TECHNICAL NOTE

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# A Video Microscopy System for Teaching and Casework

**REFERENCE:** Rowe, W. F., "**A Video Microscopy System for Teaching and Casework,**" *Journal of Forensic Sciences*, JFSCA, Vol. 36, No. 4, July 1991, pp. 1213–1218.

**ABSTRACT:** This paper discusses an inexpensive video microscopy system built around a high-resolution, solid-state color camera. The system includes a VHS-format videocassette recorder, a color monitor, and a home computer to provide titling and other data input. The entire system is mounted on a small table designed as a personal-computer workstation so that it can be moved to different locations within the laboratory.

**KEYWORDS:** forensic science, video microscopy system, computers

The period since World War II has seen a vast increase in the availability of video equipment. Light, portable video cameras are readily available and are priced within the means of the average citizen. In the past decade, the videocassette recorder (VCR) has become almost as common in American homes as the television set itself.

Closed-circuit television (CCTV), as applied to commerce, education, industry, medicine, science, and the military, became commonplace following the introduction of the vidicon camera tube in 1950. The coupling of the microscope to the vidicon tube followed rapidly on the introduction of this new television imaging technology. Educators immediately recognized the instructional potential of real-time microscope images displayed on a classroom CCTV setup. Video images could also be manipulated to provide enhanced contrast. The vidicon camera tubes also permitted the extension of the spectral range of images into the ultraviolet (UV) and the infrared (IR) [*1*].

The application of video imaging in the forensic sciences has in the past lagged significantly behind applications in other branches of science. Routine video applications are presently limited to video documentation of crime scenes and to the examination of questioned documents with IR-sensitive video cameras [*2*]. More specialized video imaging devices have been developed for reading and classifying ten-finger fingerprint patterns [*3–5*]. The recent introduction of video scanning of deoxyribonucleic acid (DNA) autoradiographs represents an additional application that will probably become routine in the next decade [*6*].

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## Materials and Methods

The initial experiments with video microscopy used already-available equipment. A tripod-mounted RCA CMR200 ProWonder Video Camcorder was oriented vertically, aligned with the optic axis of a research-quality compound microscope (an Ernst Leitz Dialux microscope) from which the binocular head had been removed. Although interesting video images were obtained, this setup was clearly not suitable for serious video microscopy: the ½-in. (1 cm) vidicon tube lacked sufficient resolution; sharply focused video images could not be obtained with all of the microscope objective lenses; vignetting was observed with the lower-power objective lenses; and prolonged operation of the vidicon tube in this orientation would probably damage the vidicon tube.

The RCA Camcorder was replaced with a Panasonic WV-CD110A solid-state color camera, powered by a Panasonic WV-PS10A camera drive unit. The camera is connected to its drive unit by means of a single coaxial cable with baby "N" connectors (BNCs) that simultaneously provides d-c power and vertical drive pulse to the camera and returns the video signal from the camera to the drive unit. The light weight of the camera [400 g (0.9 lb)] permits it to be attached directly to a microscope eyepiece by using a special adaptor. Normal eyepieces were found to produce vignetting because the small exit pupil of the normal microscope eyepiece illuminates only a portion of the camera's entrance pupil; the use of an American Optical ×10 wide-field eyepiece, however, solved this problem. Not only can this latter eyepiece be used on the American Optical UFM-2 forensic microscopes with which it had originally been supplied, but it is also compatible with a number of other microscopes, including Leitz Dialux laboratory microscopes, Leitz HM-POL polarizing microscopes, and Bausch and Lomb StereoZoom microscopes.

Figure 1 shows the video microscopy system that has been built around the Panasonic solid-state color camera. The output of the camera drive unit is connected to the A side of an Archer 75-Ω mini A/B switch. A Timex-Sinclair 2068 personal color computer is connected to the B side of the A/B switch, following a suggestion by Inoue [*1*]. When this arrangement is used, the input to the VCR and video monitor may come from either the video camera or the computer. This provides a straightforward way of including titling information (via the computer) with any recorded video images. Any of the numerous home computers with outputs for video monitors could be substituted for the Timex-Sinclair computer.

The output side of the A/B switch is connected to a Tamron Fotovix Editor. The Fotovix Editor has capabilities for selective masking of the video image and for the insertion of moveable pointers into the video image. The output of the Fotovix Editor is connected to a Toshiba M-5330 VCR (VHS format). Finally, the video images are viewed on a Sharp 20KV555 VI Linytron color television with a 20-in. (51 cm) screen.

The laboratories of the Department of Forensic Sciences at George Washington University have microscopes in a variety of locations. It would not have been convenient to move experiments to the site of the video microscopy equipment; therefore, the video equipment was placed on a mobile cart so that it could be moved from place to place. A metal cart designed to hold a personal-computer workstation proved to be ideal. Figure 2 shows the video equipment on this cart in use in one of the Department's microscope laboratories. Figure 3 demonstrates the resolution of which the video microscopy setup is capable: This figure shows the image produced on the monitor by a sliding toolmark observed with the ×2 objective of an American Optical UFM-2 forensic microscope.

## Advantages

1. An unanticipated advantage of using video microscopy has turned out to be the greater comfort with which the video images can be viewed. Prolonged viewing with this

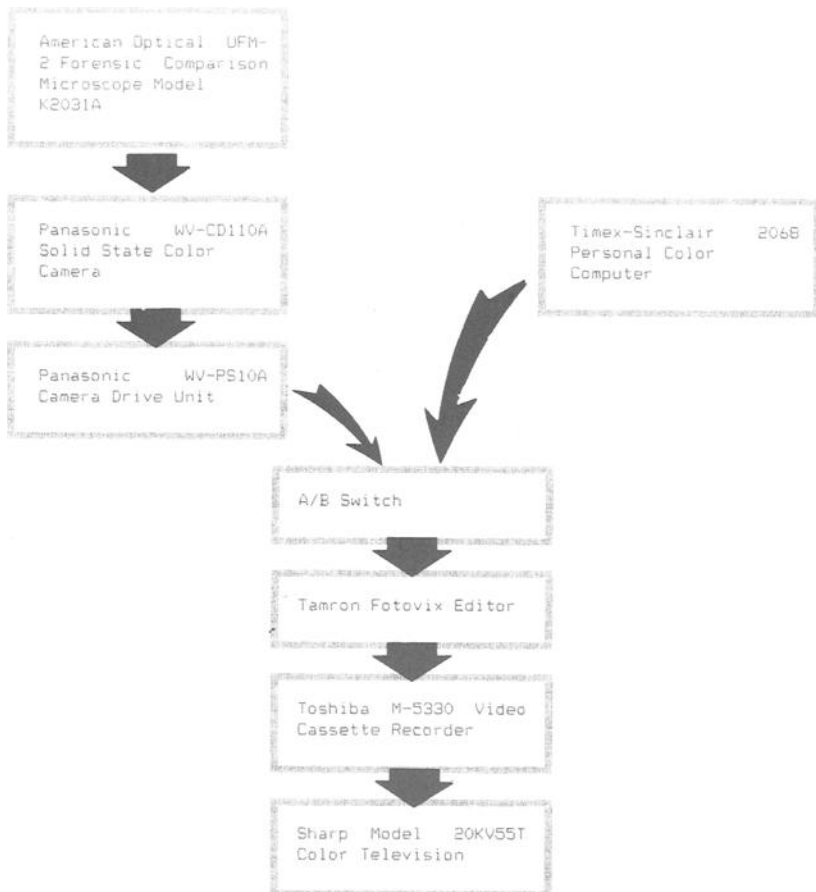


FIG. 1—*Diagram of the Video microscopy system.*

video system does not result in the kind of eyestrain commonly produced by prolonged microscopic observations.

2. Video microscopy facilitates instruction in microscopic technique. Both instructor and students may simultaneously view microscopic images; moveable pointers permit the instructor to highlight significant features. Dynamic phenomena such as changes in birefringence colors upon specimen rotation are easily exhibited.

3. Video images may be recorded for later review. Thus, the observations of a technician may be reviewed by a supervisor at a later date. Other experts may review the technician's work, also. Such video records may be used for teaching purposes. They may also be converted into still photograph formats (slides or prints). Videocassettes can be useful demonstrative evidence at trial. [If such use is contemplated, a date-time generator should be incorporated into the system. Provision should also be made for verification of the fidelity of the color rendition of the system. The fidelity of color rendition of the camera, VCR, and monitor combination can be determined by using any of the variety of color test cards for color photography. Verification of the fidelity of color rendition of the entire video microscopy setup is a more difficult problem. A

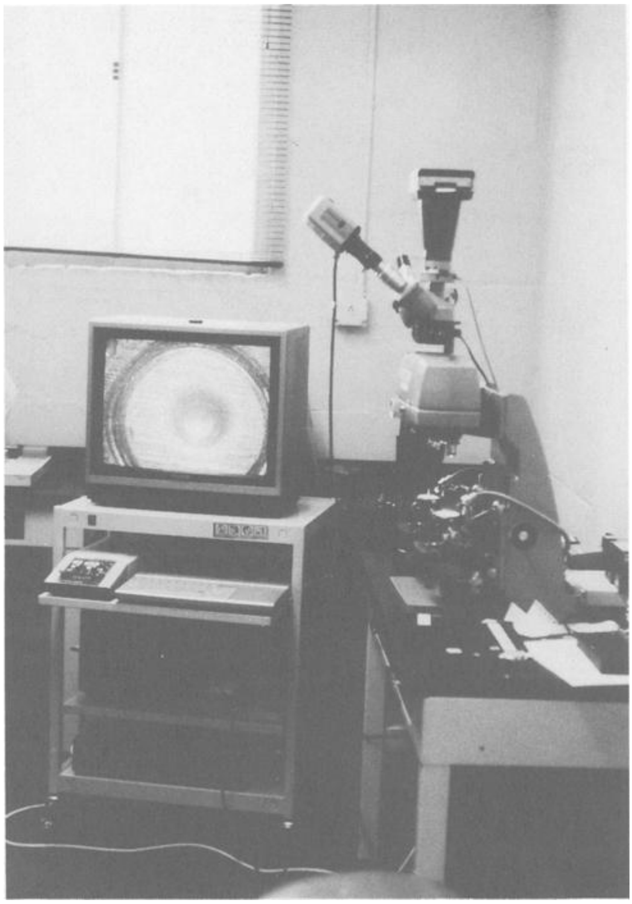

FIG. 2—*Video microscopy system in use.*

relatively simple solution is to observe the interference colors produced by a quartz wedge between crossed polarizing filters and compare them with one of the many printed Michel-Levy color charts available.]

Because the images seen on the monitor are the images recorded by the VCR, the user of this system knows immediately whether he or she has captured the desired image. Moreover, the production of a visual record is effectively instantaneous; no additional processing is required. Many videocassettes now cost less than rolls of 35-mm color print film. A 120-min videocassette can hold many times more visual information than comparably priced film.

4. Video images may be subjected to digital image processing and enhancement. Several manufacturers (such as MetraByte Corporation, Taunton, and Data Translation, Inc., Marlboro, both of Massachusetts) have produced video-frame grabber boards for personal computers such as the IBM PC/XT, PC/AT, PS/2, and compatibles. These companies have also produced software packages for the manipulation of the video images acquired by the frame grabber boards.

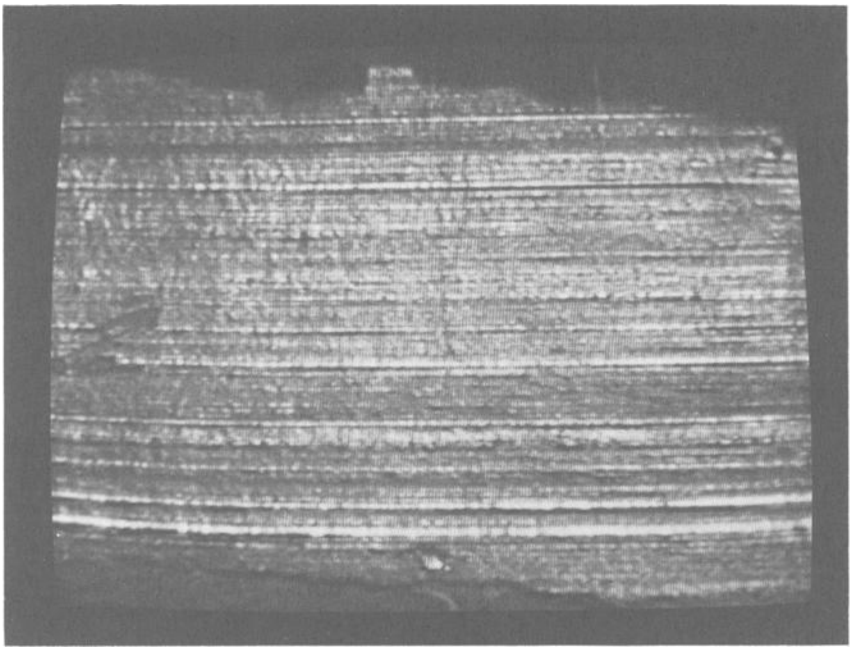

FIG. 3—*Monitor image of a sliding toolmark, observed with the ×2 objective of an American Optical UFM-2 forensic microscope.*

**Disadvantages**

1. The Panasonic solid-state color camera is not very light sensitive: according to the manufacturer's specifications, the minimum required illumination is 1 footcandle (10 lux). This means that certain phenomena that can readily be observed with the human eye cannot be recorded with this camera. As a case in point, optic axis figures and their associated colors proved almost impossible to observe through the camera when a monocular polarizing microscope (Leitz HM-POL) with ×40 objective and Bertrand lens were used; even the addition of immersion oil between the specimen and the objective did not significantly improve the faint video image. Moreover, at low illumination levels, the Panasonic color camera produces essentially black-and-white images.

2. The resolution of present color video cameras is less than that of the light microscopes and of the human eye. Consequently, critical details may not be discernible in a video image.

As solid-state video technology advances, these deficiencies will probably be remedied.

**References**

[1] Inoue, S., *Video Microscopy*, Plenum Press, New York, 1986.
[2] Richards, G. B., "The Application of Electronic Video Techniques to Infrared and Ultraviolet Examinations," *Journal of Forensic Sciences*, Vol. 22, No. 1, Jan. 1977, pp. 53–60.
[3] Buraker, C. D. and Stover, W. K., "The FBI's Approach to Automatic Fingerprint Identification," *FBI Law Enforcement Bulletin*, Vol. 44, No. 1, Jan. 1975, p. 2.

[4] Banner, C. S. and Stock, R. M., "Automated Fingerprint Identification," *FBI Law Enforcement Bulletin*, Vol. 53, No. 8, Aug. 1984, p. 1.
[5] Neudorfer, C. D., "Fingerprint Automation: Progress in the FBI's Identification Division," *FBI Law Enforcement Bulletin*, Vol. 55, No. 3, March 1986, pp. 3–8.
[6] Monson, K. L., "Imaging and DNA Size Markers," International Symposium on the Forensic Aspects of DNA Analysis, FBI Academy, Quantico, VA, 19–23 June 1989.

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