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CASE REPORT

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Identification of an Eccentricity in the Date/Time Metadata of a PAL MiniDV Recording*

ABSTRACT: A Phase-Alternation Line (PAL) Mini Digital Video (MiniDV) recording and camcorder were provided by the Law Society of Singapore for forensic examination. During visual analyses of the submitted recording and a test recording produced on the submitted camcorder, the number of occurrences of each unique date/time stamp varied from the nominal value of 25 frames (the frame rate per second of PAL recordings), within a range of ±3 frames. This embedded date/time information is recorded in the digital bit stream along with the video and audio information and can be optionally displayed during playback. These visual observations prompted detailed analyses of the digital metadata of the recordings which consisted of locating the portions of the bit stream associated with the date/time information, and then identifying their redundancy characteristics, data structure, and encoding protocol. Automated scripts were developed using digital data analysis software to locate, extract, convert, and count all of the unique date/time stamps, and to provide an easily-viewable output of the results. The application of the scripting process to both the submitted tape and the test recording produced on the submitted camcorder revealed that the date/time information on each exhibited a nonstandard but consistent timing pattern, which confirmed the visual observations and provided evidence that the submitted recording was consistent with having been produced on the submitted camcorder.

KEYWORDS: forensic science, forensic video, forensic audio, MiniDV, recording, recorder, comparison, metadata

BEK TEK LLC was retained by the Law Society of Singapore in an administrative matter in which a surreptitious video/audio recording was being challenged by the accused/respondent. Specifically, assertions were made that the "recording…was edited to remove evidence which would exonerate the Respondent" and that certain audible phrases attributed to her had been fabricated (1). The alleged original recording and a Samsung (Suwon, South Korea) model number VP-D21i camcorder (with associated cables and connectors) were submitted to the authors for a detailed video authenticity analysis. In this matter, the Law Society specifically requested that BEK TEK LLC determine if any alterations had been made to the video and/or audio information of the submitted recording and to determine if the submitted recording was consistent with having been produced on the provided Samsung camcorder. This paper discusses analyses conducted to address the latter request.

Both the alleged original recording and the Samsung camcorder were in the Mini Digital Video (MiniDV) format, and both utilized the Phase-Alternation Line (PAL) video standard. MiniDV is a high-quality, digital tape-based format that is widely used in consumer camcorders, due in part to its relatively small cassette size (66 mm wide by 48 mm deep by 12.2 mm high). The video information is recorded at a data rate of 25 million bits per second onto 6.35 mm-wide tape through the use of record heads rotating at *c.* 9000 revolutions per min on a tilted drum, around which the tape is wrapped. This helical scan configuration produces 10 μm-wide tracks which are at a shallow angle to the edge of the tape (2).

The PAL video standard is employed in the U.K., Brazil, and many other countries, including Singapore, and it operates at a video frame rate of 25 frames per second, with each frame consisting of 625 video lines. In comparison, the National Television System (or Standards) Committee (NTSC) standard, utilized in countries, such as the U.S.A., Canada, Korea, and Japan, functions at a video frame rate of 29.97 frames per second, with each frame consisting of 525 video lines (3).

The recording date/time information of the submitted MiniDV recording, which is embedded in the digital data stream, was displayed during playback. A frame-by-frame visual review was then conducted of the alleged original recording, which found that the number of frames exhibiting unique date/time information was not constant. Based on the PAL video frame rate, each unique second of date/time information is expected to be visually present exactly 25 times consecutively in the recorded information. However, the numbers of occurrences of the date/time information for the submitted recording were observed at values above and below the nominal value of 25, and in a generally alternating manner from second to second. The approximate range of values was ±3 frames, and the most common numbers of occurrence were 22, 27, and 28 frames, appearing in an alternating fashion with occasional deviations (e.g., 22, 27, 22, 28, 22, 27, 28, 22, and so on).

This observed, eccentric date/time pattern had no effect on the standard playback of the video and audio data of the recording. However, before continuing on with additional analyses of the submitted tape, the BEK TEK LLC examiners sought to confirm that the eccentricity of the date/time information was present in the digital data stream itself and was not an artifact of the tape playback.

Methods

In an effort to corroborate that the observed eccentricity was in the embedded recording date/time information of the submitted MiniDV recording, research was conducted to determine the following:

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1 The location of the date/time information in the data stream.
2 The redundancy of the information.
3 The data structure of the information.
4 The encoding protocol.

MiniDV recordings are comprised of digital audio, video, and pack header (metadata) information, which adhere to the consumer DV specification set forth in the IEC 61834 standard (4). Each of the 25 frames per second in the PAL video standard consist of multiple recorded data tracks on the MiniDV tape. These data tracks are made up of sectors of information, including the insert and track information sector, the audio sector, the video sector, and the subcode sector. For PAL video recordings, there are 12 recorded data tracks per video frame; for NTSC recordings, there are 10 recorded data tracks per video frame. Figure 1 illustrates the layout and general structure of the data tracks for one video frame of both PAL and NTSC MiniDV recordings (2,4,5).

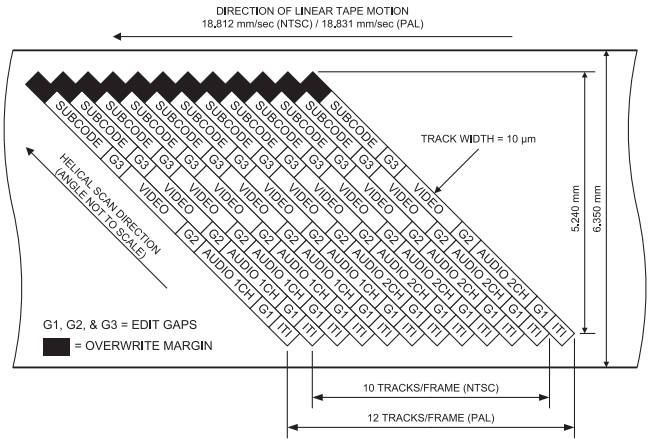

FIG. 1—*Layout and general structure of the recorded tracks for one video frame of a MiniDV recording, in both the PAL and NTSC standards (2,4,5).*

The recorded date/time information is contained within the video sector of MiniDV recordings, specifically within the video auxiliary (VAUX) group. The VAUX group is subdivided into "packs" of 40 binary digits or bits (each with a value of 0 or 1), with each pack equivalent to five bytes of information (one byte is comprised of eight bits). Each of the five-byte packs corresponds to a different aspect of metadata information related to the recording, and their contents and structure are set forth in IEC 61834–4 (6).

Packs 62 and 63 correspond to the date and time, respectively, that the video data was recorded, as taken from the internal clock of the camcorder or video cassette recorder (VCR). Pack 62 (the recording date) includes the following information, as illustrated in Table 1:

1 Header byte identifying it as pack 62.
2 Daylight saving time status.
3 Thirty-min unit of the time differential from Greenwich Mean Time (GMT).
4 Time zone differential from GMT (in positive number of hours).
5 Day of the month (number).
6 Day of the week (Sunday, Monday, and so on).
7 Month.
8 Year.

Byte 1 consists entirely of the header information, which is always 0b01100010 (with the binary or base 2 notation signified by a "0b" prefix) or 0x62 (with the hexadecimal or base 16 notation signified by a "0x" prefix). Table 2 lists the binary and hexadecimal representations for the decimal values 0 through 15. Byte 2 contains

TABLE 1—*Pack 62 (recording date) information, with the data reflected in a most significant bit (MSB) to least significant bit (LSB) format (6).*

Byte	Data Segments							
	MSB							LSB
1	0	1	1	0	0	0	1	0
2	DS	TM	Tens of time zone		Units of time zone			
3	1	1	Tens of day		Units of day			
4	Day of the week			Tens of month	Units of month			
5	Tens of year				Units of year			

Daylight saving time (DS):
0b0 = Daylight saving time
0b1 = Normal

Thirty minutes flag (TM):
0b0 = 30-minute differential from GMT
0b1 = 0-minute differential from GMT

Time zone (differential from GMT, in positive number of hours; decimal notation in parentheses):
0b00|0000 (00) through 0b00|1001 (09)
0b01|0000 (10) through 0b01|1001 (19)
0b10|0000 (20) through 0b10|0011 (23)
0b11|1111 = No information

Day:
0b00|0001 (01) through 0b00|1001 (09)
0b01|0000 (10) through 0b01|1001 (19)
0b10|0000 (20) through 0b10|1001 (29)
0b11|0000 (30) through 0b11|0001 (31)
0b11|1111 = No information

Day of the week:
0b000 (Sunday) through 0b110 (Saturday)
0b111 = No information

Month:
0b0|0001 (January) through 0b0|1001 (September)
0b1|0000 (October) through 0b1|0010 (December)
0b1|1111 = No information

Year:
0b0000|0000 (00) through 0b0000|1001 (09)
0b0001|0000 (10) through 0b0001|1001 (19)
0b0010|0000 (20) through 0b0010|1001 (29)
0b0011|0000 (30) through 0b0011|1001 (39)
0b0100|0000 (40) through 0b0100|1001 (49)
0b0101|0000 (50) through 0b0101|1001 (59)
0b0110|0000 (60) through 0b0110|1001 (69)
0b0111|0000 (70) through 0b0111|1001 (79)
0b1000|0000 (80) through 0b1000|1001 (89)
0b1001|0000 (90) through 0b1001|1001 (99)
0b1111|1111 = No information

TABLE 2—*Binary and hexadecimal representations for decimal values 0–15.*

Decimal	Binary	Hexadecimal
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

one bit each for the daylight saving time status and the 30-min flag, followed by the 10s (two bits) and units (four bits) of time zone differential in a positive number of hours. The first two bits of byte 3 are always 0b11, followed by the 10s (two bits) and units (four bits) of the day of the month. Byte 4 consists of a three-bit value corresponding to the day of the week and the 10s (one bit) and units (four bits) of the month. Lastly, the 10s and units of the year, each as four-bit values, are contained in byte 5. Table 3 presents an example of pack 62 for a recording produced on Thursday, October 16, 2008, in Orlando, Florida (Eastern time zone [+19 h-differential from GMT], daylight saving time observed) (6).

Pack 63 (the recording time) includes the following information, as illustrated in Table 4:

1 Header byte identifying it as pack 63.
2 Frame number of the current video frame.
3 Seconds value of the current video frame.
4 Minutes value of the current video frame.
5 Hours value of the current video frame.

Byte 1 consists entirely of the header information, which is always 0b01100011 (0x63). The first two bits of bytes 2 and 5, and the first bits of bytes 3 and 4 are all 0b1, unless pack 64 (Binary Group) is utilized for storing information regarding a professional time code format. Bits three through eight of byte 2 are the 10s (two bits) and units (four bits) of the frame number. Bits two through eight of byte 3 are the 10s (three bits) and units (four bits) of the seconds value. Bits two through eight of byte 4 are the 10s (three bits) and units (four bits) of the minutes value. Lastly, bits three through eight of byte 5 are the 10s (two bits) and units (four bits) of the hours value. Table 5 presents an example of pack 63 for the 17th frame captured at 2:21:44 PM for a PAL recording, with pack 64 not utilized (6). The two examples shown in Tables 3 and 5, when combined into one date/time stamp, would be represented as the following ten-byte sequence: 0x6259D6900863D7C4A1D4.

With each VAUX group containing one instance of the embedded recording date/time information, and with each of the 12 data tracks per PAL video frame containing one VAUX group, it follows that there are 12 occurrences of the recording date/time information per video frame. Therefore, the expected number of occurrences per unique second of information in a PAL MiniDV data stream is 300 (25 frames/sec × 12 occurrences/frame).

To access and analyze the digital data contained on the submitted MiniDV tape, the recording was played back on a laboratory PAL MiniDV VCR and digitally transferred into a nonlinear video editing system, via the IEEE1394 input/output. The transfer was saved as a DV-encoded Audio Video Interleave (DV-AVI) file, which stored the video/audio information in the DV standard and retained the pack header information (7).

Based on the location and encoding protocol of the recording date/time information, a set of process instructions, known as scripts, was developed using digital data analysis software to automatically locate, extract, convert, and count all of the unique date/time stamps in the DV-AVI file of the submitted recording. The first script was designed to locate each of the date/time stamps based on a search for the six-byte sequence of 0x62, four bytes having any value (referred to as wild cards), and lastly 0x63. This sequence corresponded to the expected byte sequence for the locations of packs 62 and 63. Once the sequence was found in the DV-AVI file, the offset (in bytes) between the beginning of the file and the location of the date/time stamp, and the 10-byte date/time stamp sequence (starting with 0x62) were written out to a data file. The process was then repeated, with each of the subsequent offsets

TABLE 3—*Pack 62 (recording date) information for Thursday, October 16, 2008, in Orlando, Florida (Eastern time zone [+19 h differential from GMT], daylight saving time observed), with the data reflected in a most significant bit (MSB) to least significant bit (LSB) format (6).*

Byte	Data Segments							
	MSB							LSB
1	0	1	1	0	0	0	1	0
2	0	1	0	1	1	0	0	1
3	1	1	0	1	0	1	1	0
4	1	0	0	1	0	0	0	0
5	0	0	0	0	1	0	0	0

Daylight saving time:
0b0 = Daylight saving time

Thirty minutes flag:
0b1 = 0-minute differential from GMT

Time zone:
0b01|1001 (19)

Day:
0b01|0110 (16)

Day of the week:
0b100 (Thursday)

Month:
0b1|0000 (October)

Year:
0b0000|1000 (08)

TABLE 4—*Pack 63 (recording time) information, with pack 64 not utilized and with the data reflected in a most significant bit (MSB) to least significant bit (LSB) format (6).*

Byte	Data Segments							
	MSB							LSB
1	0	1	1	0	0	0	1	1
2	1	1	Tens of frames		Units of frames			
3	1	Tens of seconds			Units of seconds			
4	1	Tens of minutes			Units of minutes			
5	1	1	Tens of hours		Units of hours			

Frames (NTSC):
0b00|0000 (00) through 0b00|1001 (09)
0b01|0000 (10) through 0b01|1001 (19)
0b10|0000 (20) through 0b10|1001 (29)
0b11|1111 = Frames are not used

Frames (PAL):
0b00|0000 (00) through 0b00|1001 (09)
0b01|0000 (10) through 0b01|1001 (19)
0b10|0000 (20) through 0b10|0100 (24)
0b11|1111 = Frames are not used

Seconds:
0b000|0000 (00) through 0b000|1001 (09)
0b001|0000 (10) through 0b001|1001 (19)
0b010|0000 (20) through 0b010|1001 (29)
0b011|0000 (30) through 0b011|1001 (39)
0b100|0000 (40) through 0b100|1001 (49)
0b101|0000 (50) through 0b101|1001 (59)

Minutes:
0b000|0000 (00) through 0b000|1001 (09)
0b001|0000 (10) through 0b001|1001 (19)
0b010|0000 (20) through 0b010|1001 (29)
0b011|0000 (30) through 0b011|1001 (39)
0b100|0000 (40) through 0b100|1001 (49)
0b101|0000 (50) through 0b101|1001 (59)

Hours:
0b00|0000 (00) through 0b00|1001 (09)
0b01|0000 (10) through 0b01|1001 (19)
0b10|0000 (20) through 0b10|0011 (23)

TABLE 5—*Pack 63 (recording time) information for 2:21:44* PM and 17 frames (PAL recording), with pack 64 not utilized and with the data reflected in a most significant bit (MSB) to least significant bit (LSB) format *(6).*

Byte	Data Segments							
	MSB							LSB
1	0	1	1	0	0	0	1	1
2	1	1	0	1	0	1	1	1
3	1	1	0	0	0	1	0	0
4	1	0	1	0	0	0	0	1
5	1	1	0	1	0	1	0	0

Frames (PAL):
0b01|0111 (17)

Seconds:
0b100|0100 (44)

Minutes:
0b010|0001 (21)

Hours:
0b01|0100 (14)

and date/time stamps appended to the same data file, until no additional matches were found in the DV-AVI file.

The data file containing the offsets and date/time stamps was then processed by the second script, which first read the offset and the hexadecimal representation of the date/time stamp for the first entry and wrote these values to a text file. The date and time were then converted to their corresponding decimal values and appended to the data in the text file (8,9). The second entry of the data file was then read and, if found to be identical to the first, an integer variable representing the number of consecutive occurrences of a particular date/time stamp was incremented by one. If the first and second entries were not identical, then the current value of the integer variable and its equivalence in number of video frames (number of consecutive occurrences ÷ 12) were written to the text file. The subsequent entries of the data file were then read and processed accordingly, until the script was completed for all of the entries in the data file.

The two scripts were applied to the DV-AVI file created from the submitted MiniDV recording, a DV-AVI file created from a test recording that was produced on the submitted Samsung camcorder, and a DV-AVI file created from a test recording that was produced on the laboratory PAL MiniDV playback unit. The results of the scripting process for the submitted MiniDV recording were reviewed, and numerous false positive results were located during the search process of the first script. These false matches were easily identifiable in the output text file from their date and/or time values that were out of context (e.g., >59 min or sec, >31 days, and so on). Table 6 shows the results of the original scripting process for a 10-sec portion of the submitted recording. The use of the wild cards between 0x62 and 0x63 in the search criteria of the first script was identified as the cause of the additional, unrelated matches.

To correct for this problem, the first script was modified by additionally specifying the second byte (daylight saving time, 30 min flag, and time zone) of pack 62 for the search criteria. This

TABLE 6—*Ten-sec portion of the submitted recording as processed by the original scripting process, showing the number of occurrences (#Occ) and the corresponding number of frames (#Frames).*

Offset (# bytes)	Date/Time (0x)	Date (mm/dd/yy)	Time (h:min:sec)	#Occ	#Frames
17768854	62FFD5E30463FFC896D5	03/15/04	15:16:48	170	14 2/12
19876924	**62780DB00F63FFE1C22D**	**10/13/15**	**33:42:61**	**1**	**0 1/12**
19880758	62FFD5E30463FFC896D5	03/15/04	15:16:48	119	9 11/12
21358684	**626F07B5FC63FFE7F09B**	**15/07/162**	**21:70:67**	**1**	**0 1/12**
21359913	62FFD5E30463FFC896D5	03/15/04	15:16:48	47	3 11/12
21944662	62FFD5E30463FFC996D5	03/15/04	15:16:49	264	22
25225654	62FFD5E30463FFD096D5	03/15/04	15:16:50	279	23 3/12
28681538	**62D06E332663FFD0F058**	**13/34/26**	**18:70:50**	**1**	**0 1/12**
28691577	62FFD5E30463FFD096D5	03/15/04	15:16:50	45	3 9/12
29252326	62FFD5E30463FFD196D5	03/15/04	15:16:51	264	22
32533318	62FFD5E30463FFD296D5	03/15/04	15:16:52	70	5 10/12
33387484	**621E030C1963FFEC58DB**	**12/03/19**	**21:58:72**	**1**	**0 1/12**
33398998	62FFD5E30463FFD296D5	03/15/04	15:16:52	266	22 2/12
36709126	62FFD5E30463FFD396D5	03/15/04	15:16:53	264	22
39990118	62FFD5E30463FFD496D5	03/15/04	15:16:54	324	27
44016790	62FFD5E30463FFD596D5	03/15/04	15:16:55	264	22
47297782	62FFD5E30463FFD696D5	03/15/04	15:16:56	148	12 4/12
49126460	**6257A383C563FFA05BE7**	**03/23/125**	**27:61:20**	**1**	**0 1/12**
49135414	62FFD5E30463FFD696D5	03/15/04	15:16:56	188	15 8/12
51473590	62FFD5E30463FFD796D5	03/15/04	15:16:57	324	27

The false positive matches located by the process are indicated in bold text.

TABLE 7—*Ten-sec portion of the submitted recording as processed by the modified scripting process, showing the number of occurrences (#Occ) and the corresponding number of frames (#Frames).*

Offset (# bytes)	Date/Time (0x)	Date (mm/dd/yy)	Time (h:min:sec)	#Occ	#Frames
17768854	62FFD5E30463FFC896D5	03/15/04	15:16:48	336	28
21944662	62FFD5E30463FFC996D5	03/15/04	15:16:49	264	22
25225654	62FFD5E30463FFD096D5	03/15/04	15:16:50	324	27
29252326	62FFD5E30463FFD196D5	03/15/04	15:16:51	264	22
32533318	62FFD5E30463FFD296D5	03/15/04	15:16:52	336	28
36709126	62FFD5E30463FFD396D5	03/15/04	15:16:53	264	22
39990118	62FFD5E30463FFD496D5	03/15/04	15:16:54	324	27
44016790	62FFD5E30463FFD596D5	03/15/04	15:16:55	264	22
47297782	62FFD5E30463FFD696D5	03/15/04	15:16:56	336	28
51473590	62FFD5E30463FFD796D5	03/15/04	15:16:57	324	27

The unrelated matches identified in the original scripting process (see Table 6) are no longer present.

byte of information is not expected to change within a continuous recording and provided for a more targeted search. The only drawback to this modified script is that the contents of the second byte of pack 62 in a particular recording must be determined prior to modification of the first script. For the submitted recording, the time zone information was not utilized, daylight saving time was not indicated (“Normal”), and there was a zero-min differential from GMT; these settings resulted in the second byte of pack 62 having a value of 0xFF. Accordingly, the search criteria were modified to locate the sequence 0x62FF, three wild card bytes, and lastly 0x63. Table 7 shows the results of the modified scripting process for the same 10-sec portion of the submitted recording as shown in Table 6; the false positive results located by the original first script were no longer present in the modified version.

Since frame numbers were not used in the submitted recording, further narrowing of the search criteria could have been performed by specifying the byte containing the frame number (byte 2) in pack 63 as 0xFF (see Table 4). In this case, however, it was not necessary since the modified script above was sufficient for the removal of the false positive matches.

Results and Discussion

Following the modification of the first script, the results of the frame-by-frame visual analysis of the submitted recording were compared with the results of the modified scripting process. Table 8 presents the results of the modified scripting process for a 30-sec portion of the submitted recording. The observed “above and below nominal” behavior in the number of date/time stamp occurrences from second-to-second was also present in the output of the scripting process; therefore, the results of the scripting process were consistent with the visual observations. For the length of the recording (1715 sec, excluding the partial seconds at the beginning and end), the total number of date/time stamp occurrences was 514,435, which equated to an average of 300.0 occurrences per second with a standard deviation of 33.2. The number of occurrences for two out of the 1715 unique date/time stamps was not divisible by 12 and resulted in a fractional number of frames. No unique date/time stamps were missing within the recording and none were out of sequence.

Table 9 presents the results of the modified scripting process for a 30-sec portion of the test recording produced on the laboratory PAL MiniDV playback unit. For a portion of the test recording, matching the length of the submitted recording above (1715 sec), the total number of date/time stamp occurrences was 514,499, which equated to an average of 300.0 occurrences per second with a standard deviation of 0.0. The number of occurrences for one out of the 1715 unique date/time stamps was not divisible by 12 and resulted in a fractional number of frames. No unique date/time stamps were missing within the recording and none were out of

TABLE 8—*Results of the scripting process for a 30-sec portion of the submitted PAL MiniDV recording, showing the number of occurrences (#Occ) and the corresponding number of frames (#Frames).*

Date (mm/dd/yy)	Time (h:min:sec)	#Occ	#Frames
03/15/04	15:15:45	264	22
03/15/04	15:15:46	336	28
03/15/04	15:15:47	264	22
03/15/04	15:15:48	324	27
03/15/04	15:15:49	336	28
03/15/04	15:15:50	264	22
03/15/04	15:15:51	324	27
03/15/04	15:15:52	264	22
03/15/04	15:15:53	336	28
03/15/04	15:15:54	264	22
03/15/04	15:15:55	324	27
03/15/04	15:15:56	264	22
03/15/04	15:15:57	336	28
03/15/04	15:15:58	264	22
03/15/04	15:15:59	324	27
03/15/04	15:16:00	336	28
03/15/04	15:16:01	264	22
03/15/04	15:16:02	324	27
03/15/04	15:16:03	264	22
03/15/04	15:16:04	336	28
03/15/04	15:16:05	264	22
03/15/04	15:16:06	324	27
03/15/04	15:16:07	264	22
03/15/04	15:16:08	336	28
03/15/04	15:16:09	264	22
03/15/04	15:16:10	324	27
03/15/04	15:16:11	336	28
03/15/04	15:16:12	264	22
03/15/04	15:16:13	324	27
03/15/04	15:16:14	264	22

TABLE 9—*Results of the scripting process for a 30-sec portion of a test recording produced on the laboratory PAL MiniDV playback unit, showing the number of occurrences (#Occ) and the corresponding number of frames (#Frames).*

Date (mm/dd/yy)	Time (h:min:sec)	#Occ	#Frames
12/15/05	11:04:15	300	25
12/15/05	11:04:16	300	25
12/15/05	11:04:17	300	25
12/15/05	11:04:18	300	25
12/15/05	11:04:19	300	25
12/15/05	11:04:20	300	25
12/15/05	11:04:21	300	25
12/15/05	11:04:22	300	25
12/15/05	11:04:23	300	25
12/15/05	11:04:24	300	25
12/15/05	11:04:25	300	25
12/15/05	11:04:26	300	25
12/15/05	11:04:27	300	25
12/15/05	11:04:28	300	25
12/15/05	11:04:29	300	25
12/15/05	11:04:30	300	25
12/15/05	11:04:31	300	25
12/15/05	11:04:32	300	25
12/15/05	11:04:33	300	25
12/15/05	11:04:34	300	25
12/15/05	11:04:35	300	25
12/15/05	11:04:36	300	25
12/15/05	11:04:37	300	25
12/15/05	11:04:38	300	25
12/15/05	11:04:39	300	25
12/15/05	11:04:40	300	25
12/15/05	11:04:41	300	25
12/15/05	11:04:42	300	25
12/15/05	11:04:43	300	25
12/15/05	11:04:44	300	25

TABLE 10—*Results of the scripting process for a 30-sec portion of a test recording produced on the submitted PAL MiniDV camcorder, showing the number of occurrences (#Occ) and the corresponding number of frames (#Frames).*

Date (mm/dd/yy)	Time (h:min:sec)	#Occ	#Frames
12/15/05	06:04:31	336	28
12/15/05	06:04:32	264	22
12/15/05	06:04:33	336	28
12/15/05	06:04:34	264	22
12/15/05	06:04:35	324	27
12/15/05	06:04:36	336	28
12/15/05	06:04:37	264	22
12/15/05	06:04:38	324	27
12/15/05	06:04:39	264	22
12/15/05	06:04:40	336	28
12/15/05	06:04:41	264	22
12/15/05	06:04:42	324	27
12/15/05	06:04:43	264	22
12/15/05	06:04:44	336	28
12/15/05	06:04:45	264	22
12/15/05	06:04:46	324	27
12/15/05	06:04:47	336	28
12/15/05	06:04:48	264	22
12/15/05	06:04:49	324	27
12/15/05	06:04:50	264	22
12/15/05	06:04:51	336	28
12/15/05	06:04:52	264	22
12/15/05	06:04:53	324	27
12/15/05	06:04:54	264	22
12/15/05	06:04:55	336	28
12/15/05	06:04:56	264	22
12/15/05	06:04:57	324	27
12/15/05	06:04:58	336	28
12/15/05	06:04:59	264	22
12/15/05	06:05:00	324	27

sequence. Based on these results, the authors were then confident that the eccentricity of the date/time information was, in fact, present in the digital data stream of the recording and not an artifact of playback.

The results of the scripting process for the test recording produced on the submitted Samsung camcorder further revealed that the eccentric nature of the date/time information was present and was consistent with the pattern observed in the submitted recording. Table 10 presents the results of the scripting process for a 30-sec portion of the test recording. For a portion of the test recording, matching the length of the submitted recording above (1715 sec), the total number of date/time stamp occurrences was 514,508, which equated to an average of 300.0 occurrences per second with a standard deviation of 33.2. The number of occurrences for two out of the 1715 unique date/time stamps was not divisible by 12 and resulted in a fractional number of frames. No unique date/time stamps were missing within the recording and none were out of sequence. The presence and statistical consistency of the eccentricity in the test recording provided support to the Law Society of Singapore's notion that the submitted recording was consistent with having been produced on the Samsung camcorder. However, because the degree to which the eccentricity in the data/time information was unique to the submitted camcorder was not tested by the authors, an explicit determination that the submitted recorder produced the submitted recording, to the exclusion of all other PAL MiniDv camcorders, could not be made solely on the basis of the date/time metadata analysis.

The detailed analysis of the recording date/time information provided valuable information regarding the submitted recording

which, when combined with the results of the visual/aural analyses, aided in forming conclusions regarding the authenticity of the submitted MiniDV tape. Prior to the development of this scripting process, the authors were limited to viewing the recording date/time information within the video frame, which obscured the visual information of the recording. Through the analysis of the actual digital data stream, the nonstandard pattern of the date/time information was confirmed and determined to be consistent with the test recording produced on the Samsung camcorder. Ultimately, testimony was provided before the Law Society of Singapore Disciplinary Committee, which accepted the conclusions presented and ruled that the evidence should not be excluded (1).

It is recommended that further research be conducted into (i) the uniqueness of the eccentricity in the date/time information; (ii) the source of the eccentricity in the submitted camcorder (e.g., mechanical, electrical, etc.); (iii) other information that can be gleaned from the use of this scripting process; (iv) the usefulness of the other pack header information contained in a DV data stream in forensic video examinations; (v) comparisons between the pack header information for the various video standards (PAL, NTSC, SECAM, and so on); and (vi) the applicability of the scripting process to Digital8 video/audio recordings (which adhere partially to the DV video specification).

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