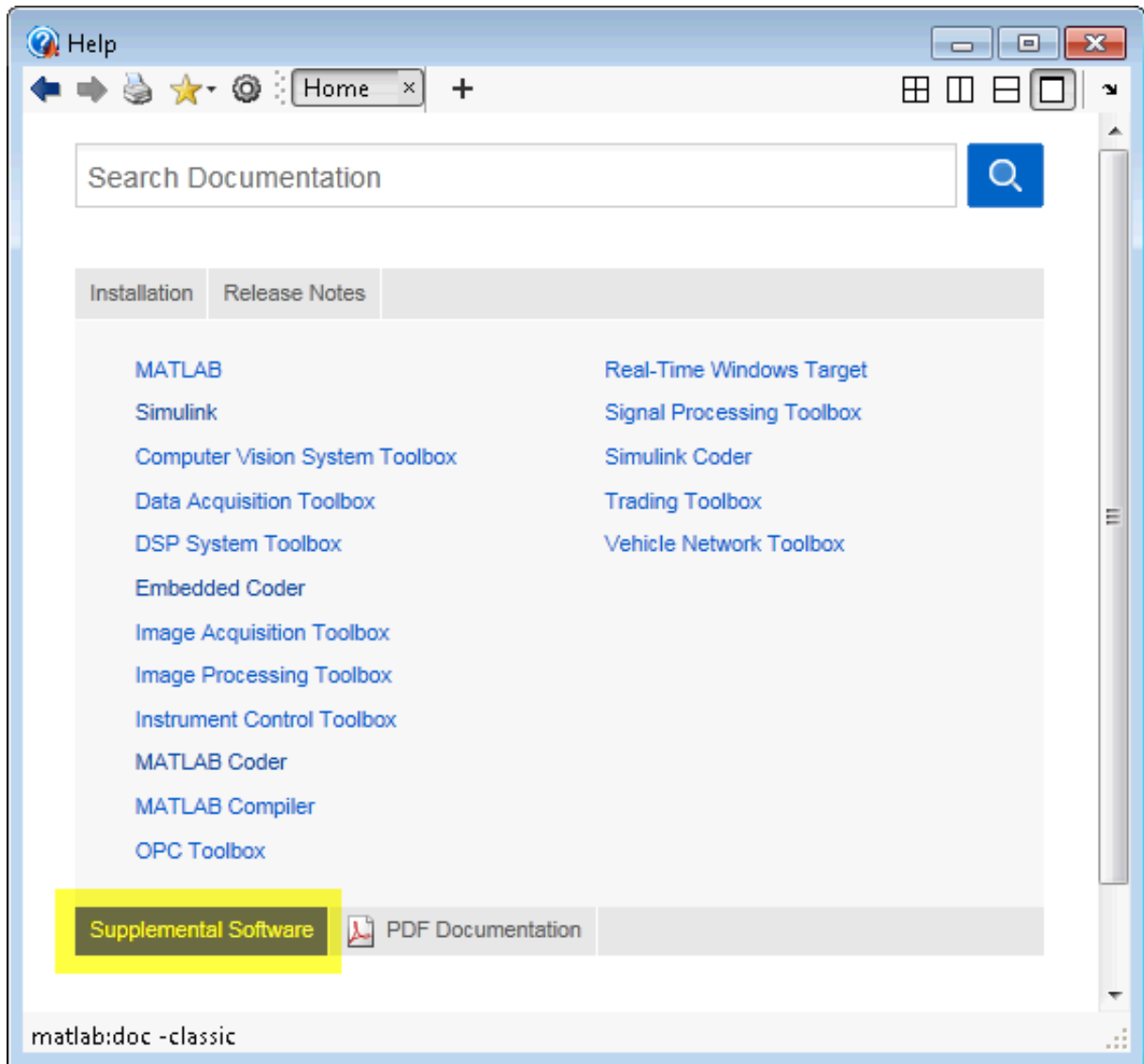
Open Examples for This Support Package

In this section...
“Using the Help Browser” on page 10-41
“Using the Block Library” on page 10-43
“Using Support Package Installer” on page 10-44

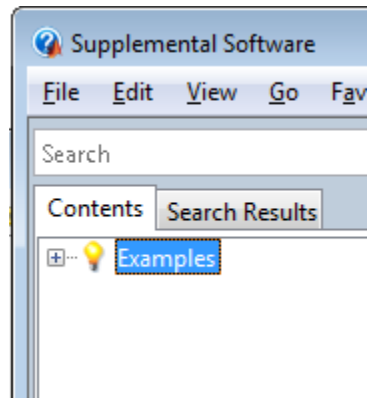
Using the Help Browser

You can open support package examples from the Help browser:

- 1 Enter `doc` in the MATLAB Command Window.
- 2 In the Help browser, click **Supplemental Software** in the lower left corner of the Home page.



3 In Supplemental Software, double-click **Examples**.



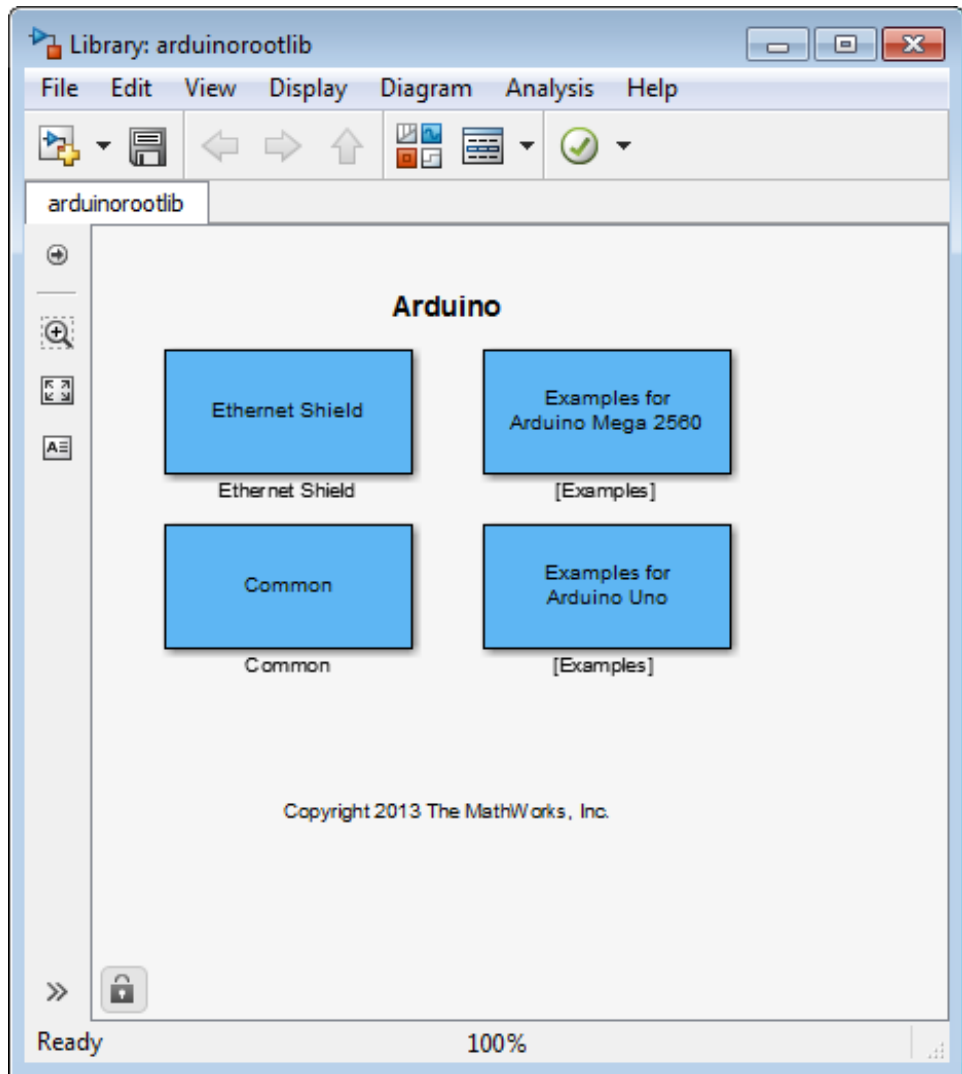
- 4 Select the examples for your support package.

Note For other types of examples, open the Help browser and search for your product name followed by “examples”.

Using the Block Library

To open support package from the support package block library:

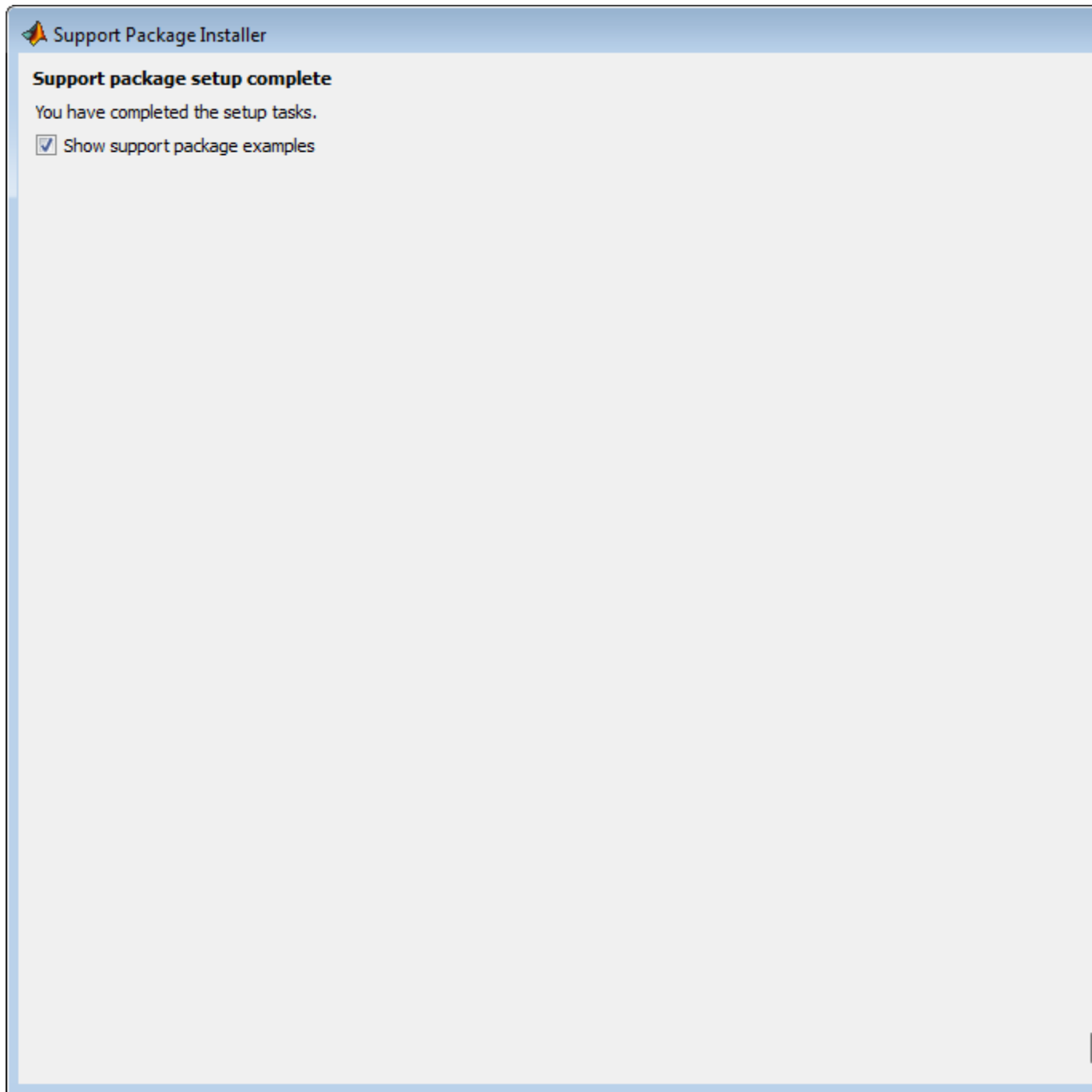
- 1 Enter `simulink` in the MATLAB Command Window.
- 2 In Simulink Library Browser, open the support package block library.
- 3 In the block library, double-click the Examples block.



Using Support Package Installer

Support Package Installer (supportPackageInstaller) automatically displays the support package examples when you complete the process of installing and setting up a support package.

On the last screen in Support Package Installer, leave **Show support package examples** enabled and click **Finish**.



Using the VideoDevice System Object

- “VideoDevice System Object Overview” on page 11-2
- “Creating the VideoDevice System Object” on page 11-3
- “Using VideoDevice System Object to Acquire Frames” on page 11-5
- “Using Properties on a VideoDevice System Object” on page 11-10
- “Code Generation with VideoDevice System Object” on page 11-14

VideoDevice System Object Overview

The Image Acquisition Toolbox introduces the VideoDevice System object™, which allows single-frame image acquisition and code generation from MATLAB.

You use the `imaq.VideoDevice` function to create the System object. It supports the same adaptors and hardware that the `videoinput` object supports; however, it has different functions and properties associated with it. For example, the System object uses the `step` function to acquire single frames.

Creating the VideoDevice System Object

You use the `imaq.VideoDevice` function to create the System object. You can specify the `adaptorname`, `deviceid`, and `format` at the time of object creation, or it will use defaults, as follows.

Constructor	Purpose
<code>obj = imaq.VideoDevice</code>	Creates a VideoDevice System object, <code>obj</code> , that acquires images from a specified image acquisition device. When you specify no parameters, by default, it selects the first available device for the first adaptor returned by <code>imaqhwinfo</code> .
<code>obj = imaq.VideoDevice(adaptorname)</code>	Creates a VideoDevice System object, <code>obj</code> , using the first device of the specified <code>adaptorname</code> . <code>adaptorname</code> is a text string that specifies the name of the adaptor used to communicate with the device. Use the <code>imaqhwinfo</code> function to determine the adaptors available on your system.
<code>obj = imaq.VideoDevice(adaptorname, deviceid)</code>	Creates a VideoDevice System object, <code>obj</code> , with the default format for specified <code>adaptorname</code> and <code>deviceid</code> . <code>deviceid</code> is a numeric scalar value that identifies a particular device available through the specified <code>adaptorname</code> . Use the <code>imaqhwinfo(adaptorname)</code> syntax to determine the devices available and corresponding values for <code>deviceid</code> .

Constructor	Purpose
<code>obj = imaq.VideoDevice(adaptorname, deviceid, format)</code>	Creates a VideoDevice System object, <code>obj</code> , where <code>format</code> is a text string that specifies a particular video format supported by the device or a device configuration file (also known as a camera file).
<code>obj = imaq.VideoDevice(adaptorname, deviceid, format, P1, V1, ...)</code>	Creates a VideoDevice System object, <code>obj</code> , with the specified property values. If an invalid property name or property value is specified, the object is not created.

Specifying properties at the time of object creation is optional. They can also be specified after the object is created. See “Using Properties on a VideoDevice System Object” on page 11-10 for a list of applicable properties.

Using VideoDevice System Object to Acquire Frames

You can use these functions with the VideoDevice System object.

Function	Purpose
step	<p>Acquire a single frame from the image acquisition device.</p> <pre>frame = step(obj);</pre> <p>acquires a single frame from the VideoDevice System object, <code>obj</code>.</p> <p>Note that the first time you call <code>step</code>, it acquires exclusive use of the hardware and will start streaming data.</p>
release	<p>Release VideoDevice resources and allow property value changes.</p> <pre>release(obj)</pre> <p>releases system resources (such as memory, file handles, or hardware connections) of System object, <code>obj</code>, and allows all its properties and input characteristics to be changed.</p>
isLocked	<p>Returns a value that indicates if the VideoDevice resource is locked. (Use <code>release</code> to unlock.)</p> <pre>L = isLocked(obj)</pre> <p>returns a logical value, <code>L</code>, which indicates whether properties are locked for the System object, <code>obj</code>. The object performs an internal initialization the first time the <code>step</code> function is executed. This initialization locks properties and input specifications. Once this occurs, the <code>isLocked</code> function returns a value of <code>true</code>.</p>

Function	Purpose
preview	<p>Activate a live image preview window.</p> <p><code>preview(obj)</code></p> <p>creates a Video Preview window that displays live video data for the VideoDevice System object, <code>obj</code>. The Video Preview window displays the video data at 100% magnification (one screen pixel represents one image pixel). The size of the preview image is determined by the value of the VideoDevice System object ROI property. If not specified, it uses the default resolution for the device.</p>
closepreview	<p>Close live image preview window.</p> <p><code>closepreview(obj)</code></p> <p>closes the live preview window for VideoDevice System object, <code>obj</code>.</p>
imaqhwinfo	<p>Returns information about the object.</p> <p><code>imaqhwinfo(obj)</code></p> <p>displays information about the VideoDevice System object, <code>obj</code>.</p>

The basic workflow for using the VideoDevice System object is to create the object, preview the image, set any properties, acquire a frame, and clear the object, as shown here.

- 1 Construct a VideoDevice System object associated with the Winvideo adaptor with device ID of 1.

```
vidobj = imaq.VideoDevice('winvideo', 1);
```

- 2 Set an object-level property, such as ReturnedColorSpace.

```
set(vidobj, 'ReturnedColorSpace', 'grayscale');
```

Note that the syntax for an object-level property is to use `set` on the object, then the property name and property value.

- 3 Set a device-specific property, such as `Brightness`.

```
set(vidobj.DeviceProperties, 'Brightness', 150);
```

Note that the syntax for a device-specific property is to use `set` with the `DeviceProperties` object using dot notation, then the property name and property value.

- 4 Preview the image.

```
preview(vidobj)
```

- 5 Acquire a single frame using the `step` function.

```
frame = step(vidobj);
```

- 6 Display the acquired frame.

```
imshow(frame)
```

- 7 Release the hardware resource.

```
release(vidobj);
```

- 8 Clear the `VideoDevice System` object.

```
clear vidobj;
```

Kinect for Windows Metadata

You can return Kinect for Windows skeleton data using the `VideoDevice System` object on the Kinect Depth sensor.

Typically in the Image Acquisition Toolbox, each camera or image device has one device ID. Because the Kinect for Windows camera has two separate sensors, the Color sensor and the Depth sensor, the toolbox lists two device IDs. The Kinect Color sensor is device 1 and the Kinect depth sensor is device 2.

To create a System object using the Color sensor:

```
vidobjcolor = imaq.VideoDevice('kinect', 1);
```

To create a System object using the Depth sensor:

```
vidobjdepth = imaq.VideoDevice('kinect', 2);
```

The Depth sensor returns skeleton metadata. To access this, you need to add a second output argument for the `step` function. The Color sensor works the same way as other devices. So acquiring a frame using the Kinect Color sensor is done as shown here:

```
imageData = step(vidobjcolor);
```

where `imageData` is the frame acquired if `vidobjcolor` is a System object created with Device 1, the Kinect Color sensor.

The Kinect Depth sensor requires a second output argument, as shown here:

```
[depthData metadata] = step(vidobjdepth);
```

where `depthData` is the frame acquired if `vidobjdepth` is a System object created with Device 2, the Kinect Depth sensor, and `metadata` is the skeleton metadata returned with the frame.

These metadata fields are related to tracking the skeletons. The metadata is returned as a structure that contains these parameters:

```
IsPositionTracked  
IsSkeletonTracked  
JointDepthIndices  
JointImageIndices  
JointTrackingState  
JointWorldCoordinates  
PositionDepthIndices  
PositionImageIndices  
PositionWorldCoordinates  
SegmentationData  
SkeletonTrackingID
```

You can then look at both outputs. To see the image frame:

```
imshow(imageData)
```

To see the metadata output:

```
metadata
```

Note The Kinect for Windows Depth sensor may take some seconds to be ready to begin acquiring skeletal metadata. In order to see values in the metadata output, you need to acquire multiple frames using the step function repeatedly. You can do this by using a for loop.

“Acquiring Image and Skeletal Data Using Kinect” on page 10-10 is an example that shows how to access the skeletal metadata using the `videoinput` object (not the `VideoDevice System` object), and it contains information about the properties you can set on both the Color and Depth sensors, and descriptions of all the metadata fields. The property names and values are the same as they would be for the `System` object, but you would then need to set the properties as shown in step 3 of the above example (in the current topic) for use with the `VideoDevice System` object.

Using Properties on a VideoDevice System Object

You can specify properties at the time of object creation, or they can be specified and changed after the object is created.

Properties that can be used with the VideoDevice System object include:

Property	Description
Device	<p>Device from which to acquire images.</p> <p>Specify the image acquisition device to use to acquire a frame. It consists of the device name, adaptor, and device ID. The default device is the first device returned by <code>imaqhwinfo</code>.</p> <p><code>set(obj, 'Device')</code></p> <p>shows the list of available devices for VideoDevice System object, <code>obj</code>.</p>
VideoFormat	<p>Video format to be used by the image acquisition device.</p> <p>Specify the video format to use while acquiring the frame. The default value of <code>VideoFormat</code> is the default format returned by <code>imaqhwinfo</code> for the selected device. To specify a Video Format using a device file, set the <code>VideoFormat</code> property to 'From device file' This option exists only if your device supports device configuration files.</p> <p><code>set(obj, 'VideoFormat')</code></p> <p>shows the list of available video formats.</p>
DeviceFile	<p>Name of file specifying video format. This property is only visible when <code>VideoFormat</code> is set to 'From device file'.</p>

Property	Description
DeviceProperties	<p>Object containing properties specific to the image acquisition device.</p> <pre>set(obj.DeviceProperties, <property_name>, <property_value>)</pre> <p>shows a device-specific property for VideoDevice System object, obj.</p>
ROI	<p>Region-of-interest for acquisition. This is set to the default ROI value for the specified device, which is the maximum resolution possible for the specified format. You can change the value to change the size of the captured image. The format is 1-based, that is, it is specified in pixels in a 1-by-4 element vector [x y width height], where x is x offset and y is y offset.</p> <p>Note that this differs from the <code>videoinput</code> object, the Image Acquisition Tool, and the From Video Device block, all of which are 0-based.</p>
HardwareTriggering	<p>Turn hardware triggering on/off. Set this property to 'on' to enable hardware triggering to acquire images. The property is visible only when the device supports hardware triggering.</p>
TriggerConfiguration	<p>Specifies the trigger source and trigger condition before acquisition. The triggering condition must be met via the trigger source before a frame is acquired. This property is visible only when HardwareTriggering is set to 'on'.</p> <pre>set(obj, 'TriggerConfiguration')</pre> <p>shows the list of available hardware trigger configurations.</p>

Property	Description
ReturnedColorSpace	<p>Specify the color space of the returned image. The default value of the property depends on the device and the video format selected. Possible values are {rgb grayscale YCbCr} when the default returned color space for the device is not grayscale. Possible values are {rgb grayscale YCbCr bayer} when the default returned color space for the device is grayscale</p> <p><code>set(obj, 'ReturnedColorSpace')</code></p> <p>shows the list of available color space settings.</p>
BayerSensorAlignment	<p>String indicating the 2x2 sensor alignment. Specifies Bayer patterns returned by hardware. Specify the sensor alignment for Bayer demosaicing. The default value of this property is 'grbg'. Possible values are {grbg gbrg rggb bggr}. Visible only if ReturnedColorSpace is set to 'bayer'.</p> <p><code>set(obj, 'BayerSensorAlignment')</code></p> <p>shows the list of available sensor alignments.</p>
ReturnedDataType	<p>The returned data type of the acquired frame. The default ReturnedDataType is single.</p> <p><code>set(obj, 'ReturnedDataType')</code></p> <p>shows the list of available data types.</p>

Note The setting of properties for the System object supports tab completion for enumerated properties while coding in MATLAB. Using the tab completion is an easy way to see available property values. After you type the property name, type a comma, then a space, then the first quote mark for the value, then hit tab to see the possible values.

Once you have created a VideoDevice System object, you can set either object-level properties or device-specific properties on it.

To set an object-level property, use this syntax:

```
set(vidobj, 'ReturnedColorSpace', 'grayscale');
```

You can see that the syntax for an object-level property is to use `set` on the object name, property name, and property value.

Another example of an object-level property is setting the region-of-interest, or ROI, to change the dimensions of the acquired image. The ROI format is specified in pixels in a 1-by-4 element vector [x y width height].

```
set(vidobj, 'ROI', [1 1 200 200]);
```

Note This ROI value is 1-based. This differs from the `videoinput` object, the Image Acquisition Tool, and the From Video Device block, all of which are 0-based.

To set a device-specific property, use this syntax:

```
set(vidobj.DeviceProperties, 'Brightness', 150);
```

You can see that the syntax for a device-specific property is to use `set` with the `DeviceProperties` object using dot notation, then the property name and property value.

Another example of a device-specific property is setting the frame rate for a device that supports it.

```
set(vidobj.DeviceProperties, 'FrameRate', '30');
```

Note Once you have done a step, in order to change a property or set a new one, you need to release the object using the `release` function, before setting the new property.

Code Generation with VideoDevice System Object

In this section...
“Using the codegen Function” on page 11-14
“Shared Library Dependencies” on page 11-15
“Usage Rules for System Objects in Generated MATLAB Code” on page 11-15
“Limitations on Using System Objects in Generated MATLAB Code” on page 11-16

Using the codegen Function

The VideoDevice System object supports code generation in MATLAB via the `codegen` function. To use the `codegen` function, you must have a MATLAB Coder license. System objects also support code generation using the MATLAB Function block in Simulink. You can also use the System object with MATLAB Compiler™.

Note The MATLAB Compiler software supports System objects for use inside MATLAB functions. The MATLAB Compiler does not support System objects for use in MATLAB scripts.

Note If you use the `codegen` command to generate a MEX function on a Windows platform, you need to perform `imaqreset` before running the generated MEX file.

Note The `codegen` command can be used to generate executable files on non-Windows platforms. However, generation of the MEX function is not supported on Linux and Mac platforms.

For more information see the documentation for the MATLAB codegen function.

Shared Library Dependencies

The VideoDevice System object generates code with limited portability. The System object uses precompiled shared libraries, such as DLLs, to support I/O for specific types of devices. The shared library locations that the generated executable requires are as follows:

- Specific MathWorks shared libraries under [MATLABROOT]\bin\\
- MathWorks adaptor libraries under [MATLABROOT]\toolbox\imaq\imaqadaptors\\ specific to the device selected.

You will need to add the above folders to your system path before running the generated executable outside of MATLAB.

Usage Rules for System Objects in Generated MATLAB Code

- Assign System objects to persistent variables.
- Global variables are not supported.
- Initialize System objects once by embedding the object handles in an if statement with a call to isempty().
- Call the constructor exactly once for each System object.
- Set arguments to System object constructors as compile-time constants.
- Use the object constructor to set System object properties because you cannot use dot notation for code generation. You can use the get function to display properties.
- Test your code in simulation before generating code.

The following shows an example of some of these rules.

```
% Note: System Objects created for Codegen have to be persistent variables.
```

```
persistent vid;

% Construct the IMAQ VideoDevice System Object.
if isempty(vid)
    % Note: All required parameters must be passed to the System Object at
    % the point of construction.
    vid = imaq.VideoDevice('winvideo', 1, 'MJPEG_320x240', ...
        'ROI', [1 1 320 240], ...
        'ReturnedColorSpace', 'rgb', ...
        'DeviceProperties.Brightness', 130, ...
        'DeviceProperties.Sharpness', 220);
end
```

Limitations on Using System Objects in Generated MATLAB Code

Ensure that the value assigned to a nontunable or public property is a constant and that there is at most one assignment to that property (including the assignment in the constructor). Do not set any properties during code generation.

The only System object functions supported in code generation are:

- `get`
- `getNumInputs`
- `getNumOutputs`
- `reset`
- `step`

Do not set System objects to become outputs from the MATLAB Function block.

Do not pass a System object as an example input argument to a function being compiled with `codegen`.

Do not pass a System object to functions declared as extrinsic (i.e., functions called in interpreted mode) using the `coder.extrinsic` function. Do not return System objects from any extrinsic functions.

Adding Support for Additional Hardware

Support for Additional Hardware

The Image Acquisition Toolbox software supports connections with hardware from many common vendors, but it might not support the hardware you use. To add support for your hardware, you can create an adaptor using the Image Acquisition Toolbox Adaptor Kit.

The Image Acquisition Toolbox Adaptor Kit is a C++ framework that you can use to implement an adaptor. An adaptor is a dynamic link library (DLL) that implements the connection between the Image Acquisition Toolbox engine and a device driver via the vendor's SDK API. When you use the Adaptor Kit framework, you can take advantage of many prepackaged toolbox features such as disk logging, multiple triggering modes, and a standardized interface to the image acquisition device.

After you create your adaptor DLL and register it with the toolbox using the `imaqregister` function, you can create a video input object to connect with a device through your adaptor. In this way, adaptors enable the dynamic loading of support for hardware without requiring recompilation and linking of the toolbox.

To build an adaptor requires familiarity with C++, knowledge of the application programming interface (API) provided by the manufacturer of your hardware, and familiarity with Image Acquisition Toolbox concepts, functionality, and terminology. To learn more about creating an adaptor, see “Creating Custom Adaptors”. For detailed information about the adaptor kit framework classes, see the *Image Acquisition Toolbox Adaptor Kit Class Reference*, which is available in

```
matlabroot\toolbox\imaq\imaqadaptors\kit\doc\adaptorkit.chm
```

where *matlabroot* represents your MATLAB installation directory.

Troubleshooting

This chapter provides information about solving common problems you might encounter with the Image Acquisition Toolbox software and the video acquisition hardware it supports.

- “Troubleshooting Overview” on page 13-3
- “DALSA Coreco IFC Hardware” on page 13-4
- “DALSA Coreco Sopera Hardware” on page 13-6
- “Data Translation Hardware” on page 13-8
- “DCAM IEEE 1394 (FireWire) Hardware on Windows” on page 13-9
- “Hamamatsu Hardware” on page 13-16
- “Matrox Hardware” on page 13-17
- “QImaging Hardware” on page 13-19
- “National Instruments Hardware” on page 13-21
- “Point Grey Hardware” on page 13-23
- “GigE Vision Hardware” on page 13-26
- “GenICam GenTL Hardware” on page 13-34
- “Windows Video Hardware” on page 13-36
- “Linux Video Hardware” on page 13-39
- “Linux DCAM IEEE 1394 Hardware” on page 13-41
- “Macintosh Video Hardware” on page 13-42
- “Macintosh DCAM IEEE 1394 Hardware” on page 13-43
- “Video Preview Window Troubleshooting” on page 13-44

- “Contacting MathWorks and Using the `imaqsupport` Function” on page 13-45

Troubleshooting Overview

If, after installing the Image Acquisition Toolbox software and using it to establish a connection to your image acquisition device, you are unable to acquire data or encounter other problems, try these troubleshooting steps first. They might help fix the problem.

- 1** Verify that your image acquisition hardware is functioning properly.
- 2** If the hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the Image Acquisition Toolbox software.

The following sections describe how to perform these steps for the vendors and categories of devices supported by the Image Acquisition Toolbox software.

If you are encountering problems with the preview window, see “Video Preview Window Troubleshooting” on page 13-44.

Note To see the full list of hardware that the toolbox supports, visit the Image Acquisition Toolbox product page at the MathWorks Web site www.mathworks.com/products/imaq.

DALSA Coreco IFC Hardware

In this section...

“Troubleshooting DALSA Coreco IFC Devices” on page 13-4

“Determining the Driver Version for DALSA Coreco IFC Devices” on page 13-5

Troubleshooting DALSA Coreco IFC Devices

The Image Acquisition Toolbox software supports the use of both DALSA® Coreco IFC hardware and DALSA Coreco Sopera hardware. Please see the appropriate section depending on which driver your hardware uses.

If you are having trouble using the Image Acquisition Toolbox software with a supported DALSA Coreco IFC frame grabber, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For DALSA Coreco IFC devices, run the application that came with your hardware, the IFC Camera Configurator, and verify that you can view a live video stream from your camera.

- 2 Verify that the toolbox can locate your camera file, if you are using a camera file to configure the device. Make sure that your camera file appears in the **List of Cameras** in the DALSA Coreco IFC Camera Configurator.
- 3 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox. The Image Acquisition Toolbox software is only compatible with specific driver versions provided with the DALSA Coreco hardware and is not guaranteed to work with any other versions.
 - Find out the driver version you are using on your system. To learn how to get this information, see “Determining the Driver Version for DALSA Coreco IFC Devices” on page 13-5.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of

supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the DALSA Coreco Web site (www.imaging.com) to download the correct driver.

Determining the Driver Version for DALSA Coreco IFC Devices

To determine the DALSA Coreco IFC Library version you are using, view the release notes for the driver. You can access the release notes through the Windows **Start** menu.

- 1** Click the **Start** button.
- 2** On the **Start** menu, select **Programs**.
- 3** From the **Programs** menu, select the **IFC** link.
- 4** On the **IFC** menu, select the IFC release notes.

DALSA Coreco Sopera Hardware

In this section...
“Troubleshooting DALSA Coreco Sopera Devices” on page 13-6
“Determining the Driver Version for DALSA Coreco Sopera Devices” on page 13-7

Troubleshooting DALSA Coreco Sopera Devices

The Image Acquisition Toolbox software supports the use of both DALSA Coreco IFC hardware and DALSA Coreco Sopera hardware. Please see the appropriate section depending on which driver your hardware uses.

If you are having trouble using the Image Acquisition Toolbox software with a supported DALSA Coreco Sopera frame grabber, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For DALSA Coreco Sopera devices, run the application that came with your hardware, the Sopera CamExpert, and verify that you can view a live video stream from your camera.

- 2 If you are using a camera file to configure the device, verify that the toolbox can locate your camera file. Make sure that your camera appears in the **Camera** list in the Sopera CamExpert. To test the camera, select the camera in the list and click the **Grab** button.
- 3 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox.

Note The Image Acquisition Toolbox software is compatible only with specific driver versions provided with the DALSA Coreco hardware and is not guaranteed to work with any other versions.

- Find out the driver version you are using on your system. To learn how to get this information, see “Determining the Driver Version for DALSA Coreco Sapera Devices” on page 13-7.
- Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the DALSA Coreco Web site (www.imaging.com) to download the correct driver.

Determining the Driver Version for DALSA Coreco Sapera Devices

To determine the DALSA Coreco Sapera Library version you are using, view the release notes for the driver. You can access the release notes through the Windows **Start** menu.

- 1** Click the **Start** button to open the **Start** menu.
- 2** Select **Programs > DALSA Coreco Imaging > Sapera LT** to open the **Sapera LT** menu.
- 3** Select **Readme** to view the Sapera release notes.

Data Translation Hardware

If you are having trouble using the Image Acquisition Toolbox software with a supported Data Translation frame grabber, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For Data Translation devices, run the application that came with your hardware and verify that you can receive live video.

- 2 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox. The Image Acquisition Toolbox software is only compatible with specific driver versions provided by Data Translation with the Imaging Omni CD and is not guaranteed to work with any other versions.
 - Find out the driver version you are using on your system.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the Data Translation Web site (www.datatranslation.com) to download the correct driver.

- 3 Install the Data Translation Software Development Kit (SDK).

If the `imaqhwinfo` function does not return the driver for a Data Translation frame grabber, or the `imaqhwinfo` function or `videoinput` functions return an error message about a missing DLL (`olfg32.dll`), you may need to install additional files from the Imaging Omni CD.

By default, when you install drivers for your Data Translation frame grabber, the installation program may not install all the files the device drivers need. The additional files needed by the device driver are part of the SDK installation, not the device driver installation. If you get error messages about missing files, insert the Imaging Omni CD into your CD-ROM drive and install the SDK.

DCAM IEEE 1394 (FireWire) Hardware on Windows

In this section...

“Troubleshooting DCAM IEEE 1394 Hardware on Windows” on page 13-9

“Installing the CMU DCAM Driver on Windows” on page 13-10

“Running the CMU Camera Demo Application on Windows” on page 13-12

Troubleshooting DCAM IEEE 1394 Hardware on Windows

If you are having trouble using the Image Acquisition Toolbox software with an IEEE 1394 (FireWire) camera, using the toolbox’s `dcam` adaptor, follow these troubleshooting steps:

- 1 Verify that your IEEE 1394 (FireWire) camera is plugged into the IEEE 1394 (FireWire) port on your computer and is powered up.
- 2 Verify that your IEEE 1394 (FireWire) camera can be accessed through the `dcam` adaptor.
 - Make sure the camera is compliant with the IIDC 1394-based Digital Camera (DCAM) specification. Vendors typically include this information in documentation that comes with the camera. If your digital camera is not DCAM compliant, you might be able to use the `winvideo` adaptor. See “Windows Video Hardware” on page 13-36 for information.
 - Make sure the camera outputs data in uncompressed format. Cameras that output data in Digital Video (DV) format, such as digital camcorders, cannot use the `dcam` adaptor. To access these devices, use the `winvideo` adaptor. See “Windows Video Hardware” on page 13-36 for information.
 - Make sure you specified the `dcam` adaptor when you created the video input object. Some IEEE 1394 (FireWire) cameras can be accessed through either the `dcam` or `winvideo` adaptors. If you can connect to your camera from the toolbox but cannot access some camera features, such as hardware triggering, you might be accessing the camera through a DirectX® driver. See “Creating a Video Input Object” on page 4-10 for more information about specifying adaptors.

- 3 Verify that your IEEE 1394 (FireWire) camera is using the Carnegie Mellon University (CMU) DCAM driver version 6.4.6.

Note The toolbox only supports connections to IEEE 1394 (FireWire) DCAM-compliant devices using the CMU DCAM driver. The toolbox is not compatible with any other vendor-supplied driver, even if the driver is DCAM compliant.

To verify this, run the demo application provided by CMU, `1394CameraDemo.exe`. This demo application is among the files you install from the CMU driver archive file when you install the CMU DCAM driver — see “Installing the CMU DCAM Driver on Windows” on page 13-10. To learn how to run the demo application, see “Running the CMU Camera Demo Application on Windows” on page 13-12.

- If the demo application recognizes the camera, the camera is set up to use the CMU DCAM driver and is ready for use by the toolbox.
- If the demo application does not recognize the camera, install the CMU DCAM driver. See “Installing the CMU DCAM Driver on Windows” on page 13-10 for instructions.
- If the demo application recognizes your camera, but the toolbox still does not, verify that the camera complies with the correct DCAM specification version for the camera and the correct DCAM CMU driver version required by the toolbox. For the correct information about supported hardware, visit the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

Installing the CMU DCAM Driver on Windows

The Image Acquisition Toolbox software supports acquiring data from IEEE 1394 (FireWire) cameras that support the IIDC 1394-based Digital Camera (DCAM) specification. To use a DCAM compliant camera, you must use the DCAM driver created by Carnegie Mellon University (CMU) to connect to these devices.

Note The CMU DCAM driver is the only DCAM driver supported by the toolbox. You cannot use vendor-supplied drivers, even if they are compliant with the DCAM specification.

Installing the Driver

To install the CMU DCAM driver on your system, follow this procedure:

- 1 Obtain the CMU DCAM driver files. The Image Acquisition Toolbox software includes the CMU DCAM installation file, `1394camera646.exe`, in the directory

```
matlabroot\toolbox\imaq\imaqextern\drivers\win32\dcam
```

where *matlabroot* represents the name of your MATLAB installation directory.

You can also download the DCAM driver directly from CMU. Go to the Web site www.cs.cmu.edu/~iwan/1394 and click the download link.

- 2 Start the installation by double-clicking the .exe file.

On the first page of the installation wizard under **Select components to install**, select the first three items in the installation list, and click **Next**. On the second page of the wizard, accept the default location or browse to a new one, and click **Install**.

Note To install the DCAM driver on a 32-bit Windows 7 system, you must run the installation program as administrator. Open the folder containing the installer EXE file. Right-click on it and choose **Run as administrator**. If you do not do this, it will fail to install some of the necessary files.

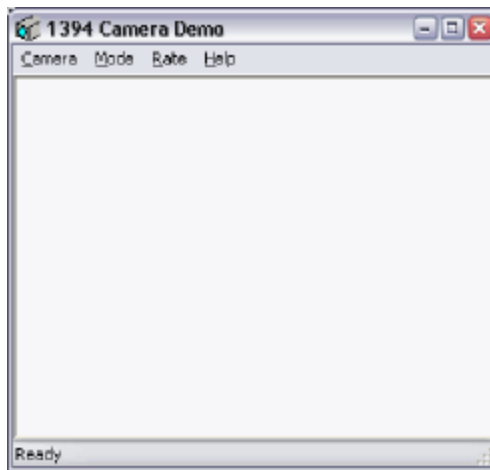
You may need to get your camera recognized after installing the driver. If this happens, open **Device Manager** and select the camera software. Right-click it and choose **Update Driver Software**. Browse for the vendor driver software and install it.

Running the CMU Camera Demo Application on Windows

The Carnegie Mellon University (CMU) DCAM driver distribution includes a camera demo application, named `1394CameraDemo.exe`. The demo application is among the files you installed in the previous section.

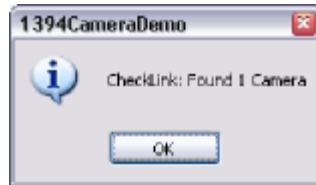
You can use this demo application to verify whether your camera is using the CMU DCAM driver. The following describes the step-by-step procedure you must perform to access a camera through this demo application.

- 1 Select **Start > Programs > CMU 1394 Camera > 1394 Camera Demo**.
- 2 The application opens a window, shown in the following figure.

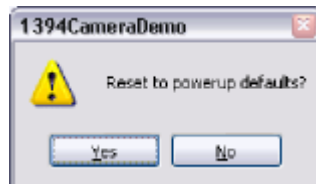


- 3 From the Camera Demo application, select **Camera > Check Link**. This option causes the demo application to look for DCAM-compatible cameras that are available through the IEEE 1394 (FireWire) connection.

The demo application displays the results of this search in a pop-up message box. In the following example, the demo application found a camera. Click **OK** to continue.

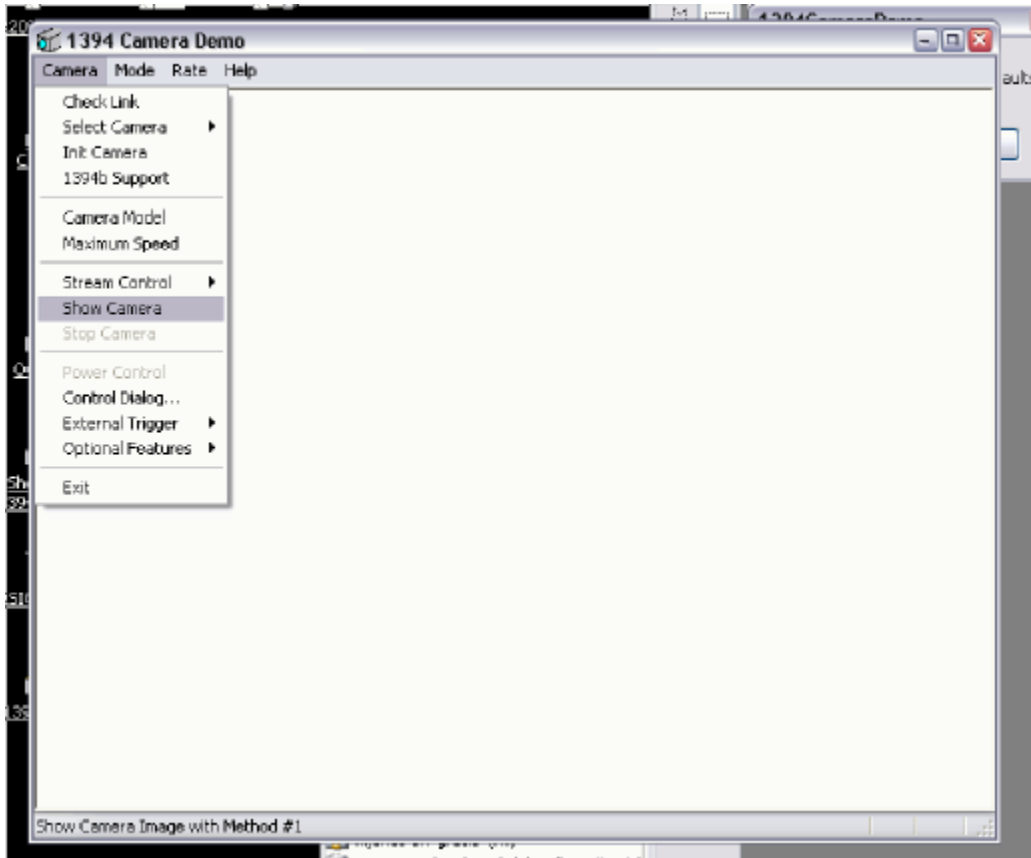


- 4 Select **Camera > Select Camera** and select the camera you want to use. The **Select Camera** option is not enabled until after the **Check Link** option has successfully found cameras.
- 5 Select **Camera > Init Camera**. In this step, the demo application checks the values of various camera properties. The demo application might resize itself to fit the video format of the specified camera. If you see the following dialog box message, click **Yes**.

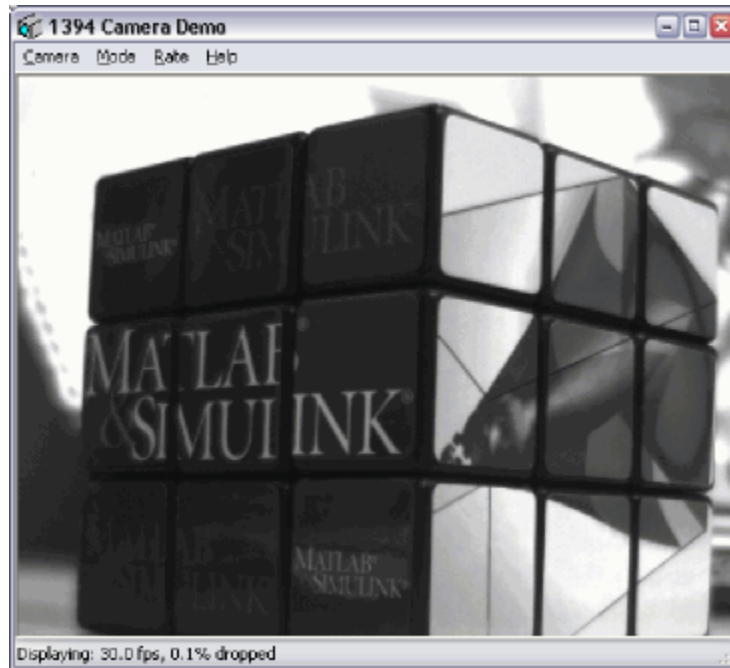


Note If you are using 1394b, select **Camera > 1394b Support**, and then check the **Maximum Speed** option after choosing 1394b support. If you do not see 400 MB per second or higher, refer to the customer technical solution on that topic, <http://www.mathworks.com/support/solutions/data/1-3LNN8U.html>.

- 6 Select **Camera > Show Camera** to start acquiring video.



The demo application starts displaying live video in the window.



7 To exit, select **Stop Camera** from the Camera menu and then click **Exit**.

Hamamatsu Hardware

If you are having trouble using the Image Acquisition Toolbox software with a x Hamamatsu digital camera, follow these troubleshooting steps:

- 1** Verify that your image acquisition hardware is functioning properly.
 - Make sure that your camera is plugged into the IEEE 1394 (FireWire) port on your computer and is powered up.
 - Run the application that came with your hardware and verify that you can acquire video frames. Use the `exAcq.exe` application, available from Hamamatsu.
- 2** Make sure you specified the hamamatsu adaptor when you created the video input object. Some IEEE 1394 (FireWire) cameras can be accessed through either the `dcam` or `winvideo` adaptors. See “Creating a Video Input Object” on page 4-10 for more information about specifying adaptors.
- 3** Verify that you are using the correct hardware device driver that is compatible with the toolbox. The Image Acquisition Toolbox software is only compatible with specific driver versions provided by Hamamatsu and is not guaranteed to work with any other versions.
 - Find out the driver version you are using on your system.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the Hamamatsu Software API Support page (www.dcamapi.com) to download the correct driver that is supported by the toolbox, if it is available there. If it is not available, please contact Hamamatsu to obtain the correct driver.

Matrox Hardware

In this section...
“Troubleshooting Matrox Devices” on page 13-17
“Determining the Driver Version for Matrox Devices” on page 13-18

Troubleshooting Matrox Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported Matrox frame grabber, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For Matrox devices, run the application that came with your hardware, Matrox Intellicam, and verify that you can receive live video.

- 2 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox. The Image Acquisition Toolbox software is only compatible with specific driver versions provided with the Matrox Imaging Library (MIL) or MIL-Lite software and is not guaranteed to work with any other versions.
 - Find out the driver version you are using on your system. To learn how to get this information, see “Determining the Driver Version for Matrox Devices” on page 13-18.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the Matrox Web site (www.matrox.com) to download the correct drivers.

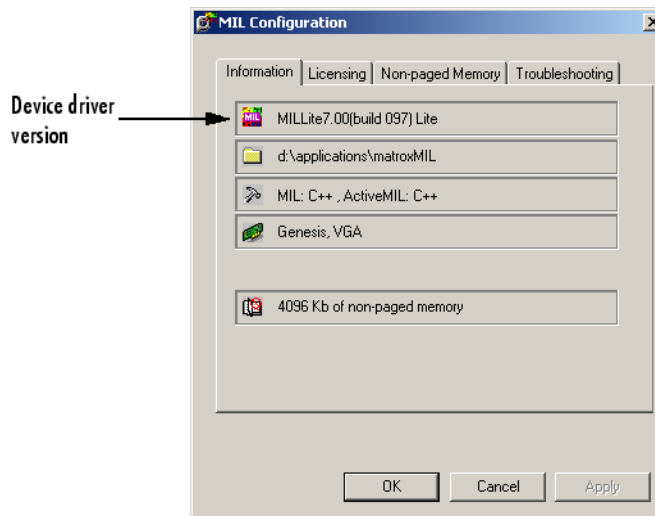
Note There is no difference between MIL and MIL-Lite software inside of MATLAB. They both work with Matrox Imaging devices.

Determining the Driver Version for Matrox Devices

To determine the Matrox Imaging Library version you are using, run the Matrox MIL Configuration utility. You can access this software through the Windows **Start** button.

Select **Start > Programs > Matrox Imaging Products > MIL Configuration**.

The software version is listed on the **Information** tab.



Matrox® MIL Configuration Utility

QImaging Hardware

In this section...
“Troubleshooting QImaging Devices” on page 13-19
“Determining the Driver Version for QImaging Devices” on page 13-20

Troubleshooting QImaging Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported QImaging® camera, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For QImaging devices, run the application that came with your hardware, QCapture, and verify that you can receive live video.

- 2 Select **Start > Programs > QCapture Suite > QCapture**.

- 3 In QCapture, select **Acquire > Live Preview** to test that the hardware is working properly.

- 4 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox.

Note The Image Acquisition Toolbox software is compatible only with specific driver versions provided with the QImaging software and is not guaranteed to work with any other versions.

- Find out the driver version you are using on your system. To learn how to get this information, see “Determining the Driver Version for QImaging Devices” on page 13-20.
- Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the QImaging Web site (www.qimaging.com) to download the correct drivers.

Determining the Driver Version for QImaging Devices

To determine the QImaging driver version you are using, run the QImaging QCapture utility.

Select **Start > Programs > QCapture Suite > QCapture**, and then select **Help > About** to see the driver version number.

National Instruments Hardware

In this section...

“Troubleshooting National Instruments Devices” on page 13-21

“Determining the Driver Version for National Instruments Devices” on page 13-22

Troubleshooting National Instruments Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported National Instruments® frame grabber, follow these troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For National Instruments devices, run the application that came with your hardware, Measurement & Automation Explorer, and verify that you can receive live video.

- 2 Select **Start > Programs > National Instruments > Measurement & Automation**.

- 3 To test that the hardware is working properly, in Measurement & Automation Explorer, expand **Devices and Interfaces**, then expand **NI-IMAQ Devices**, then expand the node that represents the board you want to use.

- 4 With the board expanded, select the channel or port that you have connected a camera to.

- 5 Click the **Grab** button to verify that your camera is working. If it is not, see the National Instruments device documentation.

- 6 If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox.

Note The Image Acquisition Toolbox software is compatible only with specific driver versions provided with the National Instruments software and is not guaranteed to work with any other versions.

- Find out the driver version you are using on your system. To learn how to get this information, see *Determining the Driver Version*.
- Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the National Instruments Web site (www.ni.com) to download the correct drivers.

Determining the Driver Version for National Instruments Devices

To determine the National Instruments driver version you are using, run the Measurement & Automation Explorer.

Select **Help > System Information**, and then see the **NI-IMAQ Software** field for the driver version number.

Point Grey Hardware

In this section...

“Troubleshooting Point Grey Devices” on page 13-23

“Determining the Driver Version for Point Grey Devices” on page 13-24

Troubleshooting Point Grey Devices

The Point Grey adaptor includes support for the following types of Point Grey devices:

- FireWire
- GigE Vision
- USB 2
- Bumblebee 2

If you are having trouble using the Image Acquisition Toolbox software with a supported Point Grey camera, follow these troubleshooting steps:

- 1** Verify that your image acquisition hardware is functioning properly.

For Point Grey devices, run the application that came with your hardware, FlyCapture, and verify that you can receive live video.

- 2** Select **Start > Programs > Point Grey Research > FlyCapture2 > FlyCap2**.

- 3** In FlyCapture, select your device and click **OK** to open the dialog box that shows the video feed to test that the hardware is working properly.

- 4** If your hardware is functioning properly, verify that you are using a hardware device driver that is compatible with the toolbox.

Note The Image Acquisition Toolbox software is compatible only with specific driver versions provided with the Point Grey software and is not guaranteed to work with any other versions.

- Find out the driver version you are using on your system. To learn how to get this information, see “Determining the Driver Version for Point Grey Devices” on page 13-24.
- Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the Point Grey Web site (www.ptgrey.com) to download the correct drivers.

Note If you are using a Point Grey camera that is a GigE Vision device, do not try to use both the Point Grey adaptor and the GigE Vision adaptor at the same time. You should use the Point Grey adaptor.

Note For use of the Bumblebee 2 cameras, certain video formats may be suppressed. To see the available video formats for your Bumblebee camera, open the Image Acquisition Tool and check the format list shown in the **Hardware Browser** under your device node.

Determining the Driver Version for Point Grey Devices

To determine the Point Grey driver version you are using, run the Point Grey FlyCapture utility.

to see the driver version number.

- 1 Select **Start > Programs > Point Grey Research > FlyCapture2 > FlyCap2** to open FlyCapture.

- 2** In FlyCapture, select **Settings > Toggle Camera Control Dialog**.
- 3** In the Control dialog, select **Camera Information**. The driver version is included in the information that is displayed there.

GigE Vision Hardware

In this section...
“Troubleshooting GigE Vision Devices on Windows” on page 13-26
“Troubleshooting GigE Vision Devices on Linux” on page 13-29
“Troubleshooting GigE Vision Devices on Mac” on page 13-31

Troubleshooting GigE Vision Devices on Windows

If you are having trouble using the Image Acquisition Toolbox software with a GigE Vision camera on a Windows machine, using the toolbox’s `gige` adaptor, follow these troubleshooting steps:

- 1 Verify that the adaptor loads. You can use the `imaqhwinfo` command to list installed adaptors. The `gige` adaptor should be included on the list.

If it does not load, make sure that GenICam is configured correctly using the `imaqsupport` function.

If your camera requires a GenICam XML file on a local drive (most cameras do not), and the adaptor loads but no devices are shown, check the `MWIMAQ_GENICAM_XML_FILES` environment variable, and make sure it contains the directory where your camera’s XML file is located.

For information on installing GenICam and checking your environment variables, see “Software Configuration” on page 9-12.

- 2 Make sure you did not install your camera vendor’s filtering or performance networking driver. If you did, you must uninstall it.
- 3 Make sure that anti-virus program drivers are unchecked in the Ethernet card Properties.

For more information on this, see Step 3 in “Installation of GigE Vision Cameras and Drivers on Windows” on page 9-4.

- 4 Make sure the Ethernet card is configured properly.

For more information on this, see “Network Hardware Configuration Notes” on page 9-3 and “Network Adaptor Configuration Notes” on page 9-4.

Also, if you have multiple cameras connected to multiple Ethernet cards, you cannot have them all set to automatic IP configuration. You must specify the IP address for each card and each card must be on a different subnet.

- 5 Test the connectivity of your device separate from using the Image Acquisition Toolbox. Use the vendor program included with your device to see if you can detect and acquire images from the camera.

- 6 If you receive an error message such as:

“Block 23 is being dropped because packets are unavailable for resend.”

and it does not mention buffer size, it is likely that packets are being dropped due to overload of the CPU. To lower the CPU load, raise the value of the `PacketSize` device-specific (source) property. In order to do this, you must be using hardware that supports jumbo frames.

You might also want to calculate and set the `PacketDelay` device-specific (source) property.

Also, if you are using a CPU that is older than an Intel® Core™ 2 Quad or equivalent AMD®, you may experience this type of error.

If you have a slower computer and experience packet loss using the GigE Vision adaptor, you can set a packet delay to avoid overloading the computer. This is useful in solving the performance issue if you cannot achieve your camera’s frame rate. The `PacketDelay` property will initially be set to use the value that is your camera’s default value. You can then adjust the value if needed. The `TimeStampTickFrequency` property is read-only but is available for calculating the actual packet delay value is being used.

For more information on the new `PacketDelay` property and how to calculate packet delay, see this solution:

<http://www.mathworks.com/support/solutions/en/data/1-F36R0R/index.html>

- 7 If you are able to start acquisition without error but do not receive any frames, and if you are using a larger `PacketSize`, make sure that your hardware and the network between the computer and the camera support jumbo frames, and also that your Ethernet card driver is set to allow them at the size that you are attempting to use.
- 8 The toolbox attaches the block ID (frame ID) as metadata to the frame. If your camera does not start a new acquisition at block 1, if you want to know if you lost initial frames, you can check the metadata. If the first frame's block ID is not 1, you may have some missing frames. For example, use this command in MATLAB:

```
[d t m]=getdata(vid,2);  
m(1)
```

The answer will include the `Block ID` and the `FrameNumber`.

- 9 Run the `imaqsupport` function for further troubleshooting information.

Troubleshooting GigE Vision Devices on Linux

If you are having trouble using the Image Acquisition Toolbox software with a GigE Vision camera on a Linux machine, using the toolbox's gige adaptor, follow these troubleshooting steps:

- 1 Verify that the adaptor loads. You can use the `imaqhwinfo` command to list installed adaptors. The gige adaptor should be included on the list.

If it does not load, make sure that GenICam is configured correctly using the `imaqsupport` function.

If your camera requires a GenICam XML file on a local drive (most do not), and the adaptor loads but no devices are shown, check the `MWIMAQ_GENICAM_XML_FILES` environment variable, and make sure it contains the directory where your camera's XML file is located.

For information on installing GenICam and checking your environment variables, see "Software Configuration" on page 9-12.

- 2 Make sure you did not install your camera vendor's filtering or performance networking driver. If you did, you should uninstall it.
- 3 Make sure the Ethernet card is configured properly.

For more information on this, see "Network Hardware Configuration Notes" on page 9-3 and "Network Adaptor Configuration Notes" on page 9-4.

Also, if you have multiple cameras connected to multiple Ethernet cards, you cannot have them all set to automatic IP configuration. You must specify the IP address for each card and each card must be on a different subnet.

- 4 Examine the connectivity of your device separate from using the Image Acquisition Toolbox. You may find using `ping -b`, `arp`, `route`, and `ifconfig` helpful with this.
- 5 If you receive an error message such as:

"Block 23 is being dropped because packets are unavailable for resend"

and it does not mention buffer size, it is likely that packets are being dropped due to overload of the CPU. To lower the CPU load, raise the value of the `PacketSize` device-specific (source) property. In order to do this, you must be using hardware that supports jumbo frames.

You might also want to calculate and set the `PacketDelay` device-specific (source) property.

Also, if you are using a CPU that is older than an Intel Core 2 Quad or equivalent AMD, you may experience this type of error.

If you have a slower computer and experience packet loss using the GigE Vision adaptor, you can set a packet delay to avoid overloading the computer. This is useful in solving the performance issue if you cannot achieve your camera's frame rate. The `PacketDelay` property will initially be set to use the value that is your camera's default value. You can then adjust the value if needed. The `TimeStampTickFrequency` property is read-only but is available for calculating the actual packet delay value is being used.

For more information on the new `PacketDelay` property and how to calculate packet delay, see this solution:

<http://www.mathworks.com/support/solutions/en/data/1-F36R0R/index.html>

- 6** If you are able to start acquisition without error but do not receive any frames, and if you are using a larger `PacketSize`, make sure that your hardware and the network between the computer and the camera support jumbo frames, and also that your Ethernet interface is set to allow them at the size that you are attempting to use.
- 7** If you receive an error that says a block or frame is being dropped because a packet is unavailable for resend, one likely cause is that the buffer size of the socket could not be set to the reported value, for example 1000000.

See your system administrator about using `sysctl` for `net.core.rmem_max`. For example, the system administrator could try:

```
sysctl -w net.inet.udp.recvspace=1000000
```

- 8** If your camera does not start a new acquisition at block 1, the toolbox will attach the block ID (frame ID) as metadata to the frame. If you want to

know if you lost initial frames, you can check the metadata – if the first frame’s block ID is not 1, you may have some missing frames. For example, use this command in MATLAB:

```
[d t m]=getdata(vid,2);  
m(1)
```

The answer will include the Block ID and the FrameNumber.

- 9 Run the `imaqsupport` function for further troubleshooting information.

Troubleshooting GigE Vision Devices on Mac

If you are having trouble using the Image Acquisition Toolbox software with a GigE Vision camera on a Mac machine, using the toolbox’s `gige` adaptor, follow these troubleshooting steps:

- 1 Verify that the adaptor loads. You can use the `imaqhwinfo` command to list installed adaptors. The `gige` adaptor should be included on the list.

If it does not load, make sure that GenICam is installed and the environment variables exist. You can check this using the `imaqsupport` function.

If your camera requires a GenICam XML file on a local drive (most do not), and the adaptor loads but no devices are shown, check the `MWIMAQ_GENICAM_XML_FILES` environment variable, and make sure it contains the directory where your camera’s XML file is located.

For information on installing GenICam and checking your environment variables, see “Software Configuration” on page 9-12.

- 2 Make sure you did not install your camera vendor’s filtering or performance networking driver. If you did, you should uninstall it.
- 3 Make sure the Ethernet card is configured properly.

For more information on this, see “Network Hardware Configuration Notes” on page 9-3 and “Network Adaptor Configuration Notes” on page 9-4.

Also, if you have multiple cameras connected to multiple Ethernet cards, you cannot have them all set to automatic IP configuration. You must

specify the IP address for each card and each card must be on a different subnet.

- 4 Examine the connectivity of your device separate from using the Image Acquisition Toolbox. You may find using `ping -b`, `arp`, `route`, and `ifconfig` helpful with this.
- 5 If you receive an error message such as:

“Block 23 is being dropped because packets are unavailable for resend”

and it does not mention buffer size, it is likely that packets are being dropped due to overload of the CPU. To lower the CPU load, raise the value of the `PacketSize` device-specific (source) property. In order to do this, you must be using hardware that supports jumbo frames.

You might also want to calculate and set the `PacketDelay` device-specific (source) property.

Also, if you are using a CPU that is older than an Intel Core 2 Quad or equivalent AMD, you may experience this type of error.

If you have a slower computer and experience packet loss using the GigE Vision adaptor, you can set a packet delay to avoid overloading the computer. This is useful in solving the performance issue if you cannot achieve your camera’s frame rate. The `PacketDelay` property will initially be set to use the value that is your camera’s default value. You can then adjust the value if needed. The `TimeStampTickFrequency` property is read-only but is available for calculating the actual packet delay value is being used.

For more information on the new `PacketDelay` property and how to calculate packet delay, see this solution:

<http://www.mathworks.com/support/solutions/en/data/1-F36R0R/index.html>

- 6 If you are able to start acquisition without error but do not receive any frames, and if you are using a larger `PacketSize`, make sure that your hardware and the network between the computer and the camera support jumbo frames, and also that your Ethernet interface is set to allow them at the size that you are attempting to use.

- 7** If you receive an error that says a block or frame is being dropped because a packet is unavailable for resend, one likely cause is that the buffer size of the socket could not be set to the reported value, for example 1000000.

See your system administrator about using `sysctl` for `net.core.rmem_max`. For example, the system administrator could try:

```
sysctl -w net.inet.udp.recvspace=1000000
```

- 8** If your camera does not start a new acquisition at block 1, the toolbox will attach the block ID (frame ID) as metadata to the frame. If you want to know if you lost initial frames, you can check the metadata – if the first frame’s block ID is not 1, you may have some missing frames. For example, use this command in MATLAB:

```
[d t m]=getdata(vid,2);  
m(1)
```

The answer will include the Block ID and the FrameNumber.

- 9** Run the `imaqsupport` function for further troubleshooting information.

GenICam GenTL Hardware

Troubleshooting GenICam GenTL Hardware

If you are having trouble using the Image Acquisition Toolbox software with a GenICam GenTL camera driver using the toolbox's `gentl` adaptor, follow these troubleshooting steps:

- 1 Verify that the adaptor loads. You can use the `imaqhwinfo` command to list installed adaptors. The `gentl` adaptor should be included on the list.

If it does not load, make sure that GenICam is configured correctly using the `imaqsupport` function.

For information on installing GenICam, see “Software Configuration” on page 9-12.

- 2 Make sure your camera's driver is installed.
- 3 Make sure your environment variables are set. For example, depending on the GenTL producers you have installed, on a 32-bit Windows system, it could be something like:

```
GENICAM_GENTL32_PATH=C:\Program Files\LeutronVision\Simplon\bin\cti;C:\Program Files\MATRIX VISION\mvIMPACT_acquire\bin;C:\XIMEA\GenTL Producer\x86
```

- 4 Each directory that you list in the environment variables must contain a DLL file that has a `.cti` extension and that exports the standard C functions that are expected for a GenTL producer. The Image Acquisition Toolbox `gentl` adaptor scans these directories for all the CTI files and then checks whether they export the correct minimum set of functions.
- 5 Test the connectivity of your device separate from using the Image Acquisition Toolbox. Use the vendor program included with your device to see if you can detect and acquire images from the camera.
- 6 If you are using the GenICam GenTL adaptor with a GigE Vision camera, it may be the case that the producers for GigE Vision cameras do not send a ForceIP command and so sometimes after plugging in a new camera, it will not be found. Using the toolbox's `gige` adaptor first can resolve this.

- 7** You can also look at producers in other vendor software.

For example, Leutron Vision uses a program called Simplon Explorer. Using this program you can see what producers are installed and what cameras are connected. You can double-click on a camera within the Simplon Explorer to control it.

Note that with Matrix Vision, if a device is configured for DirectShow, it will not be available to GenTL.

- 8** Run the `imaqsupport` function for further troubleshooting information.

Windows Video Hardware

In this section...

“Troubleshooting Windows Video Devices” on page 13-36

“Determining the Microsoft® DirectX® Version” on page 13-37

Troubleshooting Windows Video Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported Windows video acquisition device, follow these recommended troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

For Windows devices, run the application that came with your hardware and verify that you can receive live video.

You can also verify your hardware by running the detectDevices utility provided on the MathWorks Supported Hardware Web page: <http://www.mathworks.com/products/imaq/supportedioWindows.html>. Under “Supported Hardware – Operating System – Windows,” on this page, click the link that says download and run the detectDevices utility to install the utility.

If you can run the utility without encountering any errors, the toolbox should be able to operate with your image acquisition device. If you encounter errors, resolve them before attempting to use the toolbox with the device.

- 2 If your hardware is functioning properly, verify that you are using hardware device drivers that are compatible with the toolbox.
 - Find out the driver version you are using on your system. The Image Acquisition Toolbox software is only compatible with WDM (Windows Driver Model) or VFW (Video for Windows) drivers. Contact the hardware manufacturer to determine if the driver provided with your hardware conforms to these driver classes.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of

supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

If you discover that you are using an unsupported driver version, visit the hardware manufacturer's Web site for the correct drivers.

Note The Windows Video driver is a generic interface and should only be used if you do not have a more specific driver to use with your device. For example, use the device-specific driver if your device has one. If your device is a DCAM or FireWire device, use the DCAM driver. Only use the Windows Video driver if there is no more specific option for your device.

3 Make sure you have the correct version of Microsoft DirectX installed on your computer. The Image Acquisition Toolbox software is only compatible with specific versions of the Microsoft DirectX multimedia technology and is not guaranteed to work with any other versions.

- Find out which driver version you are using on your system. To learn how to get this information, see “Determining the Microsoft® DirectX® Version” on page 13-37.
- Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct version information, check the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).

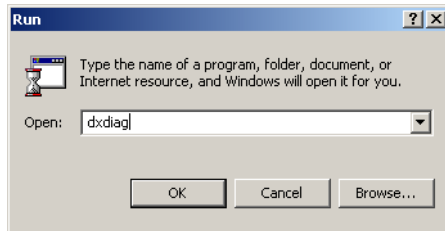
If you discover that you are using an unsupported version, visit the Microsoft DirectX Web site (www.microsoft.com/directx/) for the correct version of DirectX.

Determining the Microsoft DirectX Version

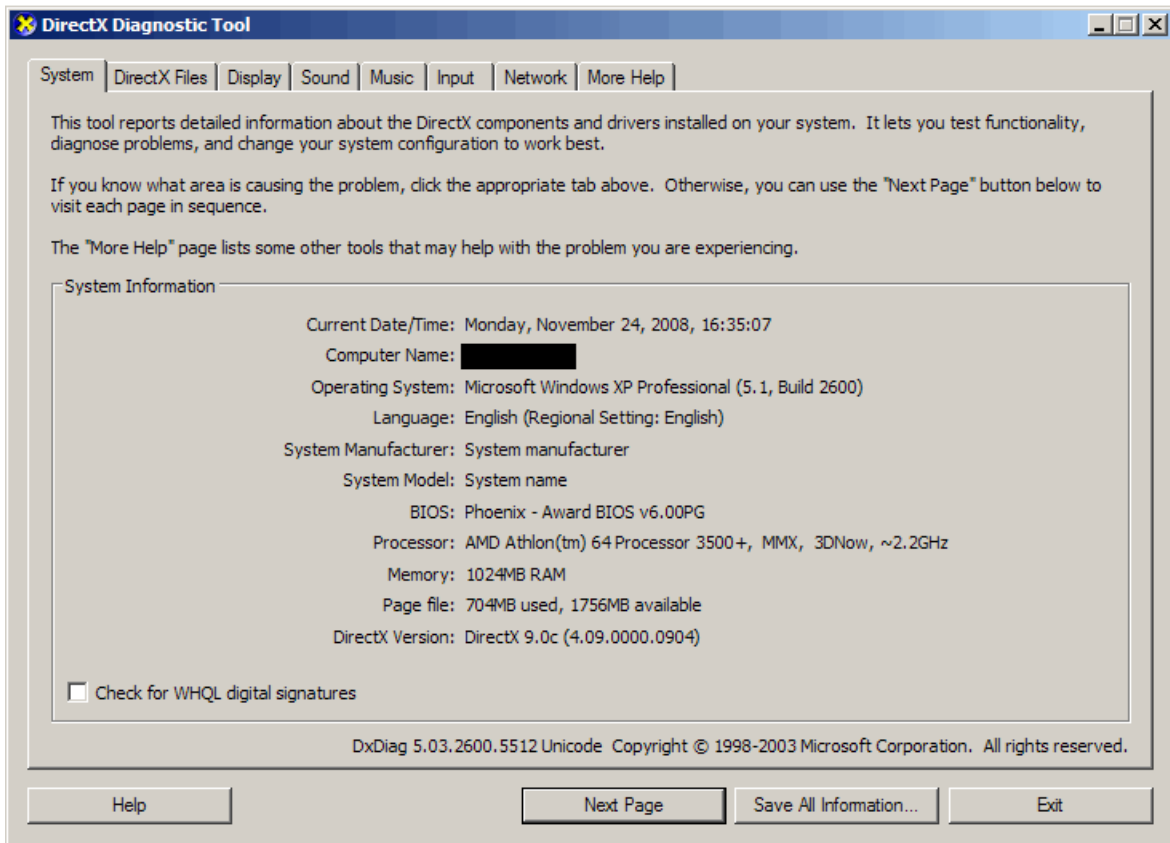
To determine the version of Microsoft DirectX you are using, run the DirectX Diagnostic Tool. You can access this software through the Windows **Start** button.

Select **Start > Run**.

In the Run dialog box, launch the DirectX Diagnostic Tool by opening the `dxdiag` program.



In the DirectX Diagnostic Tool, the Microsoft DirectX version is listed on the **System** tab under the **System Information** section.



DirectX® Diagnostic Tool

Linux Video Hardware

Troubleshooting Linux Video Devices

If you have trouble using the Image Acquisition Toolbox software with a supported Linux Video acquisition device, follow these recommended troubleshooting steps:

- 1 Verify that your image acquisition hardware functions properly and that you have permission to access it.

Be sure that your system and login have the proper permissions to access the hardware. See your system administrator if you need help.

You can verify that your hardware functions properly by running the WebCam application that came with your Linux distribution, for example, Cheese or Camorama.

If you can start the utility, run the utility, and close it without encountering any errors, the toolbox should be able to operate with your image acquisition device. If you encounter errors, resolve them before attempting to use the toolbox with the device.

- 2 If your hardware is functioning properly, verify that you are using hardware device drivers that are compatible with the toolbox.
 - Determine the driver version you are using on your system. The Image Acquisition Toolbox software is only compatible with Video 4 Linux 2 drivers. It is not supported for Video 4 Linux 1. (You may be able to get it to work – see the next step.) Contact the hardware manufacturer to determine if the driver provided with your hardware conforms to these driver classes.
 - Verify that the version is compatible with the Image Acquisition Toolbox software. For the correct driver information, check the list of supported drivers on the Image Acquisition Toolbox product page at the MathWorks Web site (www.mathworks.com/products/imaq).
- 3 The Linux Video adaptor only supports Video 4 Linux 2 compatible devices. However, there is a library that might make Video 4 Linux 1 devices work with the toolbox. The `libv4l` package provides a library that provides

compatibility between the different versions of Video 4 Linux. To try this, start MATLAB with the following command:

```
LD_PRELOAD=/usr/lib/libv4l/v4l1compat.so matlab
```

then the Linux Video adaptor may be able to detect your V4L1 hardware. The path to the `v4l1compat.so` library might vary depending on the Linux distribution. If the above command works, you can add a command similar to:

```
export LD_PRELOAD=/usr/lib/libv4l/v4l1compat.so
```

to `/etc/profile` or another persistent configuration file.

Note The Linux Video driver is a generic interface and you should only use it if you do not have a more specific driver to use with your device. If your device is a DCAM or FireWire device, use the DCAM driver. Only use the Linux Video driver if there is no more specific option for your device.

Linux DCAM IEEE 1394 Hardware

Troubleshooting Linux DCAM Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported Linux DCAM IEEE 1394 hardware acquisition device, follow these recommended troubleshooting steps:

- 1 Verify that your IEEE 1394 (FireWire) camera can be accessed through the `dcam` adaptor.
 - Make sure the camera is compliant with the IIDC 1394-based Digital Camera (DCAM) specification. Vendors typically include this information in documentation or data sheet that comes with the camera. If your digital camera is not DCAM compliant, you should be able to use the Linux Video adaptor.
- 2 Verify that your image acquisition hardware is functioning properly and that you have permission to access it.

Be sure that your system and log-in have the proper permissions to access the hardware. See your system administrator if you need help.

You can verify that your hardware is functioning properly by running `Coriander`. See your system administrator if you need help installing `Coriander`.

If you can start the utility, run the utility, and close the utility without encountering any errors, the toolbox should be able to operate with your image acquisition device. If you encounter errors, resolve them before attempting to use the toolbox with the device.

- 3 To use DCAM on Linux, you need to have installed the `libdc1394-22` package, as well as the `libraw1394-11`.

Macintosh Video Hardware

Troubleshooting Macintosh Video Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported Macintosh video acquisition device, follow these recommended troubleshooting steps:

- 1 Verify that your image acquisition hardware is functioning properly.

You can verify that your hardware is functioning properly by running the WebCam application that came with OSX, for example, Photo Booth or iMovie.

If you can start the utility, run the utility, and close the utility without encountering any errors, then the toolbox should be able to operate with your image acquisition device. If you encounter errors, resolve them before attempting to use the toolbox with the device.

- 2 Verify that you can access your device through the Macintosh Video Adaptor.
 - Make sure the camera complies with QuickTime.

Note The Macintosh Video Adaptor is a generic interface and should only be used if you do not have a more specific adaptor to use with your device. If your device is a DCAM or FireWire device, use the DCAM adaptor. Only use the Macintosh Video Adaptor if there is no more specific option for your device.

- 3 Make sure you have QuickTime installed on your computer. If you do not have it installed, you can download it.

Macintosh DCAM IEEE 1394 Hardware

Troubleshooting Macintosh DCAM Devices

If you are having trouble using the Image Acquisition Toolbox software with a supported Macintosh DCAM IEEE 1394 hardware acquisition device, follow these recommended troubleshooting steps:

- 1** Verify that your IEEE 1394 (FireWire) camera can be accessed through the `dcam` adaptor.
 - Make sure the camera complies with the IIDC 1394-based Digital Camera (DCAM) specification. Vendors typically include this information in documentation that comes with the camera. If your digital camera is not DCAM compliant, you might be able to use the Macintosh Video Adaptor.
- 2** Verify that your image acquisition hardware is functioning properly.

You can verify that your hardware is functioning properly by running an external webcam application, for example, Photo Booth or iMovie.

If you can start the utility, run the utility, and close the utility without encountering any errors, then the toolbox should be able to operate with your image acquisition device. If you encounter errors, resolve them before attempting to use the toolbox with the device.

Video Preview Window Troubleshooting

When previewing the video stream, if you encounter a problem, try one of the following solutions.

Problem	Possible Solutions
Video Preview window stops running.	<ul style="list-style-type: none"> • Close the preview window and reopen it. • Verify that your image acquisition device is working properly. Close MATLAB and run the application that came with your device. • Make sure no other application is using the device.
Video Preview window displays blank, gray window.	<ul style="list-style-type: none"> • Close the preview window and reopen it. • Check memory usage. It is possible that there is not enough memory available for the incoming image data. To increase the memory allocation, use the <code>imaqmem</code> function and specify a higher value for the <code>FrameMemoryLimit</code>. • Make sure no other application is using the device.
Video Preview window displays dropped frames message.	<ul style="list-style-type: none"> • Close the preview window and reopen it. • Check memory usage. It is possible that there is not enough memory available for the incoming image data. To increase the memory allocation, use the <code>imaqmem</code> function and specify a higher value for the <code>FrameMemoryLimit</code>.

Contacting MathWorks and Using the imaqsupport Function

If you need support from MathWorks, visit our Web site at <http://www.mathworks.com/support/>.

Before contacting MathWorks, you should run the `imaqsupport` function. This function returns diagnostic information such as:

- The versions of MathWorks products you are using
- Your MATLAB path
- The characteristics of your hardware
- Information about your adaptors

The output from `imaqsupport` is automatically saved to a text file, `imaqsupport.txt`, which you can use to help troubleshoot your problem.

To have MATLAB generate this file for you, type

```
imaqsupport
```


Functions — Alphabetical List

clear

Purpose Clear image acquisition object from MATLAB workspace

Syntax `clear obj`

Description `clear obj` removes the image acquisition object `obj` from the MATLAB workspace. `obj` can be either a video input object or a video source object.

It is important to note that if you clear a video input object that is running (the `Running` property is set to `'on'`), the object continues executing.

You can restore cleared objects to the MATLAB workspace with the `imaqfind` function.

To remove an image acquisition object from memory, use the `delete` function.

See Also `delete` | `imaqfind` | `isvalid`

Purpose Close Video Preview window

Syntax `closepreview(obj)`
`closepreview`

Description `closepreview(obj)` stops the image acquisition object `obj` from previewing and, if the default Video Preview window was used, closes the window.

`closepreview` stops all image acquisition objects from previewing and, for all image acquisition objects that used the default Video Preview window, closes the windows.

Note that if the preview window was created with a user-specified image object handle as the target, `closepreview` does not close the figure window.

See Also `preview` | `stoppreview`

delete

Purpose Remove image acquisition object from memory

Syntax `delete(obj)`

Description `delete(obj)` removes `obj`, an image acquisition object or array of image acquisition objects, from memory. Use `delete` to free memory at the end of an image acquisition session.

If `obj` is an array of image acquisition objects and one of the objects cannot be deleted, the `delete` function deletes the objects that can be deleted and returns a warning.

When `obj` is deleted, it becomes invalid and cannot be reused. Use the `clear` command to remove invalid image acquisition objects from the MATLAB workspace.

If multiple references to an image acquisition object exist in the workspace, deleting the image acquisition object invalidates the remaining references. Use the `clear` command to delete the remaining references to the object from the workspace.

If the image acquisition object `obj` is running or being previewed, the `delete` function stops the object and closes the preview window before deleting it.

Examples Create a video object, preview the object, then delete the object:

```
vid = videoinput('winvideo', 1);  
preview(vid);  
delete(vid);
```

See Also `imaqfind` | `isvalid` | `videoinput`

Purpose

Display method for image acquisition objects

Syntax

```
obj  
disp(obj)
```

Description

obj displays summary information for image acquisition object obj.

disp(obj) displays summary information for image acquisition object obj.

If obj is an array of image acquisition objects, disp outputs a table of summary information about the image acquisition objects in the array.

In addition to the syntax shown above, you can display summary information for obj by excluding the semicolon when:

- Creating an image acquisition object, using the `videoinput` function
- Configuring property values using the dot notation

Examples

This example illustrates the summary display of a video input object.

```
vid = videoinput('winvideo')
```

```
vid = videoinput('winvideo')
```

```
Summary of Video Input Object Using 'IBM PC Camera'.
```

```
Acquisition Source(s): input1 is available.
```

```
Acquisition Parameters: 'input1' is the current selected source.  
10 frames per trigger using the selected source.  
'RGB555_128x96' video data to be logged upon S  
Grabbing first of every 1 frame(s).  
Log data to 'memory' on trigger.
```

```
Trigger Parameters: 1 'immediate' trigger(s) on START.
```

```
Status: Waiting for START.  
0 frames acquired since starting.  
0 frames available for GETDATA.
```

This example shows the summary information displayed for an array of video input objects.

```
vid2 = videoinput('winvideo');
```

```
[vid vid2]
```

```
Video Input Object Array:
```

Index:	Type:	Name:
1	videoinput	RGB555_128x96-winvideo-1
2	videoinput	RGB555_128x96-winvideo-1

See Also

videoinput

Purpose Remove data from memory buffer used to store acquired image frames

Syntax flushdata(obj)
flushdata(obj,mode)

Description flushdata(obj) removes all the data from the memory buffer used to store acquired image frames. obj can be a single video input object or an array of video input objects.

flushdata(obj,mode) removes all the data from the memory buffer used to store acquired image frames, where mode can have either of the following values:

Mode	Description
'all'	Removes all the data from the memory buffer and sets the FramesAvailable property to 0 for the video input object obj. This is the default mode when none is specified, flushdata(obj).
'triggers'	Removes data from the memory buffer that was acquired during the oldest trigger executed. TriggerRepeat must be greater than 0 and FramesPerTrigger must not be set to inf.

See Also getdata | imaqhelp | peekdata | propinfo | videoinput

get

Purpose Return image acquisition object properties

Syntax

```
get(obj)
V = get(obj)
V = get(obj,PropertyName)
```

Description `get(obj)` displays all property names and their current values for image acquisition object `obj`.

`V = get(obj)` returns a structure, `V`, in which each field name is the name of a property of `obj` and each field contains the value of that property.

`V = get(obj,PropertyName)` returns the value of the property specified by `PropertyName` for image acquisition object `obj`. Use the `get(obj)` syntax to view a list of all the properties supported by a particular image acquisition object.

If `PropertyName` is a 1-by-`N` or `N`-by-1 cell array of strings containing property names, `V` is a 1-by-`N` cell array of values. If `obj` is a vector of image acquisition objects, `V` is an `M`-by-`N` cell array of property values where `M` is equal to the length of `obj` and `N` is equal to the number of properties specified.

Examples Create video object, then get values of two frame-related properties, then display all proprieties of the object:

```
vid = videoinput('matrox', 1);
get(vid, {'FramesPerTrigger', 'FramesAcquired'})
out = get(vid, 'LoggingMode')
get(vid);
```

See Also `set` | `videoinput`

Purpose

Acquired image frames to MATLAB workspace

Syntax

```
data = getdata(obj)
data = getdata(obj,n)
data = getdata(obj,n,type)
data = getdata(obj,n,type,format)
[data,time] = getdata(...)
[data, time, metadata] = getdata(...)
```

Description

`data = getdata(obj)` returns `data`, which contains the number of frames specified in the `FramesPerTrigger` property of the video input object `obj`. `obj` must be a 1-by-1 video input object.

`data` is returned as an H-by-W-by-B-by-F matrix where

H	Image height, as specified in the object's <code>ROIPosition</code> property
W	Image width, as specified in the object's <code>ROIPosition</code> property
B	Number of color bands, as specified in the <code>NumberOfBands</code> property
F	The number of frames returned

`data` is returned to the MATLAB workspace in its native data type using the color space specified by the `ReturnedColorSpace` property.

You can use the MATLAB `image` or `imagesc` functions to view the returned data. Use `imaqmontage` to view multiple frames at once.

`data = getdata(obj,n)` returns `n` frames of data associated with the video input object `obj`.

`data = getdata(obj,n,type)` returns `n` frames of data associated with the video input object `obj`, where `type` is one of the text strings in the following table that specify the data type used to store the returned data.

Type String	Data Type
'uint8'	Unsigned 8-bit integer
'uint16'	Unsigned 16-bit integer
'uint32'	Unsigned 32-bit integer
'single'	Single precision
'double'	Double precision
'native'	Uses native data type. This is the default.

If *type* is not specified, 'native' is used as the default. If there is no MATLAB data type that matches the object's native data type, `getdata` chooses a MATLAB data type that preserves numerical accuracy. For example, the components of 12-bit RGB color data would each be returned as `uint8` data.

`data = getdata(obj,n,type,format)` returns *n* frames of data associated with the video input object *obj*, where *format* is one of the text strings in the following table that specify the MATLAB format of data.

Format String	Description
'numeric'	Returns data as an H-by-W-by-B-by-F array. This is the default format if none is specified.
'cell'	Returns data as an F-by-1 cell array of H-by-W-by-B matrices

`[data,time] = getdata(...)` returns *time*, an F-by-1 matrix, where F is the number of frames returned in *data*. Each element of *time* indicates the relative time, in seconds, of the corresponding frame in *data*, relative to the first trigger.

`time = 0` is defined as the point at which data logging begins. When data logging begins, the object's `Logging` property is set to 'On'. *time* is measured continuously with respect to 0 until the acquisition stops.

When the acquisition stops, the object's `Running` property is set to `'Off'`.

`[data, time, metadata] = getdata(...)` returns `metadata`, an `F`-by-1 array of structures, where `F` is the number of frames returned in `data`. Each structure contains information about the corresponding frame in `data`. The `metadata` structure contains these fields:

Metadata Field	Description
'AbsTime'	Absolute time the frame was acquired, expressed as a time vector
'FrameNumber'	Number identifying the n th frame since the <code>start</code> command was issued
'RelativeFrame'	Number identifying the n th frame relative to the start of a trigger
'TriggerIndex'	Number of the trigger in which this frame was acquired

In addition to the fields in the above table, some adaptors may choose to add other adaptor-specific metadata as well.

`getdata` is a blocking function that returns execution control to the MATLAB workspace after the requested number of frames becomes available within the time period specified by the object's `Timeout` property. The object's `FramesAvailable` property is automatically reduced by the number of frames returned by `getdata`. If the requested number of frames is greater than the frames to be acquired, `getdata` returns an error.

It is possible to issue a **Ctrl+C** while `getdata` is blocking. This does not stop the acquisition but does return control to MATLAB.

Examples

Construct a video input object associated with a Matrox device at ID 1.

```
obj = videoinput('matrox', 1);
```

getdata

Initiate an acquisition and access the logged data.

```
start(obj);  
data = getdata(obj);
```

Display each image frame acquired.

```
imaqmontage(data);
```

Remove the video input object from memory.

```
delete(obj);
```

See Also

[getsnapshot](#) | [imaqhelp](#) | [imaqmontage](#) | [peekdata](#) | [propinfo](#)

Purpose Return currently selected video source object

Syntax `src = getselectedsource(obj)`

Description `src = getselectedsource(obj)` searches all the video source objects associated with the video input object `obj` and returns the video source object, `src`, that has the `Selected` property value set to 'on'.
To select a source for acquisition, use the `SelectedSourceName` property of the video input object.
`obj` must be a 1-by-1 video input object.

See Also `imaqhelp | get | videoinput`

getsnapshot

Purpose Immediately return single image frame

Syntax
`frame = getsnapshot(obj)`
`[frame, metadata] = getsnapshot(obj)`

Description `frame = getsnapshot(obj)` immediately returns one single image frame, `frame`, from the video input object `obj`. The frame of data returned is independent of the video input object `FramesPerTrigger` property and has no effect on the value of the `FramesAvailable` or `FramesAcquired` property.

The object `obj` must be a 1-by-1 video input object.

`frame` is returned as an H-by-W-by-B matrix where

- H Image height, as specified in the `ROIPosition` property
- W Image width, as specified in the `ROIPosition` property
- B Number of bands associated with `obj`, as specified in the `NumberOfBands` property

`frame` is returned to the MATLAB workspace in its native data type using the color space specified by the `ReturnedColorSpace` property.

You can use the MATLAB `image` or `imagesc` function to view the returned data.

`[frame, metadata] = getsnapshot(obj)` returns `metadata`, a 1-by-1 array of structures. This structure contains information about the corresponding frame. The metadata structure contains the field `AbsTime`, which is the absolute time the frame was acquired, expressed as a time vector. In addition to that field, some adaptors may choose to add other adaptor-specific metadata as well.

Note If `obj` is running but not logging, and has been configured with a hardware trigger, a timeout error will occur.

To interrupt the `getsnapshot` function and return control to the MATLAB command line, issue the `^C (Ctrl+C)` command.

Examples

Create a video input object.

```
obj = videoinput('matrox', 1);
```

Acquire and display a single frame of data.

```
frame = getsnapshot(obj);  
image(frame);
```

Remove the video input object from memory.

```
delete(obj);
```

For an example of using `getsnapshot`, see the Image Acquisition Toolbox example **Acquiring a Single Image in a Loop** in the **Examples** list at the top of the Image Acquisition Toolbox main Documentation Center page, or open the file `demoimaq_GetSnapshot.m` in the MATLAB Editor.

See Also

`getdata` | `imaqhelp` | `peekdata`

imaqfind

Purpose Find image acquisition objects

Syntax

```
imaqfind
out = imaqfind
out = imaqfind(PropertyName, Value, PropertyName2, Value2,
    ...)
out = imaqfind(S)
out = imaqfind(obj, PropertyName, Value, PropertyName2,
    Value2,...)
```

Description `imaqfind` returns an array containing all the video input objects that exist in memory. If only a single video input object exists in memory, `imaqfind` displays a detailed summary of that object.

`out = imaqfind` returns an array, `out`, of all the video input objects that exist in memory.

`out = imaqfind(PropertyName, Value, PropertyName2, Value2, ...)` returns a cell array, `out`, of image acquisition objects whose property names and property values match those passed as arguments. You can specify the property name/property value pairs in a cell array. You can use a mixture of strings, structures, and cell arrays. Use the `get` function to determine the list of properties supported by an image acquisition object.

`out = imaqfind(S)` returns a cell array, `out`, of image acquisition objects whose property values match those defined in the structure `S`. The field names of `S` are image acquisition object property names and the field values are the requested property values.

`out = imaqfind(obj, PropertyName, Value, PropertyName2, Value2,...)` restricts the search for matching parameter/value pairs to the image acquisition objects listed in `obj`. `obj` can be an array of image acquisition objects.

Note When searching for properties with specific values, `imaqfind` performs case-sensitive searches. For example, if the value of an object's `Name` property is `'MyObject'`, `imaqfind` does not find a match if you specify `'myobject'`. Note, however, that searches for properties that have an enumerated list of possible values are not case sensitive. For example, `imaqfind` will find an object with a `Running` property value of `'Off'` or `'off'`. Use the `get` function to determine the exact spelling of a property value.

Examples

To illustrate various `imaqfind` syntaxes, first create two video input objects.

```
obj1 = videoinput('matrox',1,'M_RS170','Tag','FrameGrabber');  
obj2 = videoinput('winvideo',1,'RGB24_320x240','Tag','Webcam');
```

Now use `imaqfind` to find these objects by type and tag.

```
out1 = imaqfind('Type', 'videoinput')  
out2 = imaqfind('Tag', 'FrameGrabber')  
out3 = imaqfind({'Type', 'Tag'}, {'videoinput', 'Webcam'})
```

See Also

`get` | `videoinput`

imaqhelp

Purpose Image acquisition object function and property help

Syntax

```
imaqhelp
imaqhelp(Name)
imaqhelp(obj)
imaqhelp(obj,Name)
out = imaqhelp(...)
```

Description `imaqhelp` provides a complete listing of image acquisition object functions.

`imaqhelp(Name)` provides online help for the function or property specified by the text string *Name*.

`imaqhelp(obj)` displays a listing of functions and properties for the image acquisition object `obj` along with the online help for the object's constructor. `obj` must be a 1-by-1 image acquisition object.

`imaqhelp(obj,Name)` displays the help for the function or property specified by the text string *Name* for the image acquisition object `obj`. If *Name* is a device-specific property name, `obj` must be provided.

`out = imaqhelp(...)` returns the help text in string out.

When property help is displayed, the names in the “See Also” section that contain all uppercase letters are function names. The names that contain a mixture of upper- and lowercase letters are property names.

When function help is displayed, the “See Also” section contains only function names.

Examples Getting general function and property help.

```
imaqhelp('videoinput')
out = imaqhelp('videoinput');
imaqhelp set
imaqhelp LoggingMode
```

Getting property help with device-specific information.


```
vid = videoinput('dt', 1);  
src = getselectedsource(vid);  
imaqhelp(vid, 'TriggerType')  
imaqhelp(src, 'FrameRate')
```

See Also

propinfo

imaqhwinfo

Purpose Information about available image acquisition hardware

Syntax

```
out = imaqhwinfo
out = imaqhwinfo(adaptorname)
out = imaqhwinfo(adaptorname,field)
out = imaqhwinfo(adaptorname, deviceID)
out = imaqhwinfo(obj)
out = imaqhwinfo(obj,field)
```

Description `out = imaqhwinfo` returns `out`, a structure that contains information about the image acquisition adaptors available on the system. An adaptor is the interface between MATLAB and the image acquisition devices connected to the system. The adaptor's main purpose is to pass information between MATLAB and an image acquisition device via its driver.

`out = imaqhwinfo(adaptorname)` returns `out`, a structure that contains information about the adaptor specified by the text string *adaptorname*. The information returned includes adaptor version and available hardware for the specified adaptor. To get a list of valid adaptor names, use the `imaqhwinfo` syntax.

`out = imaqhwinfo(adaptorname,field)` returns the value of the field specified by the text string *field* for the adaptor specified by the text string *adaptorname*. The argument can be a single string or a cell array of strings. If *field* is a cell array, `out` is a 1-by-*n* cell array where *n* is the length of *field*. To get a list of valid field names, use the `imaqhwinfo('adaptorname')` syntax.

`out = imaqhwinfo(adaptorname, deviceID)` returns `out`, a structure containing information about the device specified by the numeric device ID `deviceID`. The `deviceID` can be a scalar or a vector. If `deviceID` is a vector, `out` is a 1-by-*n* structure array where *n* is the length of `deviceID`.

`out = imaqhwinfo(obj)` returns `out`, a structure that contains information about the specified image acquisition object `obj`. The information returned includes the adaptor name, device name, video resolution, native data type, and device driver name and version. If `obj`

is an array of device objects, then `out` is a 1-by-`n` cell array of structures where `n` is the length of `obj`.

`out = imaqhwinfo(obj, field)` returns the information in the field specified by `field` for the device object `obj`. `field` can be a single field name or a cell array of field names. `out` is an `m`-by-`n` cell array where `m` is the length of `obj` and `n` is the length of `field`. You can return a list of valid field names with the `imaqhwinfo(obj)` syntax.

Note After you call `imaqhwinfo` once, hardware information is cached by the toolbox. To force the toolbox to search for new hardware that might have been installed while MATLAB was running, use `imaqreset`.

Examples

This example returns information about all the adaptors available on the system.

```
imaqhwinfo
```

```
ans =
```

```
InstalledAdaptors: {'matrox' 'winvideo'}
    MATLABVersion: '7.4 (R2007a)'
    ToolboxName: 'Image Acquisition Toolbox'
    ToolboxVersion: '2.1 (R2007a)'
```

This example returns information about all the devices accessible through a particular adaptor.

```
info = imaqhwinfo('winvideo')
info =
```

```
    AdaptorDllName: [1x73 char]
    AdaptorDllVersion: '2.1 (R2007a)'
    AdaptorName: 'winvideo'
    DeviceIDs: {[1]}
    DeviceInfo: [1x1 struct]
```

imaqhwinfo

This example returns information about a specific device accessible through a particular adaptor. You identify the device by its device ID.

```
dev_info = imaqhwinfo('winvideo', 1)

dev_info =
    DefaultFormat: 'RGB555_128x96'
    DeviceFileSupported: 0
    DeviceName: 'IBM PC Camera'
    DeviceID: 1
    VideoInputConstructor: 'videoinput('winvideo', 1)'
    VideoDeviceConstructor: 'imaq.VideoDevice('winvideo', 1)'
    SupportedFormats: {1x34 cell}
```

This example gets information about the device associated with a particular video input object.

```
obj = videoinput('winvideo', 1);

obj_info = imaqhwinfo(obj)

obj_info =
    AdaptorName: 'winvideo'
    DeviceName: 'IBM PC Camera'
    MaxHeight: 96
    MaxWidth: 128
    NativeDataType: 'uint8'
    TotalSources: 1
    VendorDriverDescription: 'Windows WDM Compatible Driver'
    VendorDriverVersion: 'DirectX 9.0'
```

This example returns the value of a particular field in the device information associated with a particular video input object.

```
field_info = imaqhwinfo(vid,'adaptorname')
field_info =
```

winvideo

See Also

imqhelp | imqreset

imaqmem

Purpose Limit memory or display memory usage for Image Acquisition Toolbox software

Syntax

```
mem = imaqmem  
imaqmem(field)  
imaqmem(limit)
```

Description mem = imaqmem returns a structure containing the following fields:

Field	Description
MemoryLoad	Number between 0 and 100 that gives a general idea of current memory utilization.
TotalPhys	Total number of bytes of physical memory.
AvailPhys	Number of bytes of physical memory currently available.
TotalPageFile	Total number of bytes that can be stored in the paging file.
AvailPageFile	Number of bytes available in the paging file.
TotalVirtual	Total number of bytes that can be addressed in the user mode portion of the virtual address space. This is a Windows only property.
AvailVirtual	Number of bytes of unreserved and uncommitted memory in the user mode portion of the virtual address space. This is a Windows only property.
FrameMemoryLimit	Total number of bytes image acquisition frames can occupy in memory. By default, the toolbox sets this limit to equal all available physical memory at the time the toolbox is first used or queried.
FrameMemoryUsed	Number of bytes currently allocated by the Image Acquisition Toolbox software.

`imaqmem(field)` returns information for the field specified by the text string *field*.

`imaqmem(limit)` configures the frame memory limit, in bytes, for the Image Acquisition Toolbox software. *limit* is used to determine the maximum amount of memory the toolbox can use for logging image frames.

Note Configuring the frame memory limit does not remove any logged frames from the image acquisition memory buffer. To remove frames from the buffer, you can bring them into the MATLAB workspace, using the `getdata` function, or remove them from memory, using the `flushdata` function.

Examples

Use `imaqmem` to get information about system memory.

```
imaqmem
```

```
ans =
```

```
    MemoryLoad: 85
    TotalPhys: 263766016
    AvailPhys: 37306368
    TotalPageFile: 643878912
    AvailPageFile: 391446528
    TotalVirtual: 2.1474e+009
    AvailVirtual: 1.6307e+009
    FrameMemoryLimit: 38313984
    FrameMemoryUsed: 0
```

Retrieve information about a specific field returned by `imaqmem`.

```
memlimit = imaqmem('FrameMemoryLimit')
```

```
memlimit =
```

imaqmem

```
38313984
```

Specify the amount of memory available for the toolbox to log image frames (FrameMemoryLimit).

```
imaqmem(30000000)
```

```
ans =
```

```
MemoryLoad: 85
TotalPhys: 263766016
AvailPhys: 37634048
TotalPageFile: 643878912
AvailPageFile: 391479296
TotalVirtual: 2.1474e+009
AvailVirtual: 1.6307e+009
FrameMemoryLimit: 30000000
FrameMemoryUsed: 0
```

See Also

```
flushdata | getdata | videoinput
```


Purpose

Sequence of image frames as montage

Syntax

```
imaqmontage(frames)
imaqmontage(obj)
imaqmontage(...,CLIM)
imaqmontage(..., 'CLim', CLIM, 'Parent', PARENT)
h = imaqmontage(...)
```

Description

`imaqmontage(frames)` displays a montage of image frames in a MATLAB figure window using the `imagesc` function.

`frames` can be any data set returned by `getdata`, `peekdata`, or `getsnapshot`.

`imaqmontage(obj)` calls the `getsnapshot` function on video input object `obj` and displays a single image frame in a MATLAB figure window using the `imagesc` function. `obj` must be a 1-by-1 video input object.

`imaqmontage(...,CLIM)` displays a montage of image frames, where `CLIM` is a two-element vector, `[CLOW CHIGH]`, specifying the image scaling. Use `CLIM` to specify a scaling value when overscaling the image data is a risk, for example, when you are working with devices that provide data in a 12-bit format.

`imaqmontage(..., 'CLim', CLIM, 'Parent', PARENT)` where `CLIM` is as noted previously, and `PARENT` is a valid AXES object that allows you to specify where the montage is displayed. One or both property/value pairs can be specified. See the example below.

`h = imaqmontage(...)` returns a handle to an image object.

Examples

Construct a video input object associated with a Matrox device at ID 1.

```
obj = videoinput('matrox', 1);
```

Initiate an acquisition and access the logged data.

```
start(obj);
data = getdata(obj);
```

imaqmontage

Create an axes object.

```
a = axes;
```

Display each image frame acquired on axes a.

```
imaqmontage(data, 'Parent', a);
```

Remove the video input object from memory.

```
delete(obj);
```

See Also

[getdata](#) | [getsnapshot](#) | [imaqhelp](#) | [peekdata](#)

Purpose Disconnect and delete all image acquisition objects

Syntax `imaqreset`

Description `imaqreset` deletes any image acquisition objects that exist in memory and unloads all adaptors loaded by the toolbox. As a result, the image acquisition hardware is reset.

`imaqreset` is the image acquisition command that returns MATLAB to the known state of having no image acquisition objects and no loaded image acquisition adaptors.

You can use `imaqreset` to force the toolbox to search for new hardware that might have been installed while MATLAB was running.

Note that `imaqreset` should not be called from any of the callbacks of a `videoinput` object, such as the `StartFcn` or `FramesAcquiredFcn`.

See Also `delete` | `videoinput`

imaqtool

Purpose Launch Image Acquisition Tool

Syntax `imaqtool`
`imaqtool(file)`

Description `imaqtool` launches an interactive GUI to allow you to explore, configure, and acquire data from your installed and supported image acquisition devices.

The functionality of the Image Acquisition Toolbox software is available in this desktop application. You connect directly to your hardware in the tool and can preview and acquire image data. You can log the data to MATLAB in several formats, and also generate an AVI file, right from the tool.

The Image Acquisition Tool provides a desktop environment that integrates a preview/acquisition area with Acquisition Parameters so that you can change settings and see the changes dynamically applied to your image data.

For complete information on how to use the Image Acquisition Tool, see “Getting Started with the Image Acquisition Tool” on page 3-5.

`imaqtool(file)` starts the tool and then immediately reads an Image Acquisition Tool configuration file, where `file` is the name of an IAT-file that you previously saved.

This configuration file contains parameter settings that you save using **File > Save Configuration** in the tool.

Tutorials

- “Getting Started with the Image Acquisition Tool” on page 3-5

Purpose

Acquire one frame at a time from video device

Syntax

```
obj = imaq.VideoDevice
obj = imaq.VideoDevice(adaptorname)
obj = imaq.VideoDevice(adaptorname, deviceid)
obj = imaq.VideoDevice(adaptorname, deviceid, format)
obj = imaq.VideoDevice(adaptorname, deviceid, format, P1, V1,
    ...)
frame = step(obj)
[frame metadata] = step(obj)
```

Description

The VideoDevice System object allows single-frame image acquisition and code generation from MATLAB. You use the `imaq.VideoDevice` function to create the System object. It supports the same adaptors and hardware that the `videoinput` object supports; however, it has different functions and properties associated with it. For example, the System object uses the `step` function to acquire single frames.

`obj = imaq.VideoDevice` creates a VideoDevice System object, `obj`, that acquires images from a specified image acquisition device. When you specify no parameters, by default, it selects the first available device for the first adaptor returned by `imaqhwinfo`.

`obj = imaq.VideoDevice(adaptorname)` creates a VideoDevice System object, `obj`, using the first device of the specified `adaptorname`. `adaptorname` is a text string that specifies the name of the adaptor used to communicate with the device. Use the `imaqhwinfo` function to determine the adaptors available on your system.

`obj = imaq.VideoDevice(adaptorname, deviceid)` creates a VideoDevice System object, `obj`, with the default format for specified `adaptorname` and `deviceid`. `deviceid` is a numeric scalar value that identifies a particular device available through the specified `adaptorname`. Use the `imaqhwinfo(adaptorname)` syntax to determine the devices available and corresponding values for `deviceid`.

`obj = imaq.VideoDevice(adaptorname, deviceid, format)` creates a VideoDevice System object, `obj`, where `format` is a text string that

imaq.VideoDevice

specifies a particular video format supported by the device or a device configuration file (also known as a camera file).

`obj = imaq.VideoDevice(adaptorname, deviceid, format, P1, V1, ...)` Creates a VideoDevice System object, `obj`, with the specified property values. If an invalid property name or property value is specified, the object is not created.

Specifying properties at the time of object creation is optional. They can also be specified after the object is created. See the table below for a list of applicable properties.

`frame = step(obj)` acquires a single frame from the VideoDevice System object, `obj`.

`[frame metadata] = step(obj)` acquires a single image frame from the VideoDevice System object, `obj`, plus metadata from the Kinect for Windows Depth sensor. You can return Kinect for Windows skeleton data using the VideoDevice System object on the Kinect Depth sensor. For information on how to do this, see “Kinect for Windows Metadata” on page 11-7.

Properties

You can specify properties at the time of object creation, or they can be specified and changed after the object is created. Properties that can be used with the VideoDevice System object include:

Property	Description
Device	Device from which to acquire images. Specify the image acquisition device to use to acquire a frame. It consists of the device name, adaptor, and device ID. The default device is the first device returned by <code>imaqhwinfo</code> .
VideoFormat	Video format to be used by the image acquisition device. Specify the video format to use while acquiring the frame. The default value of <code>VideoFormat</code> is the default format returned by <code>imaqhwinfo</code> for the

Property	Description
	selected device. To specify a Video Format using a device file, set the VideoFormat property to 'From device file' This option exists only if your device supports device configuration files.
DeviceFile	Name of file specifying video format. This property is only visible when VideoFormat is set to 'From device file'.
DeviceProperties	Object containing properties specific to the image acquisition device.
ROI	Region-of-interest for acquisition. This is set to the default ROI value for the specified device, which is the maximum resolution possible for the specified format. You can change the value to change the size of the captured image. The format is 1-based, that is, it is specified in pixels in a 1-by-4 element vector [x y width height].Note that this differs from the videoinput object, the Image Acquisition Tool, and the From Video Device block, all of which are 0-based.
HardwareTriggering	Turn hardware triggering on/off. Set this property to 'on' to enable hardware triggering to acquire images. The property is visible only when the device supports hardware triggering.
TriggerConfiguration	Specifies the trigger source and trigger condition before acquisition. The triggering condition must be met via the trigger source before a frame is acquired. This property is visible only when HardwareTriggering is set to 'on'.

imaq.VideoDevice

Property	Description
ReturnedColorSpace	Specify the color space of the returned image. The default value of the property depends on the device and the video format selected. Possible values are {rgb grayscale YCbCr} when the default returned color space for the device is not grayscale. Possible values are {rgb grayscale YCbCr bayer} when the default returned color space for the device is grayscale
BayerSensorAlignment	String indicating the 2x2 sensor alignment. Specifies Bayer patterns returned by hardware. Specify the sensor alignment for Bayer demosaicing. The default value of this property is 'grbg'. Possible values are {grbg gbrg rggb bggr}. Visible only if ReturnedColorSpace is set to 'bayer'.
ReturnedDataType	The returned data type of the acquired frame. The default ReturnedDataType is single.

The setting of properties for the System object supports tab completion for enumerated properties while coding in MATLAB. Using the tab completion is an easy way to see available property values. After you type the property name, type a comma, then a space, then the first quote mark for the value, then hit tab to see the possible values.

You can also use the `set` function with the object name and property name to get a list of available values for that property. For example:

```
set(obj, 'ReturnedColorSpace')
```

gets the list of available color space settings for the VideoDevice System object, `obj`.

Note that once you have done a step, in order to change a property or set a new one, you need to release the object using the `release` function, before setting the new property.

Functions

You can use these functions with the VideoDevice System object.

Function	Purpose
<code>step</code>	<p>Acquire a single frame from the image acquisition device.</p> <pre>frame = step(obj);</pre> <p>acquires a single frame from the VideoDevice System object, <code>obj</code>.</p> <p>Note that the first time you call <code>step</code>, it acquires exclusive use of the hardware and will start streaming data.</p>
<code>release</code>	<p>Release VideoDevice resources and allow property value changes.</p> <pre>release(obj)</pre> <p>releases system resources (such as memory, file handles, or hardware connections) of System object, <code>obj</code>, and allows all its properties and input characteristics to be changed.</p>

imaq.VideoDevice

Function	Purpose
isLocked	<p>Returns a value that indicates if the VideoDevice resource is locked. (Use <code>release</code> to unlock.)</p> <p><code>L = isLocked(obj)</code></p> <p>returns a logical value, L, which indicates whether properties are locked for the System object, obj. The object performs an internal initialization the first time the <code>step</code> function is executed. This initialization locks properties and input specifications. Once this occurs, the <code>isLocked</code> function returns a value of <code>true</code>.</p>
preview	<p>Activate a live image preview window.</p> <p><code>preview(obj)</code></p> <p>creates a Video Preview window that displays live video data for the VideoDevice System object, obj. The Video Preview window displays the video data at 100% magnification (one screen pixel represents one image pixel). The size of the preview image is determined by the value of the VideoDevice System object ROI property. If not specified, it uses the default resolution for the device.</p>

Function	Purpose
<code>closepreview</code>	Close live image preview window. <code>closepreview(obj)</code> closes the live preview window for VideoDevice System object, <code>obj</code> .
<code>imaqhwinfo</code>	Returns information about the object. <code>imaqhwinfo(obj)</code> displays information about the VideoDevice System object, <code>obj</code> .

Examples

Construct a VideoDevice System object associated with the Winvideo adaptor with device ID of 1.

```
vidobj = imaq.VideoDevice('winvideo', 1);
```

Set an object-level property, such as `ReturnedColorSpace`. The syntax for an object-level property is to use `set` on the object name, property name, and property value.

```
set(vidobj, 'ReturnedColorSpace', 'grayscale');
```

Set a device-specific property, such as `Brightness`. The syntax for a device-specific property is to use `set` with the `DeviceProperties` object using dot notation, then the property name and property value.

```
set(vidobj.DeviceProperties, 'Brightness', 150);
```

Preview the image.

```
preview(vidobj)
```

Acquire a single frame.

imaq.VideoDevice

```
frame = step(vidobj);
```

Display the acquired frame.

```
imshow(frame)
```

Release the hardware resource.

```
release(vidobj);
```

Clear the VideoDevice System object.

```
clear vidobj;
```

Purpose Determine whether video input object is logging

Syntax `bool = islogging(obj)`

Description `bool = islogging(obj)` returns true if the video input object `obj` is logging data, otherwise false. A video input object is logging if the value of its `Logging` property is set to 'on'.

If `obj` is an array of video input objects, `bool` is a logical array where each element in `bool` represents the corresponding element in `obj`. If an object in `obj` is logging data, `islogging` sets the corresponding element in `bool` to true, otherwise false. If any of the video input objects in `obj` is invalid, `islogging` returns an error.

Examples Create a video input object.

```
vid = videoinput('winvideo');
```

To put the video input object in a logging state, start acquiring data. The example acquires 50 frames to increase the amount of time that the object remains in logging state.

```
set(vid, 'FramesPerTrigger', 50)  
start(vid)
```

When the call to the `start` function returns, and the object is still acquiring data, use `islogging` to check the state of the object.

```
bool = islogging(vid)  
bool =
```

```
1
```

Create a second video input object.

```
vid2 = videoinput('winvideo');
```

islogging

Start one of the video input objects again, such as `vid`, and use `islogging` to determine which of the two objects is logging.

```
start(vid)
bool = islogging([vid vid2])
```

```
bool =
```

```
    1    0
```

See Also

[isrunning](#) | [isvalid](#) | [videoinput](#) | [Logging](#) | [LoggingMode](#)

Purpose Determine whether video input object is running

Syntax `bool = isrunning(obj)`

Description `bool = isrunning(obj)` returns `true` if the video input object `obj` is running, otherwise `false`. A video input object is running if the value of its `Running` property is set to `'on'`.

If `obj` is an array of video input objects, `bool` is a logical array where each element in `bool` represents the corresponding element in `obj`. If an object in `obj` is running, the `isrunning` function sets the corresponding element in `bool` to `true`, otherwise `false`. If any of the video input objects in `obj` is invalid, `isrunning` returns an error.

Examples Create a video input object, configure a manual trigger, and then start the object. This puts the object in running state.

```
vid = videoinput('winvideo');  
triggerconfig(vid,'manual')  
start(vid)
```

Use `isrunning` to check the state of the object.

```
bool = isrunning(vid)  
bool =  
    1
```

Create a second video input object.

```
vid2 = videoinput('winvideo');
```

Use `isrunning` to determine which of the two objects is running.

```
bool = isrunning([vid vid2])  
bool =  
    1    0
```

See Also `islogging` | `isvalid` | `start` | `stop` | `videoinput` | `Running`

isvalid

Purpose Determine whether image acquisition object is associated with image acquisition device

Syntax `bool = isvalid(obj)`

Description `bool = isvalid(obj)` returns `true` if the video input object `obj` is valid, otherwise `false`. An object is an invalid image acquisition object if it is no longer associated with any hardware; that is, the object was deleted using the `delete` function. If this is the case, `obj` should be cleared from the workspace.

If `obj` is an array of video input objects, `bool` is a logical array where each element in `bool` represents the corresponding element in `obj`. If an object in `obj` is valid, the `isvalid` function sets the corresponding element in `bool` to `true`, otherwise `false`.

See Also `delete` | `imaqfind` | `videoinput`

Purpose	Load image acquisition object into MATLAB workspace
Syntax	<pre>load filename load filename obj1 obj2 ... S = load(filename,obj1,obj2,...)</pre>
Description	<p><code>load filename</code> returns all variables from the MAT-file <code>filename</code> to the MATLAB workspace.</p> <p><code>load filename obj1 obj2 ...</code> returns the specified image acquisition objects (<code>obj1</code>, <code>obj2</code>, etc.) from the MAT-file specified by <code>filename</code> to the MATLAB workspace.</p> <p><code>S = load(filename,obj1,obj2,...)</code> returns the structure <code>S</code> with the specified image acquisition objects (<code>obj1</code>, <code>obj2</code>, etc.) from the MAT-file <code>filename</code>. The field names in <code>S</code> match the names of the image acquisition objects that were retrieved. If no objects are specified, then all variables existing in the MAT-file are loaded.</p> <p>Values for read-only properties are restored to their default values when loaded. For example, the <code>Running</code> property is restored to <code>'off'</code>. Use <code>propinfo</code> to determine if a property is read only.</p>
Examples	<pre>obj = videoinput('winvideo', 1); set(obj, 'SelectedSourceName', 'input1') save fname obj load fname load('fname', 'obj');</pre>
See Also	<code>imaqhelp</code> <code>propinfo</code> <code>save</code>

obj2mfile

Purpose Convert video input objects to MATLAB code

Syntax

```
obj2mfile(obj,filename)
obj2mfile(obj,filename,syntax)
obj2mfile(obj,filename,syntax,mode)
obj2mfile(obj,filename,syntax,mode,reuse)
```

Description `obj2mfile(obj,filename)` converts the video input object `obj` into an M-file with the name specified by `filename`. The M-file contains the MATLAB code required to create the object and set its properties. `obj` can be a single video input object or an array of objects.

The `obj2mfile` function simplifies the process of restoring an object with specific property settings and can be used to create video input objects. `obj2mfile` also creates and configures the video source object associated with the video input object.

If `filename` does not specify an extension or if it has an extension other than the MATLAB M-file extension (`.m`), `obj2mfile` appends `.m` to the end of `filename`. To recreate `obj`, execute the M-file by calling `filename`.

If the `UserData` property of the object is set, or if any of the callback properties is set to a cell array or to a function handle, `obj2mfile` writes the data stored in those properties to a MAT-file. `obj2mfile` gives the MAT-file the same name as the M-file, but uses the `.mat` filename extension. `obj2mfile` creates the MAT-file in the same directory as the M-file.

Note `obj2mfile` does not restore the values of read-only properties. For example, if an object is saved with a `Logging` property set to `'on'`, the object is recreated with a `Logging` property set to `'off'` (the default value). Use the `propinfo` function to determine if a property is read only.

`obj2mfile(obj,filename,syntax)` converts `obj` to the equivalent MATLAB code where `syntax` specifies how `obj2mfile` assigns values to properties of the object. `syntax` can be either of the following text strings. The default value is enclosed in braces (`{}`).

String	Description
{ 'set' }	<code>obj2mfile</code> uses the <code>set</code> function when specifying property values.
'dot'	<code>obj2mfile</code> uses subscripted assignment (dot notation) when specifying property values.

`obj2mfile(obj,filename,syntax,mode)` converts `obj` to the equivalent MATLAB code where `mode` specifies which properties are configured. `mode` can be either of the following strings. The default value is enclosed in braces (`{}`).

String	Description
{ 'modified' }	Configure writable properties that are not set to their default values.
'all'	Configure all writable properties. <code>obj2mfile</code> does not restore the values of read-only properties.

Note that `obj2mfile(obj,filename,mode)` is a valid syntax. If the `syntax` argument is not specified, `obj2mfile` uses the default value.

`obj2mfile(obj,filename,syntax,mode,reuse)` converts `obj` to the equivalent MATLAB code where `reuse` specifies whether `obj2mfile` searches for a reusable video input object or creates a new one. `reuse` can be either of the following strings. The default value is enclosed in braces (`{}`).

String	Description
{ 'reuse' }	Find and modify an existing object, if the existing object is associated with the same adaptor and the values of the DeviceID, VideoFormat, and Tag properties match the object being created. If no matching object can be found, obj2mfile creates a new object.
'create'	Create a new object regardless of whether there are reusable objects.

Note that `obj2mfile(obj, filename, reuse)` is a valid syntax. If the *syntax* and *mode* arguments are not specified, `obj2mfile` uses their default values.

Examples

Create a video input object.

```
vidobj = videoinput('winvideo', 1, 'RGB24_640x480');
```

Configure several properties of the video input object.

```
set(vidobj, 'FramesPerTrigger', 100);  
set(vidobj, 'FrameGrabInterval', 2);  
set(vidobj, 'Tag', 'CAM1');
```

Retrieve the selected video source object associated with the video input object.

```
src = getselectedsource(vidobj);
```

Configure the properties of the video source object.

```
set(src, 'Contrast', 85);  
set(src, 'Saturation', 125);
```

Save the video input object.

```
obj2mfile(vidobj, 'myvidobj.m', 'set', 'modified');
```

Delete the object and clear it from the workspace.

```
delete(vidobj);  
clear vidobj;
```

Execute the M-file to recreate the object. Note that `obj2mfile` creates and configures the associated video source object as well.

```
vidObj = myvidobj;
```

See Also

`getselectedsource` | `imaqhelp` | `propinfo` | `set` | `videoinput`

peekdata

Purpose Most recently acquired image data

Syntax `data = peekdata(obj, frames)`

Description `data = peekdata(obj, frames)` returns data containing the latest number of frames specified by `frames`. If `frames` is greater than the number of frames currently acquired, all available frames are returned with a warning message stating that the requested number of frames was not available. `obj` must be a 1-by-1 video input object.

`data` is returned as an H-by-W-by-B-by-F matrix where

H Image height, as specified in the object's `ROIPosition` property

W Image width, as specified in the object's `ROIPosition` property

B Number of color bands, as specified in the `NumberOfBands` property

F Number of frames returned

`data` is returned to the MATLAB workspace in its native data type using the color space specified by the `ReturnedColorSpace` property.

You can use the MATLAB `image` or `imagesc` functions to view the returned data. Use `imaqmontage` to view multiple frames at once.

`peekdata` is a nonblocking function that immediately returns image frames and execution control to the MATLAB workspace. Not all requested data might be returned.

Note `peekdata` provides a look at the data; it does not remove data from the memory buffer. The object's `FramesAvailable` property value is not affected by the number of frames returned by `peekdata`.

The behavior of peekdata depends on the settings of the Running and the Logging properties.

Running	Logging	Object State	Result
On	Off	The object has been started but is waiting for a trigger. (TriggerType is set to 'manual' or 'hardware'). No data has been acquired so none is available.	peekdata returns a single frame of data and issues a warning, if you requested more than one frame.
On	On	The object has been started, a trigger has executed, and the object is actively acquiring data.	peekdata returns the n most recently acquired frames of data. The frames are not removed from the buffer.
Off	Off	The object has stopped running because it acquired the requested number of frames or you called the stop function.	peekdata can be called once to return the n most recently acquired frames of data, assuming FramesAvailable is greater than 0. Otherwise, peekdata returns an error. The frames returned are not removed from the memory buffer.

The number of frames available to peekdata is determined by recalling the last frame returned by a previous peekdata call, and the number of frames that were acquired since then.

peekdata can be used only after the start command is issued and while the object is running. peekdata can also be called once after obj has stopped running.

Note The peekdata function does not return any data while running if in disk logging mode.

peekdata

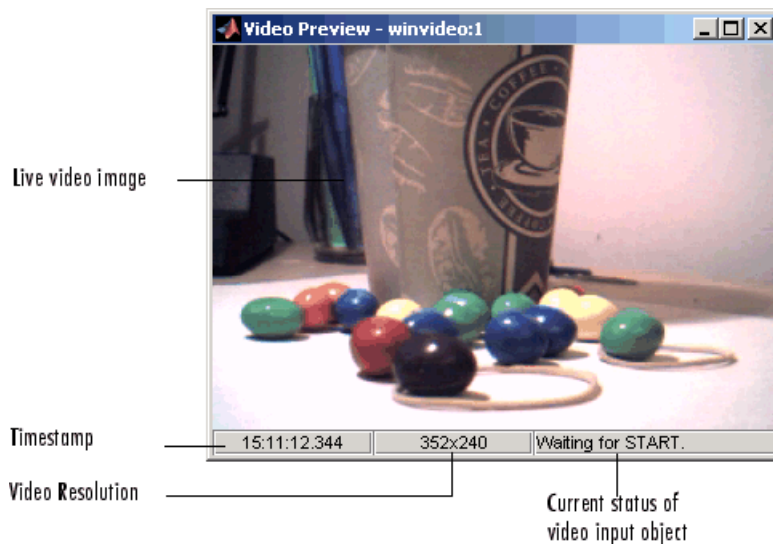
See Also

`getdata` | `getsnapshot` | `imaqhelp` | `imaqmontage` | `propinfo` | `start`

Purpose Preview of live video data

Syntax
`preview(obj)`
`preview(obj,himage)`
`himage = preview(...)`

Description `preview(obj)` creates a Video Preview window that displays live video data for video input object `obj`. The window also displays the timestamp and video resolution of each frame, and the current status of `obj`. The Video Preview window displays the video data at 100% magnification (one screen pixel represents one image pixel). The size of the preview image is determined by the value of the video input object `ROIPosition` property.



Components of a Video Preview Window

The Video Preview window remains active until it is either stopped using `stoppreview` or closed using `closepreview`. If you delete the object, by calling `delete(obj)`, the Video Preview window stops previewing and closes automatically.

preview

`preview(obj, himage)` displays live video data for video input object `obj` in the image object specified by the handle `himage`. `preview` scales the image data to fill the entire area of the image object but does not modify the values of any image object properties. Use this syntax to preview video data in a custom GUI of your own design (see Examples).

`himage = preview(...)` returns `himage`, a handle to the image object containing the previewed data. To obtain a handle to the figure window containing the image object, use the `ancestor` function. For more information about using image objects, see `image`. See the Custom Update Function section for more information about the image object returned.

Notes

The behavior of the Video Preview window depends on the video input object's current state and trigger configuration.

Object State	Preview Window Behavior
Running=off	Displays a live view of the image being acquired from the device, for all trigger types. The image is updated to reflect changes made to configurations of object properties. (The <code>FrameGrabInterval</code> property is ignored until a trigger occurs.)
Running=on	If <code>TriggerType</code> is set to <code>immediate</code> or <code>manual</code> , the Video Preview window continues to update the image displayed. If <code>TriggerType</code> is set to <code>hardware</code> , the Video Preview window stops updating the image displayed until a trigger occurs.
Logging=on	Video Preview window might drop some data frames, but this will not affect the frames logged to memory or disk.

Note The Image Acquisition Toolbox Preview window and the Preview window that is built into the Image Acquisition Tool support the display of up to 16-bit image data. The Preview window was designed to only show 8-bit data, but many cameras return 10-, 12-, 14-, or 16-bit data. The Preview window display supports these higher bit-depth cameras. However, larger bit data is scaled to 8-bit for the purpose of displaying previewed data. If you need the full resolution of the data, use the `getsnapshot` or `getdata` functions.

Custom Update Function

`preview` creates application-defined data for the image object, `himage`, assigning it the name `'UpdatePreviewWindowFcn'` and setting its value to an empty array (`[]`). You can configure the value of the `'UpdatePreviewWindowFcn'` application data and retrieve its value using the MATLAB `setappdata` and `getappdata` functions, respectively.

The `'UpdatePreviewWindowFcn'` will not necessarily be called for every frame that is acquired. If a new frame is acquired and the `'UpdatePreviewWindowFcn'` for the previous frame has not yet finished executing, no update will be generated for the new frame. If you need to execute a function for every acquired frame, use the `FramesAcquiredFcn` instead.

You can use this function to define custom processing of the previewed image data. When `preview` invokes the function handle you specify, it passes three arguments to your function:

- `obj` — The video input object being previewed
- `event` — An event structure containing image frame information. For more information, see below.
- `himage` — A handle to the image object that is being updated

The event structure contains the following fields:

Field	Description
Data	Current image frame specified as an H-by-W-by-B matrix where H and W are the image height and width, respectively, as specified in the ROIPosition property, and B is the number of color bands, as specified in the NumberOfBands property.
Resolution	String specifying current image width and height, as defined by the ROIPosition property.
Status	String describing the current acquisition status of the video input object.
Timestamp	String specifying the timestamp associated with the current image frame.

Examples

Create a customized GUI.

```
figure('Name', 'My Custom Preview Window');  
uicontrol('String', 'Close', 'Callback', 'close(gcf)');
```

Create an image object for previewing.

```
vidRes = get(obj, 'VideoResolution');  
nBands = get(obj, 'NumberOfBands');  
hImage = image( zeros(vidRes(2), vidRes(1), nBands) );  
preview(obj, hImage);
```

For more information on customized GUIs, see “Previewing Data in Custom GUIs” on page 2-13.

See Also

`ancestor` | `closepreview` | `image` | `imagehelp` | `stoppreview`

Purpose Property characteristics for image acquisition objects

Syntax
`out = propinfo(obj)`
`out = propinfo(obj,PropertyName)`

Description `out = propinfo(obj)` returns the structure `out` whose field names are the names of all the properties supported by `obj`. `obj` must be a 1-by-1 image acquisition object. The value of each field is a structure containing the fields shown below.

Field Name	Description
Type	Data type of the property. Possible values are 'any', 'callback', 'double', 'string', and 'struct'.
Constraint	Type of constraint on the property value. Possible values are 'bounded', 'callback', 'enum', and 'none'.
ConstraintValue	List of valid string values or a range of valid values.
DefaultValue	Default value for the property.
ReadOnly	Condition under which a property is read only: <ul style="list-style-type: none"> • 'always' — Property cannot be configured. • 'whileRunning' — Property cannot be configured while Running is set to on. • 'never' — Property can be configured at any time.
DeviceSpecific	1 if the property is device specific; otherwise, 0 (zero).

`out = propinfo(obj,PropertyName)` returns the structure `out` for the property specified by `PropertyName`. If `PropertyName` is a cell

propinfo

array of strings, `propinfo` returns a structure for each property, stored in a cell array.

Examples

Create the video input object `vid`.

```
vid = videoinput('winvideo',1);
```

Capture all property information for all properties.

```
out = propinfo(vid);
```

Access property information for a particular property.

```
out1 = propinfo(vid,'LoggingMode');
```

See Also

`imaqhelp`

Purpose

Save image acquisition objects to MAT-file

Syntax

```
save filename
save filename obj1 obj2 ...
save(filename,obj1,obj2,...)
```

Description

`save filename` saves all variables in the MATLAB workspace to the MAT-file `filename`. If `filename` does not include a file extension, `save` appends the `.MAT` extension to the filename.

`save filename obj1 obj2 ...` saves the specified image acquisition objects (`obj1`, `obj2`, etc.) to the MAT-file `filename`.

`save(filename,obj1,obj2,...)` is the functional form of the command, where the file name and image acquisition objects must be specified as text strings. If no objects are specified, then all variables existing in the MATLAB workspace are saved.

Note that any data associated with the image acquisition object is not stored in the MAT-file. To save the data, bring it into the MATLAB workspace (using the `getdata` function), and then save the variable to the MAT-file.

To return variables from the MAT-file to the MATLAB workspace, use the `load` command. Values for read-only properties are restored to their default values upon loading. For example, the `Running` property is restored to `'off'`. Use the `propinfo` function to determine if a property is read only.

Examples

```
obj = videoinput('winvideo', 1);
set(obj, 'SelectedSourceName', 'input1')
save fname obj
set(obj, 'TriggerFcn', {'mycallback', 5});
save('fname1', 'obj')
```

See Also

`imaqhelp` | `load` | `propinfo`

Purpose Configure or display image acquisition object properties

Syntax

```
set(obj)
prop_struct = set(obj)
set(obj,PropertyName)
prop_cell = set(obj,PropertyName)
set(obj,PropertyName,PropertyValue,...)
set(obj,S)
set(obj,PN,PV)
```

Description `set(obj)` displays property names and any enumerated values for all configurable properties of image acquisition object `obj`. `obj` must be a single image acquisition object.

`prop_struct = set(obj)` returns the property names and any enumerated values for all configurable properties of image acquisition object `obj`. `obj` must be a single image acquisition object. The return value `prop_struct` is a structure whose field names are the property names of `obj`, and whose values are cell arrays of possible property values or empty cell arrays if the property does not have a finite set of possible string values.

`set(obj,PropertyName)` displays the possible values for the specified property, *PropertyName*, of image acquisition object `obj`. `obj` must be a single image acquisition object. Use the `set(obj)` syntax to get a list of all the properties for a particular image acquisition object that can be set.

`prop_cell = set(obj,PropertyName)` returns the possible values for the specified property, *PropertyName*, of image acquisition object `obj`. `obj` must be a single image acquisition object. The returned array `prop_cell` is a cell array of possible value strings or an empty cell array if the property does not have a finite set of possible string values.

`set(obj,PropertyName,PropertyValue,...)` configures the property specified by the text string *PropertyName* to the value specified by *PropertyValue* for image acquisition object `obj`. You can specify multiple property name/property value pairs in a single statement. `obj` can be a single image acquisition object or a vector of image acquisition

objects, in which case `set` configures the property values for all the image acquisition objects specified.

`set(obj,S)` configures the properties of `obj` with the values specified in `S`, where `S` is a structure whose field names are object property names.

`set(obj,PN,PV)` configures the properties specified in the cell array of strings, `PN`, to the corresponding values in the cell array `PV`, for the image acquisition object `obj`. `PN` must be a vector. If `obj` is an array of image acquisition objects, `PV` can be an `M`-by-`N` cell array, where `M` is equal to the length of the image acquisition object array and `N` is equal to the length of `PN`. In this case, each image acquisition object is updated with a different set of values for the list of property names contained in `PN`.

Note Parameter/value string pairs, structures, and parameter/value cell array pairs can be used in the same call to `set`.

Examples

These examples illustrate the various ways to use the `set` function to set the values of image acquisition object properties.

```
set(obj, 'FramesPerTrigger', 15, 'LoggingMode', 'disk');
set(obj, {'TimerFcn', 'TimerPeriod'}, {@imaqcallback, 25});
set(obj, 'Name', 'MyObject');
set(obj, 'SelectedSourceName')
```

See Also

`get` | `imaqfind` | `videoinput`

start

Purpose Obtain exclusive use of image acquisition device

Syntax `start(obj)`

Description `start(obj)` obtains exclusive use of the image acquisition device associated with the video input object `obj` and locks the device's configuration. Starting an object is a necessary first step to acquire image data, but it does not control when data is logged.

`obj` can either be a 1-by-1 video input object or an array of video input objects.

Data logging is controlled with the `TriggerType` property.

Trigger Type	Logging Behavior
'hardware'	Data logging occurs when the condition specified in the object's <code>TriggerCondition</code> property is met via the <code>TriggerSource</code> .
'immediate'	Data logging occurs immediately.
'manual'	Data logging occurs when the trigger function is called.

Use the `triggerconfig` function to configure the object's trigger settings.

When an acquisition is started, `obj` performs the following operations:

- 1 Transfers the object's configuration to the associated hardware.
- 2 Executes the object's `StartFcn` callback.
- 3 Sets the object's `Running` property to 'On'.

If the object's `StartFcn` errors, the hardware is never started and the object's `Running` property remains 'Off'.

The start event is recorded in the object's `EventLog` property.

An image acquisition object stops running when one of the following conditions is met:

- The stop function is issued.
- The requested number of frames is acquired. This occurs when

$$\text{FramesAcquired} = \text{FramesPerTrigger} * (\text{TriggerRepeat} + 1)$$

where `FramesAcquired`, `FramesPerTrigger`, and `TriggerRepeat` are properties of the video input object.

- A run-time error occurs.
- The object's `Timeout` value is reached.

Examples

The start function can be called by a video input object's event callback.

```
obj.StopFcn = {'start'};
```

See Also

`imaqfind` | `imaqhelp` | `propinfo` | `stop` | `trigger` | `triggerconfig`

stop

Purpose Stop video input object

Syntax `stop(obj)`

Description `stop(obj)` halts an acquisition associated with the video input object `obj`. `obj` can be either a single video input object or an array of video input objects.

The `stop` function

- Sets the object's `Running` property to 'Off'
- Sets the object's `Logging` property to 'Off', if needed
- Executes the object's `StopFcn` callback

An image acquisition object can also stop running under one of the following conditions:

- The requested number of frames is acquired. This occurs when

$$\text{FramesAcquired} = \text{FramesPerTrigger} * (\text{TriggerRepeat} + 1)$$

where `FramesAcquired`, `FramesPerTrigger`, and `TriggerRepeat` are properties of the video input object.

- A run-time error occurs.
- The object's `Timeout` value is reached.

The stop event is recorded in the object's `EventLog` property.

Examples The stop function can be called by a video input object's event callback.

```
obj.TimerFcn = {'stop'};
```

See Also `imaqfind` | `start` | `trigger` | `propinfo` | `videoinput`

Purpose	Stop previewing video data
Syntax	<code>stoppreview(obj)</code>
Description	<code>stoppreview(obj)</code> stops the previewing of video data from image acquisition object <code>obj</code> . To restart previewing, call <code>preview</code> again.
Examples	Create a video input object and open a Video Preview window. <pre>vid = videoinput('winvideo',1); preview(vid)</pre> <p>Stop previewing video data.</p> <pre>stoppreview(vid);</pre> <p>Restart previewing.</p> <pre>preview(vid)</pre>
See Also	<code>closepreview</code> <code>preview</code>

supportPackageInstaller

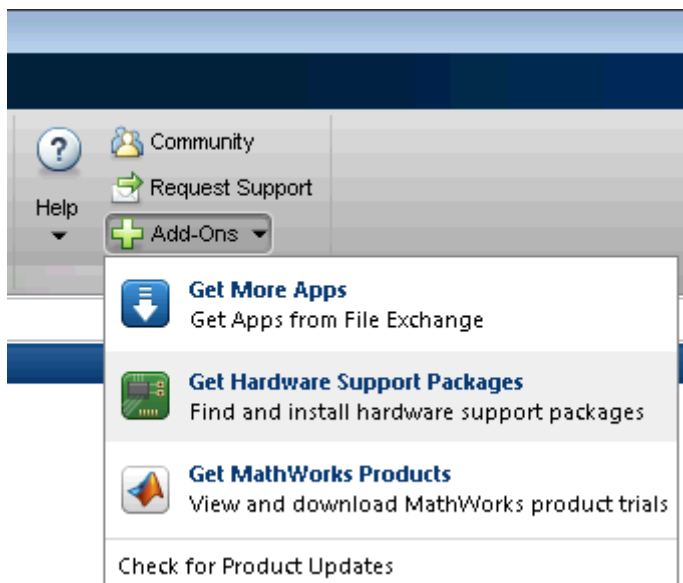
Purpose Start Support Package Installer and install support for third-party hardware or software

Syntax supportPackageInstaller

Description The supportPackageInstaller function opens *Support Package Installer*. Support Package Installer can install *support packages*, which add support for specific third-party hardware or software to specific MathWorks products. To see a list of available support packages, run Support Package Installer and advance to the second screen.

You can also start Support Package Installer in one of the following ways:

- On the MATLAB toolstrip, click **Add-Ons > Get Hardware Support Packages**.



- Double-click a support package installation file (*.mlpkginstall).

Purpose Initiate data logging

Syntax `trigger(obj)`

Description `trigger(obj)` initiates data logging for the video input object `obj`. `obj` can be either a single video input object or an array of video input objects.

The `trigger` function

- Executes the object's `TriggerFcn` callback
- Records the absolute time of the first trigger event in the object's `InitialTriggerTime` property
- Configures the object's `Logging` property to 'On'

`obj` must be running and its `TriggerType` property must be set to 'manual'. To start an object running, use the `start` function.

The trigger event is recorded in the object's `EventLog` property.

Examples The `trigger` function can be called by a video input object's event callback.

```
obj.StartFcn = @trigger;
```

See Also `imaqfind` | `start` | `stop` | `videoinput`

triggerconfig

Purpose Configure video input object trigger properties

Syntax

```
triggerconfig(obj,type)
triggerconfig(obj,type,condition)
triggerconfig(obj,type,condition,source)
config = triggerconfig(obj)
triggerconfig(obj,config)
```

Description

`triggerconfig(obj,type)` configures the value of the `TriggerType` property of the video input object `obj` to the value specified by the text string `type`. For a list of valid `TriggerType` values, use `triggerinfo(obj)`. `type` must specify a unique trigger configuration.

`obj` can be either a single video input object or an array of video input objects. If an error occurs, any video input objects in the array that have already been configured are returned to their original configurations.

`triggerconfig(obj,type,condition)` configures the values of the `TriggerType` and `TriggerCondition` properties of the video input object `obj` to the values specified by the text strings `type` and `condition`. For a list of valid `TriggerType` and `TriggerCondition` values, use `triggerinfo(obj)`. `type` and `condition` must specify a unique trigger configuration.

`triggerconfig(obj,type,condition,source)` configures the values of the `TriggerType`, `TriggerCondition`, and `TriggerSource` properties of the video input object `obj` to the values specified by the text strings `type`, `condition`, and `source`, respectively. For a list of valid `TriggerType`, `TriggerCondition`, and `TriggerSource` values, use `triggerinfo(obj)`.

`config = triggerconfig(obj)` returns a MATLAB structure `config` containing the object's current trigger configuration. `obj` must be a 1-by-1 video input object. The field names of `config` are `TriggerType`, `TriggerCondition`, and `TriggerSource`. Each field contains the current value of the object's property.

`triggerconfig(obj,config)` configures the `TriggerType`, `TriggerCondition`, and `TriggerSource` property values for video

input object `obj` using `config`, a MATLAB structure with field names `TriggerType`, `TriggerCondition`, and `TriggerSource`, each containing the desired property value.

Examples

Example 1

Construct a video input object.

```
vid = videoinput('winvideo', 1);
```

Configure trigger properties for the object.

```
triggerconfig(vid, 'manual')
```

Trigger the acquisition.

```
start(vid)  
trigger(vid)
```

Remove video input object from memory.

```
delete(vid);
```

Example 2

This example uses a structure returned from `triggerinfo` to configure trigger parameters.

Create a video input object.

```
vid = videoinput('winvideo', 1);
```

Use `triggerinfo` to get all valid configurations for the trigger properties for the object.

```
config = triggerinfo(vid);
```

Pass one of the configurations to the `triggerconfig` function.

```
triggerconfig(vid, config(2));
```

Remove video input object from memory.

triggerconfig

```
delete(vid);
```

See Also

```
imaqhelp | trigger | triggerinfo | videoinput
```

Purpose

Provide information about available trigger configurations

Syntax

```
triggerinfo(obj)
triggerinfo(obj,type)
config = triggerinfo(...)
```

Description

`triggerinfo(obj)` displays all available trigger configurations for the video input object `obj`. `obj` can only be a 1-by-1 video input object.

`triggerinfo(obj,type)` displays the available trigger configurations for the specified `TriggerType`, `type`, for the video input object `obj`. To get a list of valid `type` values for a particular image acquisition object, use `triggerinfo(obj)`.

`config = triggerinfo(...)` returns `config`, an array of MATLAB structures, containing all the valid trigger configurations for the video input object `obj`. Each structure in the array contains these fields:

Field	Description
TriggerType	Name of the trigger type
TriggerCondition	Condition that must be met before executing a trigger
TriggerSource	Hardware source used for triggering

You can pass one of the structures in `config` to the `triggerconfig` function to specify the trigger configuration.

Examples

This example illustrates how to use the `triggerinfo` function to retrieve valid configurations of the `TriggerType`, `TriggerSource`, and `TriggerCondition` properties.

- 1 Create a video input object.

```
vid = videoinput('winvideo');
```

triggerinfo

- 2 Get information about the available trigger configurations for this object.

```
config = triggerinfo(vid)
```

```
config =
```

```
1x2 struct array with fields:
```

```
    TriggerType  
    TriggerCondition  
    TriggerSource
```

- 3 View one of the trigger configurations returned by `triggerinfo`.

```
config(1)
```

```
ans =
```

```
    TriggerType: 'immediate'  
    TriggerCondition: 'none'  
    TriggerSource: 'none'
```

See Also

`imaqhelp` | `triggerconfig`

Purpose

Create video input object

Syntax

```
obj = videoinput(adaptorname)  
obj = videoinput(adaptorname,deviceID)  
obj = videoinput(adaptorname,deviceID,format)  
obj = videoinput(adaptorname,deviceID,format,P1,V1,...)
```

Description

`obj = videoinput(adaptorname)` constructs the video input object `obj`. A video input object represents the connection between MATLAB and a particular image acquisition device. *adaptorname* is a text string that specifies the name of the adaptor used to communicate with the device. Use the `imaqhwinfo` function to determine the adaptors available on your system.

`obj = videoinput(adaptorname,deviceID)` constructs a video input object `obj`, where *deviceID* is a numeric scalar value that identifies a particular device available through the specified adaptor, *adaptorname*. Use the `imaqhwinfo(adaptorname)` syntax to determine the devices available through the specified adaptor. If *deviceID* is not specified, the first available device ID is used. As a convenience, a device's name can be used in place of the *deviceID*. If multiple devices have the same name, the first available device is used.

`obj = videoinput(adaptorname,deviceID,format)` constructs a video input object, where *format* is a text string that specifies a particular video format supported by the device or the full path of a device configuration file (also known as a camera file).

To get a list of the formats supported by a particular device, view the `DeviceInfo` structure for the device that is returned by the `imaqhwinfo` function. Each `DeviceInfo` structure contains a `SupportedFormats` field. If *format* is not specified, the device's default format is used.

When the video input object is created, its `VideoFormat` field contains the format name or device configuration file that you specify.

`obj = videoinput(adaptorname,deviceID,format,P1,V1,...)` creates a video input object `obj` with the specified property values. If an invalid property name or property value is specified, the object is not created.

videoinput

The property name and property value pairs can be in any format supported by the `set` function, i.e., parameter/value string pairs, structures, or parameter/value cell array pairs.

To view a complete listing of video input object functions and properties, use the `imaqhelp` function.

```
imaqhelp videoinput
```

Tips

The toolbox chooses the first available video source object as the selected source and specifies this video source object's name in the object's `SelectedSourceName` property. Use `getselectedsource(obj)` to access the video source object that is used for acquisition.

Examples

Construct a video input object.

```
obj = videoinput('matrox', 1);
```

Select the source to use for acquisition.

```
set(obj, 'SelectedSourceName', 'input1')
```

View the properties for the selected video source object.

```
src_obj = getselectedsource(obj);  
get(src_obj)
```

Preview a stream of image frames.

```
preview(obj);
```

Acquire and display a single image frame.

```
frame = getsnapshot(obj);  
image(frame);
```

Remove video input object from memory.

```
delete(obj);
```

See Also

`delete` | `imaqfind` | `isvalid` | `preview`

wait

Purpose Wait until image acquisition object stops running or logging

Syntax
`wait(obj)`
`wait(obj,waittime)`
`wait(obj,waittime,state)`

Description `wait(obj)` blocks the MATLAB command line until the video input object `obj` stops running (`Running = 'off'`). `obj` can be either a single video input object or an array of video input objects. When `obj` is an array of objects, the `wait` function waits until all objects in the array stop running. If `obj` is not running or is an invalid object, `wait` returns immediately. The `wait` function can be useful when you want to guarantee that data is acquired before another task is performed.

`wait(obj,waittime)` blocks the MATLAB command line until the video input object or array of objects `obj` stops running or until `waittime` seconds have expired, whichever comes first. By default, `waittime` is set to the value of the object's `Timeout` property.

`wait(obj,waittime,state)` blocks the MATLAB command line until the video input object or array of objects `obj` stops running or logging, or until `waittime` seconds have expired, whichever comes first. `state` can be either of the following text strings. The default value is enclosed in braces (`{}`).

State	Description
{ 'running' }	Blocks until the value of the object's <code>Running</code> property is <code>'off'</code> .
'logging'	Blocks until the value of the object's <code>Logging</code> property is <code>'off'</code> .

Note The video input object's stop event callback function (`StopFcn`) might not be called before this function returns.

An image acquisition object stops running or logging when one of the following conditions is met:

- The stop function is issued.
- The requested number of frames is acquired. This occurs when

$$\text{FramesAcquired} = \text{FramesPerTrigger} * (\text{TriggerRepeat} + 1)$$

where `FramesAcquired`, `FramesPerTrigger`, and `TriggerRepeat` are properties of the video input object.

- A run-time error occurs.
- The object's `Timeout` value is reached.

Examples

Create a video input object.

```
vid = videoinput('winvideo');
```

Specify an acquisition that should take several seconds. The example sets the `FramesPerTrigger` property to 300.

```
vid.FramesPerTrigger = 300;
```

Start the object. Because it is configured with an immediate trigger (the default), acquisition begins when the object is started. The example calls the `wait` function after calling the `start` function. Notice how `wait` blocks the MATLAB command line until the acquisition is complete.

```
start(vid), wait(vid);
```

See Also

`imaqhelp` | `start` | `stop` | `trigger` | `propinfo`

wait

Properties — Alphabetical List

BayerSensorAlignment property

Purpose Specify sensor alignment for Bayer demosaicing

Description If the ReturnedColorSpace property is set to 'bayer', then the Image Acquisition Toolbox software will demosaic Bayer patterns returned by the hardware. This color space setting will interpolate Bayer pattern encoded images into standard RGB images. If your camera uses Bayer filtering, the toolbox supports the Bayer pattern and can return color if desired.

In order to perform the demosaicing, the toolbox needs to know the pixel alignment of the sensor. This is the order of the red, green, and blue sensors and is normally specified by describing the four pixels in the upper-left corner of the sensor. It is the band sensitivity alignment of the pixels as interpreted by the camera's internal hardware. You must get this information from the camera's documentation and then specify the value for the alignment, as described in the following table.

There are four possible sensor alignments.

Value	Description
'gbrg'	The 2-by-2 sensor alignment is green blue red green
'grbg'	The 2-by-2 sensor alignment is green red blue green
'bggr'	The 2-by-2 sensor alignment is blue green green red
'rggb'	The 2-by-2 sensor alignment is red green green blue

BayerSensorAlignment property

The value of this property is only used if the ReturnedColorSpace property is set to 'bayer'.

For examples showing how to convert Bayer images, see “Converting Bayer Images” on page 6-19.

Characteristics

Access	Read/write
Data type	String
Values	[{'grbg'} 'gbrg' 'rggb' 'bggr']

See Also

Functions

getdata, getsnapshot, peekdata, videoinput

Properties

ReturnedColorSpace, VideoFormat

How To's

“Specifying the Color Space” on page 6-17

“Converting Bayer Images” on page 6-19

DeviceID property

Purpose Identify image acquisition device represented by video input object

Description The DeviceID property identifies the device represented by the video input object.

A device ID is a number, assigned by an adaptor, that uniquely identifies an image acquisition device. The adaptor assigns the first device it detects the identifier 1, the second device it detects the identifier 2, and so on.

You must specify the device ID as an argument to the `videoinput` function when you create a video input object. The object stores the value in the `DeviceID` property and also uses the value when constructing the default value of the `Name` property.

To get a list of the IDs of the devices connected to your system, use the `imaqhwinfo` function, specifying the name of a particular adaptor as an argument.

Characteristics

Access	Read only
Data type	double
Values	Any nonnegative integer

Examples

Use the `imaqhwinfo` function to determine which adaptors are connected to devices on your system.

```
imaqhwinfo
```

```
ans =
```

```
InstalledAdaptors: {'matrox' 'winvideo'}  
MATLABVersion: '7.4 (R2007a)'  
ToolboxName: 'Image Acquisition Toolbox'  
ToolboxVersion: '2.1 (R2007a)'
```

Use the `imaqhwinfo` function again, specifying the name of the adaptor, to find out how many devices are available through that adaptor. The `imaqhwinfo` function returns the device IDs for all the devices in the `DeviceIds` field.

```
info = imaqhwinfo('winvideo')

info =

    AdaptorDllName: [1x73 char]
    AdaptorDllVersion: '2.0 (R2006a+)'
    AdaptorName: 'winvideo'
    DeviceIDs: {[1]}
    DeviceInfo: [1x1 struct]
```

See Also

Functions

`imaqhwinfo`, `videoinput`

Properties

Name

DiskLogger property

Purpose

Specify MATLAB VideoWriter file used to log data

Description

The DiskLogger property specifies the VideoWriter or AVI file object used to log data when the LoggingMode property is set to 'disk' or 'disk&memory'. For the best performance, VideoWriter is the recommended file type.

VideoWriter File

For the best performance, logging to disk requires a MATLAB VideoWriter object, which is a MATLAB object, not an Image Acquisition Toolbox object. After you create and configure a VideoWriter object, you provide it to the DiskLogger property.

A MATLAB VideoWriter object specifies the file name and other characteristics. For example, you can use VideoWriter properties to specify the profile used for data compression and the desired quality of the output. For complete information about the VideoWriter object and its properties, see the VideoWriter documentation.

Note Do not use the variable returned by the VideoWriter function to perform any operation on a VideoWriter file while it is being used by a video input object for data logging. For example, do not change any of the VideoWriter file properties, add frames, or close the object. Your changes could conflict with the video input object.

After Logging and Running are off, it is possible that the DiskLogger might still be writing data to disk. When the DiskLogger finishes writing data to disk, the value of the DiskLoggerFrameCount property should equal the value of the FramesAcquired property. Do not close or modify the DiskLogger until this condition is met.

For more information about logging image data using a VideoWriter file, see “Logging Image Data to Disk” on page 5-46.

AVI File

A MATLAB AVI file object specifies the name and other characteristics of an AVI file. For example, you can use AVI file object properties to specify the codec used for data compression and the desired quality of the output. For complete information about the AVI file object and its properties, see the `avifile` documentation.

Note Do not use the variable returned by the `avifile` function to perform any operation on an AVI file object while it is being used by a video input object for data logging. For example, do not change any of the AVI file object properties, add frames, or close the object. Your changes could conflict with the video input object.

When the video input object finishes logging data to disk, the AVI file object remains open. The video input object does not open or close an AVI file object used for logging. The video input object, however, does update the `Width`, `Height`, and `TotalFrames` fields in the AVI file object to reflect the current acquisition settings.

After `Logging` and `Running` are off, it is possible that the `DiskLogger` might still be writing data to disk. When the `DiskLogger` finishes writing data to disk, the value of the `DiskLoggerFrameCount` property should equal the value of the `FramesAcquired` property. Do not close or modify the `DiskLogger` until this condition is met.

Note The `peekdata` function does not return any data while running if in disk logging mode.

Characteristics

Access	Read only while running
Data type	VideoWriter object or AVI file object
Values	The default value is [].

DiskLogger property

Examples

Using VideoWriter

Create a video input object that accesses a GigE Vision image acquisition device and uses grayscale format at 10 bits per pixel.

```
vidobj = videoinput('gige', 1, 'Mono10');
```

You can log acquired data to memory, to disk, or both. By default, data is logged to memory. To change the logging mode to disk, configure the video input object's `LoggingMode` property.

```
set(vidobj, 'LoggingMode', 'disk')
```

Create a `VideoWriter` object with the profile set to Motion JPEG 2000. Motion JPEG 2000 allows writing the full 10 bits per pixel data to the file.

```
vidobj.DiskLogger = VideoWriter('logfile.mj2', 'Motion JPEG 2000')
```

Now that the video input object is configured for logging data to a Motion JPEG 2000 file, initiate the acquisition.

```
start(vidobj)
```

Wait for the acquisition to finish.

```
wait(vidobj)
```

When logging large amounts of data to disk, disk writing occasionally lags behind the acquisition. To determine whether all frames are written to disk, you can optionally use the `DiskLoggerFrameCount` property.

```
while (vidobj.FramesAcquired ~= vidobj.DiskLoggerFrameCount)
    pause(.1)
end
```

You can verify that the `FramesAcquired` and `DiskLoggerFrameCount` properties have identical values by using these commands and comparing the output.

```
vidobj.FramesAcquired  
vidobj.DiskLoggerFrameCount
```

When the video input object is no longer needed, delete it and clear it from the workspace.

```
delete(vidobj)  
clear vidobj
```

Using an AVI File

Create and configure an AVI file object.

```
file = avifile('logfile.avi');  
file.Quality = 50;
```

Create and configure a video input object.

```
vid = videoinput('winvideo', 1);  
vid.LoggingMode = 'disk&memory';  
vid.DiskLogger = file;
```

Start logging data to disk.

```
start(vid)
```

To ensure that the logged data is written to the disk file, close the AVI file. As an argument to the `close` function, specify the value of the video input object `DiskLogger` property, `vid.DiskLogger`, to reference the AVI file object, not the original variable, `file`, returned by the `avifile` function.

```
file = close(vid.DiskLogger);
```

DiskLogger property

Delete the image acquisition object from memory when it is no longer needed.

```
delete(vid)  
clear vid
```

See Also

Functions

videoinput

Properties

DiskLoggerFrameCount, Logging, LoggingMode

DiskLoggerFrameCount property

Purpose Specify number of frames written to disk

Description The DiskLoggerFrameCount property indicates the current number of frames written to disk by the DiskLogger. This value is only updated when the LoggingMode property is set to 'disk' or 'disk&memory'.
After Logging and Running are off, it is possible that the DiskLogger might still be writing data to disk. When the DiskLogger finishes writing data to disk, the value of the DiskLoggerFrameCount property should equal the value of the FramesAcquired property. Do not close or modify the DiskLogger until this condition is met.

Characteristics	Access	Read only
	Data type	double
	Values	Any nonnegative integer

See Also **Functions**

videoinput

Properties

DiskLogger, FramesAcquired, Logging, Running

ErrorFcn property

Purpose Specify callback function to execute when run-time error occurs

Description The ErrorFcn property specifies the function to execute when an error event occurs. A run-time error event is generated immediately after a run-time error occurs.

Run-time errors include hardware errors and timeouts. Run-time errors do not include configuration errors such as setting an invalid property value.

Run-time error event information is stored in the EventLog property. You can retrieve any error message with the Data.Message field of EventLog.

Note Callbacks, including ErrorFcn, are executed only when the video object is in a running state. If you need to use the ErrorFcn callback for error handling during previewing, you must start the video object before previewing. To do that without logging data, use a manual trigger.

Characteristics	Access	Read only while running
	Data type	String, function handle, or cell array
	Values	imaqcallback is the default callback function.

See Also **Properties**
EventLog, Timeout

Purpose Store information about events

Description The EventLog property is an array of structures that stores information about events. Each structure in the array represents one event. Events are recorded in the order in which they occur. The first EventLog structure reflects the first event recorded, the second EventLog structure reflects the second event recorded, and so on.

Each event log structure contains two fields: Type and Data.

The Type field stores a character array that identifies the event type. The Image Acquisition Toolbox software defines many different event types, listed in this table. Note that not all event types are logged.

Event Type	Description	Included in Log
Error	Run-time error occurred. Run-time errors include timeouts and hardware errors.	Yes
Frames Acquired	The number of frames specified in the FramesAcquiredFcnCount property has been acquired.	No
Start	Object was started by calling the start function.	Yes
Stop	Object stopped executing.	Yes
Timer	Timer expired.	No
Trigger	Trigger executed.	Yes

The Data field stores information associated with the specific event. For example, all events return the absolute time the event occurred in the AbsTime field. Other event-specific fields are included in Data. For more information, see “Retrieving Event Information” on page 7-8.

EventLog can store a maximum of 1000 events. If this value is exceeded, then the most recent 1000 events are stored.

EventLog property

Characteristics

Access	Read only
Data type	Structure array
Values	Default is empty structure array.

Examples

Create a video input object.

```
vid = videoinput('winvideo');
```

Start the object.

```
start(vid)
```

View the event log to see which events occurred.

```
eelog = vid.EventLog;
```

```
{eelog.Type}
```

```
ans =  
    'Start'    'Trigger'    'Stop'
```

View the data associated with a trigger event.

```
eelog(2).Data
```

```
ans =
```

```
          AbsTime: [2003 2 11 17 22 18.9740]  
FrameMemoryLimit: 12288000  
FrameMemoryUsed: 0  
FrameNumber: 0  
RelativeFrame: 0  
TriggerIndex: 1
```

See Also

Properties

Logging

FrameGrabInterval property

Purpose

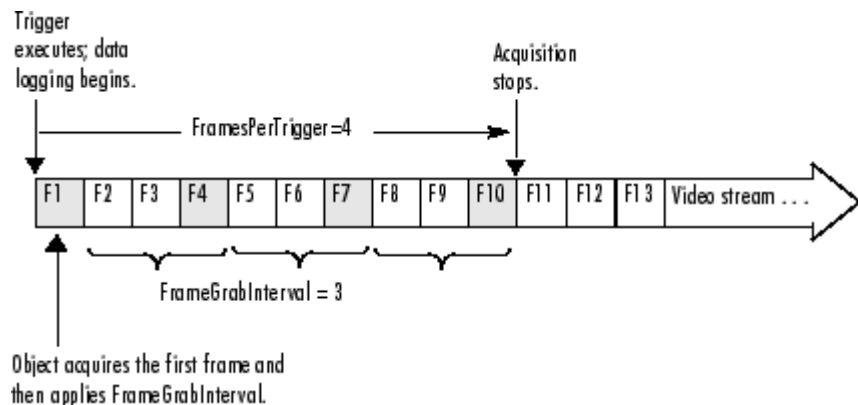
Specify how often to acquire frame from video stream

Description

The `FrameGrabInterval` property specifies how often the video input object acquires a frame from the video stream. By default, objects acquire every frame in the video stream, but you can use this property to specify other acquisition intervals.

Note Do not confuse the frame grab interval with the frame rate. The frame rate describes the rate at which an image acquisition device provides frames, typically measured in seconds, such as 30 frames per second. The frame grab interval is measured in frames, not seconds. If a particular device's frame rate is configurable, the video source object might include the frame rate as a device-specific property.

For example, when you specify a `FrameGrabInterval` value of 3, the object acquires every third frame from the video stream, as illustrated in this figure. The object acquires the first frame before applying the `FrameGrabInterval`.



You specify the source of the video stream in the `SelectedSourceName` property.

FrameGrabInterval property

Characteristics

Access	Read only while running
Data type	double
Values	Any positive integer. The default value is 1 (acquire every frame).

See Also

Functions

videoinput

Properties

SelectedSourceName

FramesAcquired property

Purpose Indicate total number of frames acquired

Description The FramesAcquired property indicates the total number of frames that the object has acquired, regardless of how many frames have been extracted from the memory buffer. The video input object continuously updates the value of the FramesAcquired property as it acquires frames.

Note When you issue a `start` command, the video input object resets the value of the FramesAcquired property to 0 (zero) and flushes the buffer.

To find out how many frames are available in the memory buffer, use the FramesAvailable property.

Characteristics	Access	Read only
	Data type	double
	Values	Any nonnegative integer. The default value is 0 (zero).

See Also

Functions

`start`

Properties

`FramesAvailable`, `FramesAcquiredFcn`, `FramesAcquiredFcnCount`

FramesAcquiredFcn property

Purpose Specify MATLAB file executed when specified number of frames have been acquired

Description The FramesAcquiredFcn specifies the MATLAB file function to execute every time a predefined number of frames have been acquired.

A frames acquired event is generated immediately after the number of frames specified by the FramesAcquiredFcnCount property is acquired from the selected video source. This event executes the MATLAB file specified for FramesAcquiredFcn.

Use the FramesAcquiredFcn callback if you must access each frame that is acquired. If you do not have this requirement, you might want to use the TimerFcn property.

Frames acquired event information is not stored in the EventLog property.

Characteristics

Access	Read/write
Data type	String, function handle, or cell array
Values	The default value is an empty matrix ([]).

See Also

Properties

EventLog, FramesAcquiredFcnCount, TimerFcn

FramesAcquiredFcnCount property

Purpose Specify number of frames that must be acquired before frames acquired event is generated

Description The FramesAcquiredFcnCount property specifies the number of frames to acquire from the selected video source before a frames acquired event is generated.

The object generates a frames acquired event immediately after the number of frames specified by FramesAcquiredFcnCount is acquired from the selected video source.

Characteristics

Access	Read only while running
Data type	double
Values	Any positive integer. The default value is 0 (zero).

See Also

Properties

FramesAcquiredFcn

FramesAvailable property

Purpose Indicate number of frames available in memory buffer

Description The FramesAvailable property indicates the total number of frames that are available in the memory buffer. When you extract data, the object reduces the value of the FramesAvailable property by the appropriate number of frames. You use the `getdata` function to extract data and move it into the MATLAB workspace.

Note When you issue a `start` command, the video input object resets the value of the FramesAvailable property to 0 (zero) and flushes the buffer.

To view the total number of frames that have been acquired since the last `start` command, use the FramesAcquired property.

Characteristics	Access	Read only
	Data type	double
	Values	Any nonnegative integer. The default value is 0 (zero).

See Also

Functions

`getdata`, `start`

Properties

FramesAcquired

FramesPerTrigger property

Purpose Specify number of frames to acquire per trigger using selected video source

Description The FramesPerTrigger property specifies the number of frames the video input object acquires each time it executes a trigger using the selected video source.

When the value of the FramesPerTrigger property is set to `Inf`, the object keeps acquiring frames until an error occurs or you issue a `stop` command.

Note When the FramesPerTrigger property is set to `Inf`, the object ignores the value of the TriggerRepeat property.

Characteristics

Access	Read only while running
Data type	double
Values	Any positive integer. The default value is 10.

See Also

Functions

`stop`

Properties

TriggerRepeat

InitialTriggerTime property

Purpose Record absolute time of first trigger

Description The `InitialTriggerTime` property records the absolute time of the first trigger. The absolute time is recorded as a MATLAB clock vector.

For all trigger types, `InitialTriggerTime` records the time when the `Logging` property is set to 'on'.

To find the time when a subsequent trigger executed, view the `Data.AbsTime` field of the `EventLog` property for the particular trigger.

Characteristics

Access	Read only
Data type	Six-element vector of doubles (MATLAB clock vector)
Values	The default value is <code>[]</code> .

Examples

Create an image acquisition object, `vid`, for a USB-based webcam.

```
vid = videoinput('winvideo',1);
```

Start the object. Because the `TriggerType` property is set to 'immediate' by default, the trigger executes immediately. The object records the time of the initial trigger.

```
start(vid)
```

```
abstime = vid.InitialTriggerTime
```

```
abstime =
```

```
1.0e+003 *
```

```
1.9990    0.0020    0.0190    0.0130    0.0260    0.0208
```

Convert the clock vector into an integer form for display.

```
t = fix(abstime);
```



```
sprintf('%d:%d:%d', t(4),t(5),t(6))
```

```
ans =
```

```
13:26:20
```

See Also

Functions

clock, getdata

Properties

EventLog, Logging, TriggerType

Logging property

Purpose Indicate whether object is currently logging data

Description The Logging property indicates whether the video input object is currently logging data.

When a trigger occurs, the object sets the Logging property to 'on' and logs data to memory, a disk file, or both, depending on the value of the LoggingMode property.

The object sets the Logging property to 'off' when it acquires the requested number of frames, an error occurs, or you issue a stop command.

To acquire data when the object is running but not logging, use the peekdata function. Note, however, that the peekdata function does not guarantee that all the requested image data is returned. To acquire all the data without gaps, you must have the object log the data to memory or to a disk file.

Characteristics Default value is enclosed in braces ({}).

Access	Read only
Data type	String
Values	[{'off'} 'on']

See Also

Functions

getdata, islogging, peekdata, stop, trigger

Properties

LoggingMode, Running

Purpose Specify destination for acquired data

Description The LoggingMode property specifies where you want the video input object to store the acquired data. You can specify any of the following values:

Value	Description
'disk'	Log acquired data to a disk file.
'disk&memory'	Log acquired data to both a disk file and to a memory buffer.
'memory'	Log acquired data to a memory buffer.

If you select 'disk' or 'disk&memory', you must specify the AVI file object used to access the disk file as the value of the DiskLogger property.

Note When logging data to memory, you must extract the acquired data in a timely manner with the `getdata` function to avoid using up all the memory that is available on your system. Use `imaqmem` to specify the amount of memory available for image frames.

Note The `peekdata` function does not return any data while running if in disk logging mode.

Characteristics

Access	Read only while running
Data type	String
Values	['disk' 'disk&memory' {'memory'}]

Default value is enclosed in braces ({}).

LoggingMode property

See Also

Functions

getdata

Properties

DiskLogger, Logging

Purpose Specify name of image acquisition object

Description The Name property specifies a descriptive name for the image acquisition object.

Characteristics	Access	Read/write
	Data type	String
	Values	Any text string. The toolbox creates the default name by combining the values of the VideoFormat and DeviceID properties with the adaptor name in this format: VideoFormat + '-' + adaptor name + '-' + DeviceID

Examples Create an image acquisition object.

```
vid = videoinput('winvideo');
```

Retrieve the value of the Name property using the get function.

```
get(vid, 'Name')
```

```
ans =
```

```
    RGB555_128x96-winvideo-1
```

See Also

Functions

videoinput

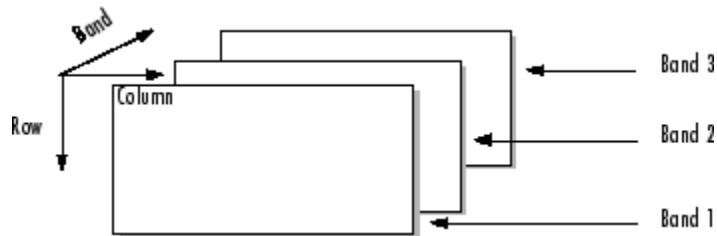
Properties

DeviceID, VideoFormat

NumberOfBands property

Purpose Indicate number of color bands in data to be acquired

Description The NumberOfBands property indicates the number of color bands in the data to be acquired. The toolbox defines *band* as the third dimension in a 3-D array, as shown in this figure.



The value of the NumberOfBands property indicates the number of color bands in the data returned by `getsnapshot`, `getdata`, and `peekdata`.

Characteristics

Access	Read only
Data type	double
Values	Any positive integer. The default value is defined at object creation time based on the video format.

Examples

Create an image acquisition object.

```
vid = videoinput('winvideo');
```

Retrieve the value of the NumberOfBands property using the `get` function.

```
get(vid, 'NumberOfBands')
```

```
ans =
```

```
3
```

If you retrieve the value of the `VideoFormat` property, you can see that the video data is in RGB format.

```
get(vid, 'VideoFormat')
```

```
ans =
```

```
RGB24_320x240
```

See Also

Functions

`getdata`, `getsnapshot`, `peekdata`

Parent property

Purpose Identify video input object that is parent of video source object

Description The Parent property identifies the video input object that is the parent of a video source object.

The parent of a video source object is defined as the video input object owning the video source object.

Characteristics

Access	Read only
Data type	Video input object
Values	Defined at object creation time

See Also

Functions

videoinput

Purpose Indicate whether object is currently previewing data in separate window

Description The Previewing property indicates whether the object is currently previewing data in a separate window.

The object sets the Previewing property to 'on' when you call the preview function.

The object sets the Previewing property to 'off' when you close the preview window using the closepreview function or by clicking the Close button in the preview window title bar.

Characteristics Default value is enclosed in braces ({}).

Access	Read only
Data type	String
Values	[{'off'} 'on']

See Also **Functions**

closepreview, preview

ReturnedColorSpace property

Purpose Specify color space used in MATLAB

Description The ReturnedColorSpace property specifies the color space you want the toolbox to use when it returns image data to the MATLAB workspace. This is only relevant when you are accessing acquired image data with the `getsnapshot`, `getdata`, and `peekdata` functions.

This property can have any of the following values:

Value	Description
'grayscale'	MATLAB grayscale color space.
'rgb'	MATLAB RGB color space.
'YCbCr'	MATLAB YCbCr color space. Note that YCbCr is often imprecisely referred to as YUV. (YUV is similar, but not identical. They differ by the scaling factor applied to the result. YUV refers to a particular scaling factor used in composite NTSC and PAL formats. In most cases, you can specify the YCbCr color space for devices that support YUV.)
'bayer'	Convert grayscale Bayer color patterns to RGB images. The bayer color space option is only available if your camera's default returned color space is grayscale. To use the BayerSensorAlignment property, you must set the ReturnedColorSpace property to bayer.

Note For some adaptors, such as GigE and GenTL, if you use a format that starts with Bayer, e.g. `BayerGB8_640x480`, we automatically convert the raw Bayer pattern to color – the ReturnedColorSpace is RGB. If you set the ReturnedColorSpace to 'grayscale', you'll get the raw pattern.

ReturnedColorSpace property

For an example showing how to determine the default color space and change the color space setting, see “Specifying the Color Space” on page 6-17.

Characteristics

Access	Read/write
Data type	String
Values	Defined at object creation time and depends on the video format selected

See Also

Functions

getdata, getsnapshot, peekdata, videoinput

Properties

BayerSensorAlignment, VideoFormat

How To's

“Specifying the Color Space” on page 6-17

ROIPosition property

Purpose Specify region-of-interest (ROI) window

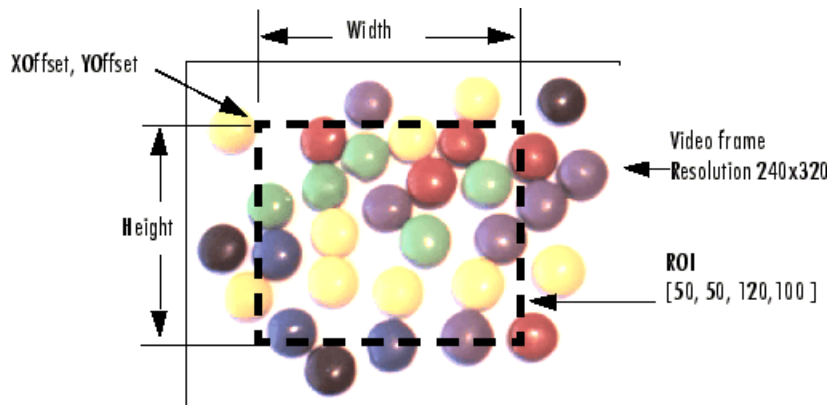
Description The ROIPosition property specifies the region-of-interest acquisition window. The ROI window defines the actual size of the frame logged by the toolbox, measured with respect to the top left corner of an image frame.

ROIPosition is specified as a 1-by-4 element vector

[XOffset YOffset Width Height]

where

XOffset	Position of the upper left corner of the ROI, measured in pixels.
YOffset	Position of the upper left corner of the ROI, measured in rows.
Width	Width of the ROI, measured in pixels. The sum of XOffset and Width cannot exceed the width specified in VideoResolution.
Height	Height of the ROI, measured in rows. The sum of YOffset and Height cannot exceed the height specified in VideoResolution.



Note The Width does not include both end points as well as the width between the pixels. It includes one end point, plus the width between pixels. For example, if you want to capture an ROI of pixels 20 through 30, including both end pixels 20 and 30, set an XOffset of 19 and a Width of 11. The same rule applies to height.

In the figure shown above, the width of the captured ROI contains pixels 51 through 170, including both end points, because the XOffset is set to 50 and the Width is set to 120.

Characteristics

Access	Read only while running
Data type	1-by-4 element vector of doubles
Values	Default is [0 0 width height] where width and height are determined by VideoResolution.

See Also

Properties

VideoResolution

Running property

Purpose Indicate whether video input object is ready to acquire data

Description The Running property indicates if the video input object is ready to acquire data.

Along with the Logging property, Running reflects the state of a video input object. The Running property indicates that the object is ready to acquire data, while the Logging property indicates that the object is acquiring data.

The object sets the Running property to 'on' when you issue the start command. When Running is 'on', you can acquire data from a video source.

The object sets the Running property to 'off' when any of the following conditions is met:

- The specified number of frames has been acquired.
- A run-time error occurs.
- You issue the stop command.

When Running is 'off', you cannot acquire image data. However, you can acquire one image frame with the getsnapshot function.

Characteristics Default value is enclosed in braces ({}).

Access	Read only
Data type	String
Values	[{'off'} 'on']

See Also

Properties

getsnapshot, start, stop

Properties

Logging

Purpose Indicate whether video source object will be used for acquisition

Description The Selected property indicates if the video source object will be used for acquisition. You select a video source object by specifying its name as the value of the video input object's SelectedSourceName property. The video input object Source property is an array of all the video source objects associated with the video input object.

If Selected is 'on', the video source object is selected. If the value is 'off', the video source object is not selected.

A video source is defined to be a collection of one or more physical data sources that are treated as a single entity. For example, hardware supporting multiple RGB sources, each of which is made up of three physical connections (red, green, and blue), is treated as a single video source object.

Characteristics Default value is enclosed in braces ({}).

Access	Read only
Data type	String
Values	[{'off'} 'on']

Examples Create an image acquisition object.

```
vid = videoinput('winvideo');
```

Determine the currently selected video source object.

```
vid.SelectedSourceName
```

```
ans =
```

```
input1
```

Retrieve the currently selected video source object.

Selected property

```
src = getselectedsource(vid);
```

View its Name and Selected properties.

```
src.SourceName
```

```
ans =
```

```
input1
```

```
src.Selected
```

```
ans =
```

```
on
```

See Also

Functions

```
getselectedsource
```

Properties

```
SelectedSourceName
```


SelectedSourceName property

Purpose Specify name of currently selected video source

Description The SelectedSourceName property specifies the name of the video source object from which the video input object acquires data. The name is specified as a string. By default, the video input object selects the first available video source object stored in the Source property.

The toolbox defines a video source as one or more hardware inputs that are treated as a single entity. For example, hardware supporting multiple RGB sources, each of which is made up of three physical connections (red-green-blue), is treated as a single video source object.

Characteristics

Access	Read only while running
Data type	String
Values	The video input object assigns a name to each video source object it creates. Names are defined at object creation time and are vendor specific. By default, the toolbox uses the first available source name.

Examples To see a list of all available sources, create a video input object.

```
vid = videoinput('matrox');
```

Use the set function to view a list of all available video source objects.

```
src_names = set(vid,'SelectedSourceName');
```

See Also

Functions

set

Properties

Source

Source property

Purpose

Indicate video source objects associated with video input object

Description

The Source property is a vector of video source objects that represent the physical data sources connected to a device. When a video input object is created, the toolbox creates a vector of video source objects associated with the video input object.

Each video source object created is provided a unique source name. You can use the source name to select the desired acquisition source by configuring the SelectedSourceName property of the video input object.

A video source object's name is stored in its SourceName property. If a video source object's SourceName is equivalent to the video input object's SelectedSourceName, the video source object's Selected property has a value of 'on'.

The video source object supports a set of common properties, such as SourceName. Each video source object can also support device-specific properties that control characteristics of the physical device such as brightness, hue, and saturation. Different image acquisition devices expose different sets of properties.

A video source is defined to be a collection of one or more physical data sources that are treated as a single entity. For example, hardware supporting multiple RGB sources, each of which is made up of three physical connections (red-green-blue), is treated as a single video source object.

The Source property encapsulates one or more video sources. To reference a video source, you use a numerical integer to index into the vector of video source objects.

Characteristics

Access	Read only
Data type	Vector of video source objects
Values	Defined at object creation time

Examples

Create an image acquisition object.

```
vid = videoinput('matrox');
```

To access all the video source objects associated with a video input object, use the **Source** property of the video input object. (To view only the currently selected video source object, use the `getselectedsource` function.)

```
sources = vid.Source;  
src = sources(1);
```

To view the properties of the video source object `src`, use the `get` function.

```
get(src)  
  General Settings:  
    Parent = [1x1 videoinput]  
    Selected = on  
    SourceName = CH1  
    Tag =  
    Type = videosource  
  
  Device Specific Properties:  
    InputFilter = lowpass  
    UserOutputBit3 = off  
    UserOutputBit4 = off  
    XScaleFactor = 1  
    YScaleFactor = 1
```

See Also

Functions

`videoinput`, `getselectedsource`

Properties

`SelectedSourceName`

SourceName property

Purpose Indicate name of video source object

Description The SourceName property indicates the name of a video source object. SourceName is one of the values in the video input object's SelectedSourceName property.

Characteristics

Access	Read only
Data type	String
Values	Defined at object creation time

See Also

Functions

getselectedsource

Properties

SelectedSourceName, Source

Purpose Specify MATLAB file executed when start event occurs

Description The StartFcn property specifies the MATLAB file function to execute when a start event occurs. A start event occurs immediately after you issue the start command.

The StartFcn callback executes synchronously. The toolbox does not set the object's Running property to 'on' until the callback function finishes executing. If the callback function encounters an error, the object never starts running.

Start event information is stored in the EventLog property.

Characteristics

Access	Read/write
Data type	String, function handle, or cell array
Values	The default value is an empty matrix ([]).

See Also

Properties

EventLog, Running

StopFcn property

Purpose Specify MATLAB file executed when stop event occurs

Description The StopFcn property specifies the MATLAB file function to execute when a stop event occurs. A stop event occurs immediately after you issue the `stop` command.

The StopFcn callback executes synchronously. Under most circumstances, the image acquisition object will be stopped and the Running property will be set to 'off' by the time the MATLAB file completes execution.

Stop event information is stored in the EventLog property.

Characteristics	Access	Read/write
	Data type	String, function handle, or cell array
	Values	The default value is an empty matrix ([]).

See Also **Properties**

EventLog, Running

Purpose Specify descriptive text to associate with image acquisition object

Description The Tag property specifies any descriptive text that you want to associate with an image acquisition object.

The Tag property can be useful when you are constructing programs that would otherwise need to define the image acquisition object as a global variable, or pass the object as an argument between callback routines.

You can use the value of the Tag property to search for particular image acquisition objects when using the `imaqfind` function.

Characteristics

Access	Read/Write
Data type	String
Values	Any text string

See Also

Functions

`imaqfind`

Timeout property

Purpose Specify how long to wait for image data

Description The Timeout property specifies the amount of time (in seconds) that the `getdata` and `getsnapshot` functions wait for data to be returned. The Timeout property is only associated with these blocking functions. If the specified time period expires, the functions return control to the MATLAB command line.

A timeout is one of the conditions for stopping an acquisition. When a timeout occurs, and the object is running, the MATLAB file function specified by `ErrorFcn` is called.

Note The Timeout property is not associated with hardware timeout conditions.

Characteristics	Access	Read only while running
	Data type	double
	Values	Any positive integer. The default value is 10 seconds.

See Also

Functions

`getdata`, `getsnapshot`

Properties

`EventLog`, `ErrorFcn`

Purpose Specify MATLAB file callback function to execute when timer event occurs

Description The TimerFcn property specifies the MATLAB file callback function to execute when a timer event occurs. A timer event occurs when the time period specified by the TimerPeriod property expires.

The toolbox measures time relative to when the object is started with the start function. Timer events stop being generated when the image acquisition object stops running.

Note Some timer events might not be processed if your system is significantly slowed or if the TimerPeriod value you specify is too small.

Characteristics

Access	Read/write
Data type	String, function handle, or cell array
Values	The default value is an empty matrix ([]).

See Also

Functions

start, stop

Properties

TimerPeriod

TimerPeriod property

Purpose Specify number of seconds between timer events

Description The `TimerPeriod` property specifies the amount of time, in seconds, that must pass before a timer event is triggered.

The toolbox measures time relative to when the object is started with the `start` function. Timer events stop being generated when the image acquisition object stops running.

Note Some timer events might not be processed if your system is significantly slowed or if the `TimerPeriod` value you specify is too small.

Characteristics	Access	Read only while running
	Data type	double
	Values	Any positive value. The minimum value is 0.01 seconds. The default value is 1 (second).

See Also **Functions**

start, stop

Properties

EventLog, TimerFcn

Purpose Indicate required condition before trigger event occurs

Description The TriggerCondition property indicates the condition that must be met, via the TriggerSource, before a trigger event occurs. The trigger conditions that you can specify depend on the value of the TriggerType property.

TriggerType Value	Conditions Available
'hardware' (if available for your device)	Device-specific. For example, some Matrox hardware supports conditions such as 'risingEdge' and 'fallingEdge'. Use the triggerinfo function to view a list of valid values to use with your image acquisition hardware.
'immediate'	'none'
'manual'	'none'

You must use the triggerconfig function to set the value of this property.

Characteristics

Access	Read only. Use the triggerconfig function to set the value of this property.
Data type	String
Values	Device specific. Use the triggerinfo function to view a list of valid values to use with your image acquisition hardware.

See Also

Functions

trigger, triggerconfig, triggerinfo

TriggerCondition property

Properties

TriggerSource, TriggerType

Purpose Specify MATLAB file callback function to execute when trigger event occurs

Description The TriggerFcn property specifies the MATLAB file callback function to execute when a trigger event occurs. The toolbox generates a trigger event when a trigger is executed based on the configured TriggerType, and data logging is initiated.

Under most circumstances, the MATLAB file callback function is not guaranteed to complete execution until sometime after the toolbox sets the Logging property to 'on'.

Trigger event information is stored in the EventLog property.

Characteristics	Access	Read/write
	Data type	String, function handle, or cell array
	Values	The default value is an empty matrix ([]).

See Also **Functions**

trigger

Properties

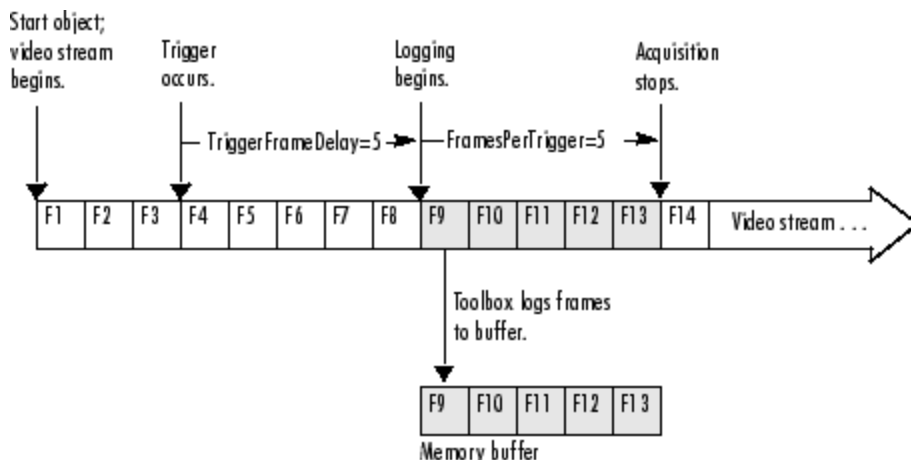
EventLog, Logging

TriggerFrameDelay property

Purpose Specify number of frames to skip before acquiring frames after trigger occurs

Description The TriggerFrameDelay property specifies the number of frames to skip before acquiring frames after a trigger occurs. The object waits the specified number of frames after the trigger before starting to log frames.

In this figure, the TriggerFrameDelay is set to 5, so the object lets five frames pass before starting to acquire frames. The number of frames captured is defined by the FramesPerTrigger property.



Characteristics	Access	Read only while running
	Data type	double
	Values	Any integer. The default value is 0 (zero).

See Also Functions

trigger

Properties

FramesPerTrigger

TriggerRepeat property

Purpose Specify number of additional times to execute trigger

Description The TriggerRepeat property specifies the number of additional times you want the object to execute a trigger. This table describes the behavior for several typical TriggerRepeat values.

Value	Behavior
0 (default)	Execute the trigger once when the trigger condition is met.
Any positive integer	Execute the trigger the specified number of additional times when the trigger condition is met.
Inf	Keep executing the trigger every time the trigger condition is met until the stop function is called or an error occurs.

To determine how many triggers have executed, check the value of the TriggersExecuted property.

Note If the FramesPerTrigger property is set to Inf, the object ignores the value of the TriggerRepeat property.

Characteristics	
Access	Read only while running
Data type	double
Values	Any nonnegative integer. The default value is 0 (zero).

See Also **Functions**

stop, trigger

Properties

FramesPerTrigger, TriggersExecuted, TriggerType

TriggersExecuted property

Purpose Indicate total number of executed triggers

Description The TriggersExecuted property indicates the total number of triggers that the video input object has executed.

Characteristics	Access	Read only
	Data type	double
	Values	Any nonnegative integer. The default value is 0 (zero).

See Also **Functions**

trigger

Properties

EventLog

TriggerSource property

Purpose Indicate hardware source to monitor for trigger conditions

Description The TriggerSource property indicates the hardware source the image acquisition object monitors for trigger conditions. When the condition specified in the TriggerCondition property is met, the object executes the trigger and starts acquiring data.

You use the `triggerconfig` function to specify this value. The value of the TriggerSource property is device specific. You specify whatever mechanism a particular device uses to generate triggers.

For example, for Matrox hardware, the TriggerSource property could have values such as 'Port0' or 'Port1'. Use the `triggerinfo` function to view a list of values that are valid for your image acquisition device.

You must use the `triggerconfig` function to set the value of this property.

Note The TriggerSource property is only used when the TriggerType property is set to 'hardware'.

Characteristics

Access	Read only. Use the <code>triggerconfig</code> function to set the value of this property.
Data type	String
Values	Device-specific. Use the <code>triggerinfo</code> function to get a list of valid values.

See Also

Functions

`trigger`, `triggerconfig`, `triggerinfo`

Properties

`TriggerCondition`, `TriggerType`

Purpose Indicate type of trigger used by video input object

Description The TriggerType property indicates the type of trigger used by the video input object. Triggers initiate data acquisition.

You use the `triggerconfig` function to specify one of the following values for this property.

Trigger Type	Description
'hardware' (if available for your device)	Trigger executes when a specified condition is met. You specify the condition using the <code>TriggerCondition</code> property and you specify the hardware source to monitor for the condition in the <code>TriggerSource</code> property. You use the <code>triggerconfig</code> function to set the values of these properties.
'immediate'	Trigger executes immediately after you call the <code>start</code> function.
'manual'	Trigger executes immediately after you call the <code>trigger</code> function.

Characteristics Default value is enclosed in braces ({}).

Access	Read only. Use the <code>triggerconfig</code> function to set the value of this property.
Data type	String
Values	['hardware' {'immediate'} 'manual'] The 'hardware' option is only included for devices that support hardware triggers.

See Also **Functions**

`trigger`, `triggerconfig`, `triggerinfo`

TriggerType property

Properties

TriggerCondition, TriggerSource

Purpose Identify type of image acquisition object

Description The Type property identifies the type of image acquisition object. An image acquisition object can be either one of two types:

- Video input object
- Video source object

Characteristics

Access	Read only
Data type	String
Values	['videoinput' 'videosource'] Defined at object creation time

Examples

```
vid = videoinput('winvideo',1)
```

```
get(vid,'Type')
```

```
ans =
```

```
videoinput
```

This example gets the type of a video source object.

```
src = getselectedsource(vid);
```

```
get(src,'type')
```

```
ans =
```

```
videosource
```

See Also

Functions

getselectedsource, videoinput

UserData property

Purpose Store data to associate with image acquisition object

Description The UserData property specifies any data that you want to associate with an image acquisition object.

Note The object does not use the data in UserData directly. However, you can access the data by using the `get` function or by referencing the property as you would a field in a MATLAB structure.

Characteristics	Access	Read/Write
	Data type	Any
	Values	User-defined

See Also **Functions**
`get`

Purpose Specify video format or name of device configuration file

Description The VideoFormat property specifies the video format used by the image acquisition device or the name of a device configuration file, depending on which you specified when you created the object using the `videoinput` function.

Image acquisition devices typically support multiple video formats. When you create a video input object, you can specify the video format that you want the device to use. If you do not specify the video format as an argument, the `videoinput` function uses the default format. Use the `imaqhwinfo` function to determine which video formats a particular device supports and find out which format is the default.

As an alternative, you can specify the name of a device configuration file, also known as a camera file or digitizer configuration format (DCF) file. Some image acquisition devices use these files to store device configuration information. The `videoinput` function can use this file to determine the video format and other configuration information.

Use the `imaqhwinfo` function to determine if your device supports device configuration files.

Characteristics

Access	Read only
Data type	String
Values	Device-specific. The example describes how to get a list of all the formats supported by a particular image acquisition device.

Examples

To determine the video formats supported by a device, check the `SupportedFormats` field in the device information structure returned by `imaqhwinfo`.

```
info = imaqhwinfo('winvideo')
```

```
info =
```

VideoFormat property

```
AdaptorDllName: [1x73 char]
AdaptorDllVersion: '2.1 (R2007a)'
AdaptorName: 'winvideo'
DeviceIDs: {[1]}
DeviceInfo: [1x1 struct]
```

```
info.DeviceInfo
```

```
ans =
```

```
DefaultFormat: 'RGB555_128x96'
DeviceFileSupported: 0
DeviceName: 'IBM PC Camera'
DeviceID: 1
VideoInputConstructor: 'videoinput('winvideo', 1)'  
VideoDeviceConstructor: 'imaq.VideoDevice('winvideo', 1)'  
SupportedFormats: {1x34 cell}
```

See Also

Functions

```
imaqhwinfo, videoinput
```


VideoResolution property

Purpose Indicate width and height of incoming video stream

Description The VideoResolution property is a two-element vector indicating the width and height of the frames in the incoming video stream. VideoResolution is specified as

[Width Height]

Width is measured in pixels and height is measured in rows.

Note You specify the video resolution when you create the video input object, by passing in the video format argument to the `videoinput` function. If you do not specify a video format, the `videoinput` function uses the default video format. Use the `imaqhwinfo` function to determine which video formats a particular device supports and find out which format is the default.

Characteristics

Access	Read only
Data type	Vector of doubles
Values	Defined by video format

See Also

Functions

`imaqhwinfo`, `videoinput`

Properties

`ROIPosition`, `VideoFormat`

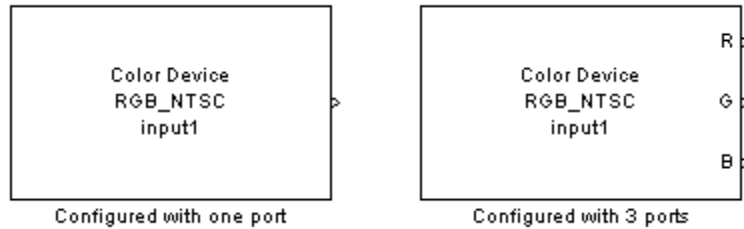
VideoResolution

Block Reference

From Video Device

Purpose Acquire live image data from image acquisition device

Library Image Acquisition Toolbox



Description

The From Video Device block lets you acquire image and video data streams from image acquisition devices, such as cameras and frame grabbers, in order to bring the image data into a Simulink model. The block also lets you configure and preview the acquisition directly from Simulink.

The From Video Device block opens, initializes, configures, and controls an acquisition device. The opening, initializing, and configuring occur once, at the start of the model's execution. During the model's run time, the block buffers image data, delivering one image frame for each simulation time step.

The block has no input ports. You can configure the block to have either one output port, or three output ports corresponding to the uncompressed color bands, such as red, green, and blue, or Y, Cb, Cr. The previous figure shows both configurations.

Other Supported Features

The From Video Device block supports the use of Simulink Accelerator mode. This feature speeds up the execution of Simulink models.

The From Video Device block supports the use of model referencing. This feature lets your model include other Simulink models as modular components.

For more information on these features, see the Simulink documentation.

The From Video Device block supports the use of code generation along with the `packNGo` function to group required source code and dependent shared libraries. See the next section.

Note For an in-depth example of using this block, see “Saving Video Data to a File” on page 8-6.

Code Generation

The From Video Device block supports the use of code generation. You can generate code from the block. This enables models containing the From Video Device block to run successfully in Accelerator, Rapid Accelerator, External, and Deployed modes.

Code Generation with the Simulink Coder

You can use the Image Acquisition Toolbox, Simulink Coder, and Embedded Coder[®] products together to generate code (on the host end) that you can use to implement your model for a practical application. For more information on code generation, see the Simulink Coder documentation.

Note If you are using a GigE Vision camera: you do not need to install GenICam to use the GigE adaptor, because it is now included in the installation of the toolbox. However, if you are using the From Video Device block and doing code generation, you would need to install GenICam to run the generated application outside of MATLAB.

Shared Library Dependencies

The From Video Device block generates code with limited portability. The block uses precompiled shared libraries, such as DLLs, to support I/O for specific types of devices. The Simulink Coder software provides functions to help you set up and manage the build information for your

From Video Device

models. One of the Build Information functions that Simulink Coder provides is `packNGo`. This function allows you to package model code and dependent shared libraries into a zip file for deployment. The target system does not need to have MATLAB installed but it does need to be supported by MATLAB.

The block supports use of the `packNGo` function. Source-specific properties for your device are honored when code is generated. The generated code compiles with both C and C++ compilers.

To set up `packNGo`:

```
set_param(gcs, 'PostCodeGenCommand', 'packNGo(buildInfo)');
```

In this example, `gcs` is the current model that you wish to build. Building the model creates a zip file with the same name as model name. You can move this zip file to another machine and the source code in the zip file can be built to create an executable which can be run independent of MATLAB and Simulink. For more information on `packNGo`, see `packNGo`.

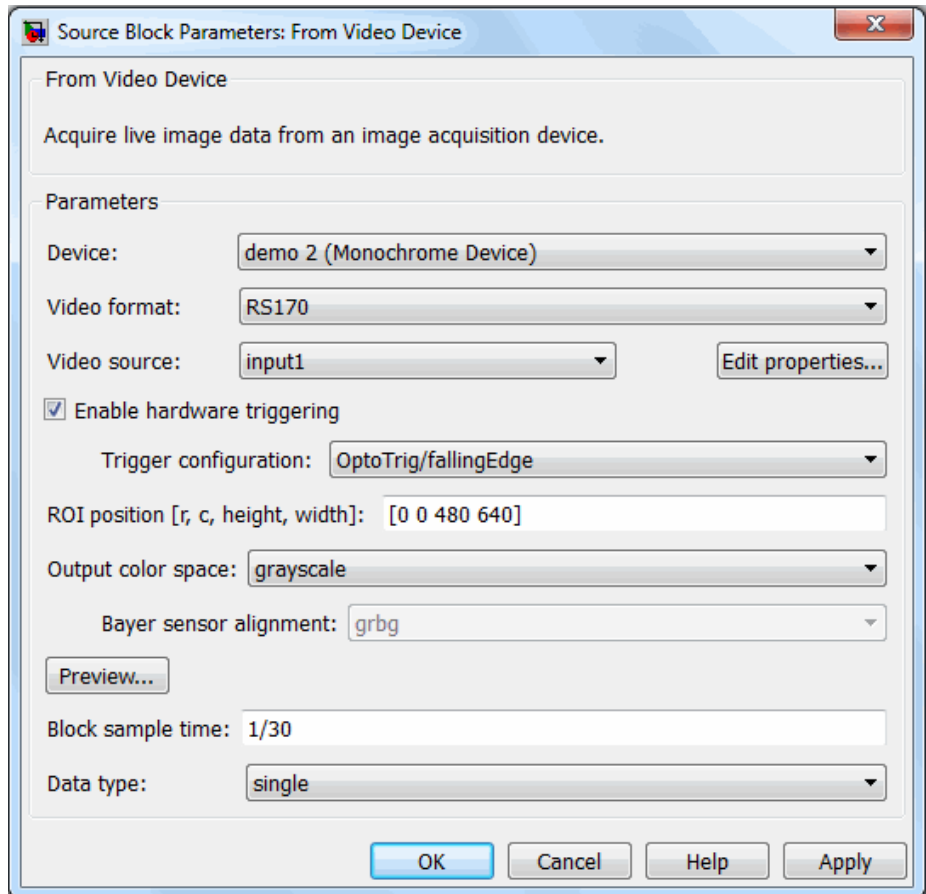
Note The From Video Device block supports the use of Simulink Rapid Accelerator mode and code generation on Windows platforms. Code generation is also supported on Linux, but Rapid Accelerator mode is not.

Note If you get a “Device in use” error message when using the block with certain hardware, such as Matrox, close any programs that are using the hardware, and then try using the block again.

Note On Linux platforms, you need to add the directory where you unzip the libraries to the environment variable `LD_LIBRARY_PATH`.

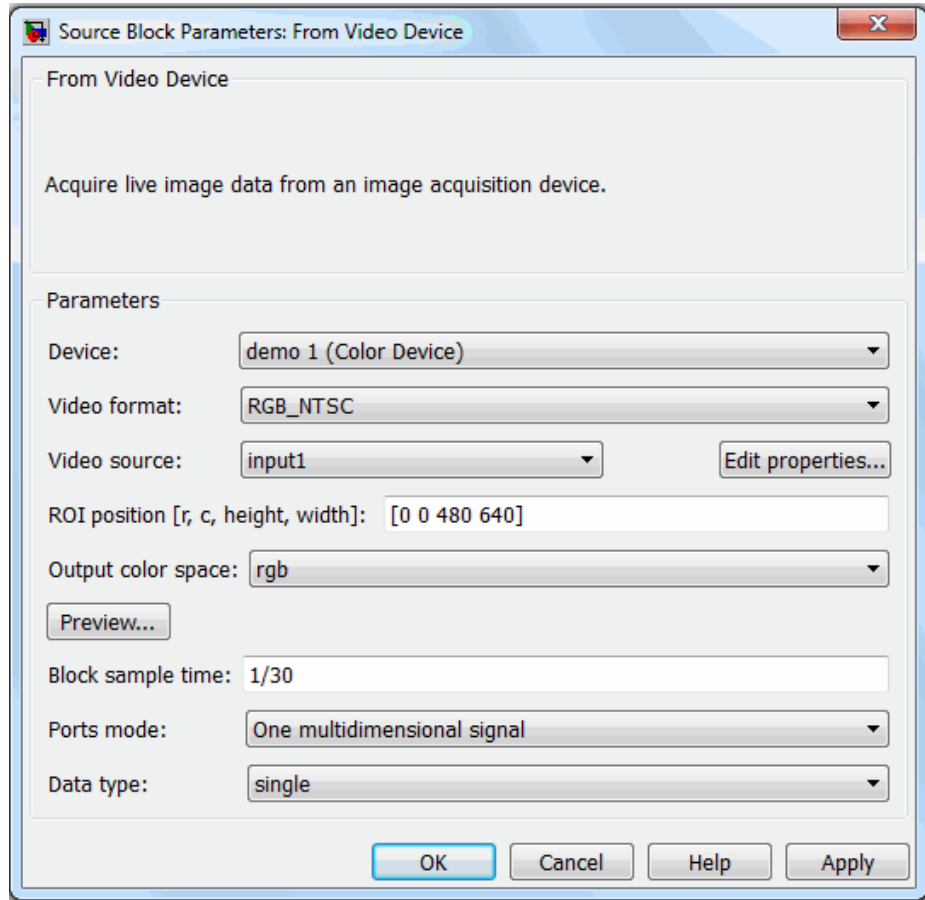
Dialog Box

In the Source Block Parameters dialog box, the options that appear are dependent on the device you are using. The first diagram illustrates the fields that may appear if your device supports hardware triggering and Bayer Sensor Alignment as a color space option.



From Video Device

The second diagram illustrates the options that may appear if your device supports using either one output port or multiple output ports for the color bands (the **Ports mode** option). Ports mode is visible if the selected device and format settings can output color data.



The following fields appear in the Source Block Parameters dialog box. Some fields may not appear, as they are device dependent. If

your selected device does not support a feature, it may not appear in the dialog box.

Device

The image acquisition device to which you want to connect. The items in the list vary, depending on which devices you have connected to your system. All video capture devices supported by the Image Acquisition Toolbox software are supported by the block.

Video format

Shows the video formats supported by the selected device. This list varies with each device. If your device supports the use of camera files, `From camera file` will be one of the choices in the list.

Camera file

This option only appears if you select a device that supports camera files. You can select `From camera file` from the **Video format** field, and enter the path and file name, or use the **Browse** button to locate the file.

Video source

The available input sources for the specified device and format. You can use the **Edit properties** button to edit the source properties. That will open the Property Inspector.

Edit properties button

Edits video source device-specific properties, such as brightness and contrast. It opens the Property Inspector. The properties that are listed vary by device. Properties that can be edited are indicated by a pencil icon or a drop-down list in the table. Properties that are grayed out cannot be edited. When you close the Property Inspector, your edits are saved.

Enable hardware triggering

This option only appears if the selected device supports hardware triggering. Select the check box to enable hardware triggering. Once enabled, you can select the **Trigger configuration**.

Trigger configuration

This option only appears if the selected device supports hardware triggering. Check the **Enable hardware triggering** box to enable it. Once enabled, you can select the **Trigger configuration**. The configuration choices are listed by trigger source/trigger condition. For example, TTL/fallingEdge means that TTL is the trigger source and the falling edge of the signal is the condition that triggers the hardware.

ROI position

Use this field to input a row vector that specifies the region of acquisition in the video image. The format is [row, column, height, width]. The default values for row and column are 0. The default values for height and width are set to the maximum allowable value, indicated by the video format's resolution. Therefore you only need to change the values in this field if you do not want to capture the full image size.

Output color space

Use this field to select the color space for devices that support color. Possible values are `rgb`, `grayscale`, and `YCbCr`. The default value is `rgb`. If your device supports Bayer Sensor Alignment, a fourth value of `bayer` is also available.

Bayer sensor alignment

This field is only visible if your device supports Bayer sensor alignment. You must set the **Output color space** field to `bayer`, then it becomes activated. Use this to set the 2-by-2 sensor alignment. Possible values are `grbg`, `gbrg`, and `rggb`, and `bggr`. The default value is `grbg`.

Preview button

Preview the video image. It opens the Video Preview window that is part of the Image Acquisition Toolbox software. If you change something in the Source Block Parameters dialog box while the preview is running, the image will adjust accordingly. This lets you set up your image acquisition to the way you want it to be acquired by the block when you run the model.

Block sample time

Specify the sample time of the block during the simulation. This is the rate at which the block is executed during simulation. The default is 1/30.

Note The block sample time does not set the frame rate on the device that is used in simulation. Frame rate is determined by the video format specified (standard format or from a camera file). Some devices even list frame rate as a device-specific source property. Frame rate is not related to the **Block sample time** option in the dialog. Block sample time defines the rate at which the block executes during simulation time.

Ports mode

Used to specify either a single output port for all color spaces, or one port for each band (for example, R, G, B). When you select **One multidimensional signal**, the output signal will be combined into one line consisting of signal information for all color signals. Select **Separate color signals** if you want to use three ports corresponding to the uncompressed red, green, and blue color bands. Note that some devices will use YCbCr for the separate color signals.

Note The block acquires data in the default `ReturnedColorSpace` setting for the specified device and format.

Data type

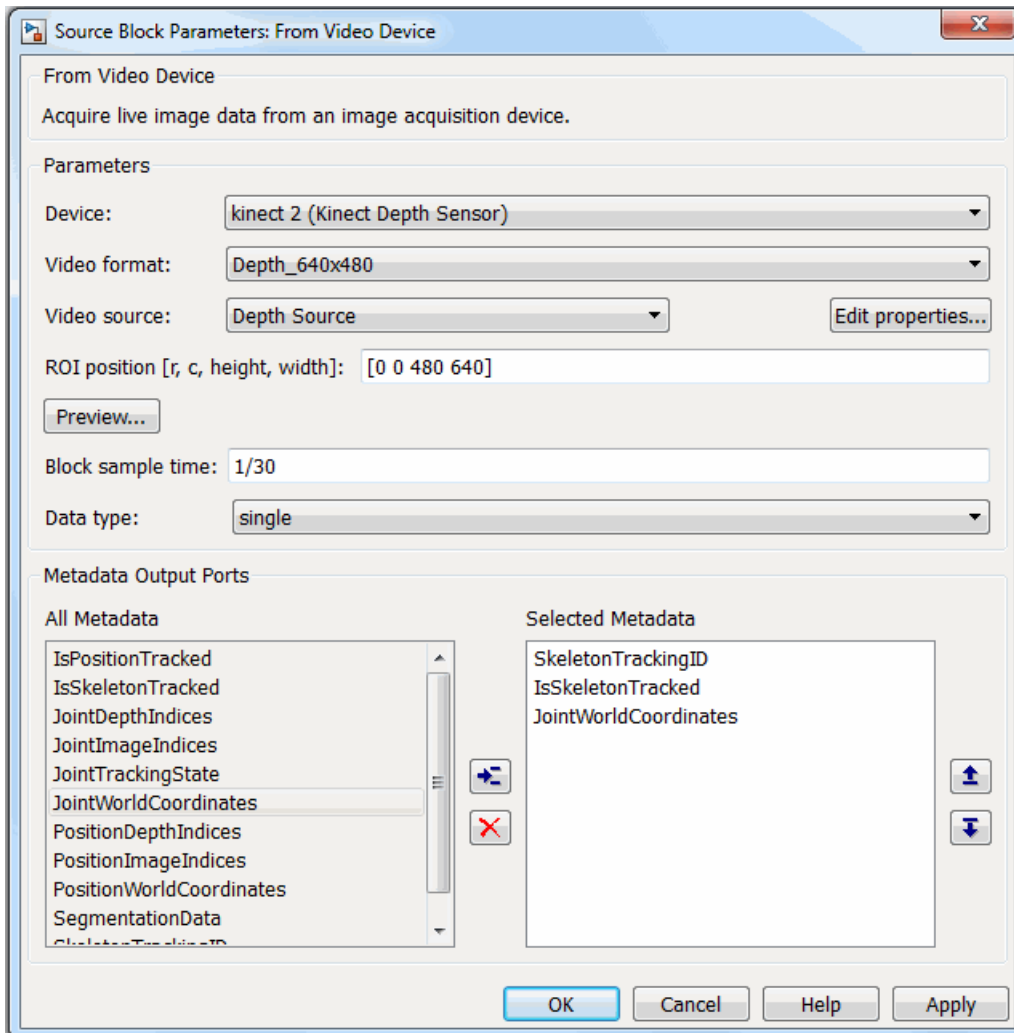
The image data type when the block outputs frames. This data type indicates how image frames are output from the block to Simulink. It supports all MATLAB data types and `single` is the default.

Kinect for Windows Metadata Output Ports

This is used to return skeleton information in Simulink during simulation and code generation. You can output metadata information in normal, accelerator, and deployed simulation modes. Each metadata item in the **Selected Metadata** list becomes an output port on the block.

If you are using a Kinect for Windows camera, and you select the Depth sensor as your **Device** and the Depth Source as your **Video source**, the **Metadata Output Ports** section appears.

The **Metadata Output Ports** section lists the metadata that is associated with the Kinect Depth sensor.

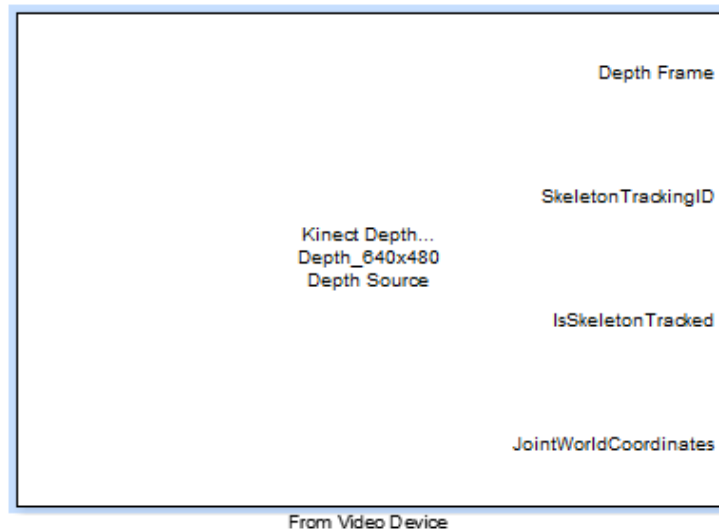


This section is only visible when a Kinect Depth sensor is selected. The **All Metadata** list shows which metadata are available. The **Selected Metadata** list shows which metadata items will be returned to Simulink. This is empty by default. To use one of the metadata, add

From Video Device

it from the **All** to the **Selected** list by selecting it in the **All** list and clicking the **Add** button (blue arrow icon). The **Remove** button (red X icon) removes an item from the **Selected Metadata** list. You can also use the **Move up** and **Move down** buttons to change the order of items in the **Selected** list. The list supports multi-select as well.

You can see in the example above that three metadata items have been put in the **Selected** list. When you click **Apply**, output ports are created on the block for these metadata, as shown here. The first port is the depth frame.



For descriptions and information on these metadata fields and using Kinect for Windows with the Image Acquisition Toolbox, see “Acquiring Image and Skeletal Data Using Kinect” on page 10-10.

Purpose Connect to image acquisition device

Library Image Acquisition Toolbox

Description



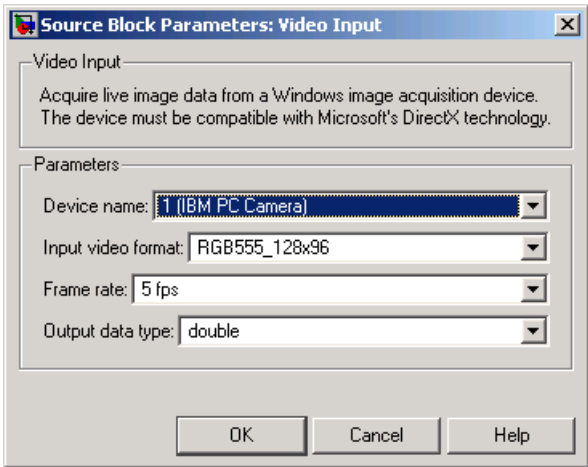
The Video Input block is obsolete. It may be removed in a future version of the Image Acquisition Toolbox block library. Use the replacement block From Video Device.

The Video Input block opens, initializes, configures, and controls an acquisition device. The opening, initializing, and configuration occur once, at the start of the model's execution. During the model's run-time, the block buffers image data, delivering the latest image frame for each simulation time step.

The block has no input ports. The block has three output ports, corresponding to the uncompressed red, green, and blue color bands.

Note The Video Input block supports only Windows video devices compatible with DirectX.

Dialog Box



Video Input (Obsolete)

Device name

The image acquisition device to which you want to connect. The items in the list vary, depending on which devices you have connected to your system.

Input video format

The video formats supported by the device. This list varies with each device.

Frame rate

The speed at which frames are delivered to the block, expressed as frames per second (fps).

Output data type

The image data type used when the block outputs frames. This data type indicates how image frames are stored internally.

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