

Forensic Video

The Forensic Examination of Video Recordings

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A 1996 publication of Video Maker Magazine cites that approximately 50 million people have purchased consumer-type camcorders and that this number is increasing exponentially and greatly exceeds the number of professional cameras involved in the broadcast industries (York, 1996). As this availability of consumer analog and digital camcorder equipment continues to increase, even larger numbers of VCRs will be purchased not only for playback of the video image but more recently to provide both non-linear (non-computer-based) and on line (computer based) editing of original videotapes. These VCRs can also selectively record, edit, title and even provide special digital effects, which are added onto the original tape during its production. This article details some of the basics of videotape recording, the editing of tape and its detection by the forensic expert, and the continuing and increasing threat posed by both linear and non-linear editing to both professional and consumer videographer and the attorney requiring forensic videotape analysis.

TECHNICAL ISSUES

Analog Recording vs. Digital Recording

Storage of information for both audio and videotape recordings is accomplished using either analog or digital magnetic tape or in the case of the computer, high-density digital computer disks (or diskettes) (Miles, 1997). An analog video signal transmits light and color information by means of both measuring and displaying voltage amplitude and frequency differences of the signal presented (MacCauley, 1988). Analog camcorders are relatively inexpensive and cost between \$400 and \$1,000, and many possess both in-camera special effects and editing capabilities.

The most popular videotapes presently in use include VHS, S-VHS, VHS-C, 8 mm, Hi-8, and DV (digital video), although greater resolution and quality of film can be obtained in the Hi-8, S-VHS and DV formats. The consumer market lately has been adopting "multi-media" or "desktop" video work stations into the recording and playback of video information. The more popular workstations provide for a combination of both analog recording and digital editing at a fraction of the cost that was possible as little as two years ago.

In digital recording, the combinations of differing high and low voltages are stored as a series of zeros and ones of binary code understandable to computers. Due to its excellent reproducibility and the tapeless medium aspect of digital audio and video recordings, this technology will soon become the predominant form of recording (Levine, 1996). The latest digital camcorders provide the highest resolution and lack of generation loss during the "dubbing" process but can cost between \$1,000 to \$3,500.

Mechanical and Electrical "Signatures" of Editing

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VCRs present instabilities during both the recording and playback of the videotape, which often causes timing differences or time-based errors in the video signal.

Essentially it is the mechanical instabilities of the recording and playback camcorders and VCRs that cause timing differences that produce anomalies in the horizontal, vertical and color synchronization pulses. Slight variations in the synchronization pulses tend to cause vertical jumping, horizontal wavering, and color and hue saturation differences in the video signal. Added to these difficulties are tape stretching and tension difficulties as the tape wraps around the respective video heads. Often these "time-based" errors in synchronization and other signal anomalies permit the forensic expert to help individualize the camcorder and/or VCR recorders (Suretow, 1996).

DETECTION OF VIDEO TAPE EDITING

Analog (Linear) vs. Computer Based (Non-Linear) Editing

The two major categories of alteration include: 1) that associated with re-recording where changes do occur to the original source recording and; 2) when an altered copy or an enhanced copy (either audio or video) is re-recorded with no physical change done to the source recording.

In the simplest type of tape editing, one need only use a camcorder, a VCR, and the appropriate connecting cable to affect the edit. Most inexpensive editing is accomplished

through connecting the VCR to the camera which has most of the editing functions, i.e. flying erase head, special effects, time-code and other analog and digital camera options.

"Assemble" editing injects not only new video, audio, and time code data, but also control track pulses are added.

A different type of editing is known as "insert" editing. Unlike the aforementioned "assemble" editing does affect the audio portion of the program. In this form of editing, part of previously shot footage is replaced with new video, but basically leaves the audio portion intact. Both of these types of simple editing can result in errors including timing, phase and synchronization problems, which would produce glitches, smears, rolls or other artifacts consistent with consumer-type editing.

Many videotape formats have at least two separate audio tracks, which lend themselves to fairly easy manipulation during any tampering effort. Tell-tale signs of the editing process may include poor synchronization with a new narration existing with the video component and ambient noise levels. The audio signal in videotape is generally much less complex and contains less information than the video signal and is much easier to manipulate or fabricate. Using audio dubbing technology, it is possible to completely rearrange words, sounds and sentences, or to produce audio segments with unintended, opposite and legally detrimental meanings. Audible signs that may reflect editing would include significant changes in volume, content, or continuity with either the main speaker's words or background sounds; sudden or strange sounds; and the audio component not fully synchronized with the relevant video picture.

Computer-Based (Non-Linear) Editing Systems

For approximately \$200 one can now purchase a video capture card while the more expensive varieties provide for the reading of a variety of time codes to include additional effects as a tilter, audio mixer, and special effects generator (Nedph, 1996).

Using digital technology, the consumer videographer is now more capable of falsification and fabrication of both still and video motion images. The tell-tale glitches or other edit artifacts often associated with cut and paste editing or assemble editing are rapidly being overcome as the digital video work station becomes more powerful and accessible to the community. Obviously this type of "seamless" editing poses an increasing threat to tape admissibility, especially if authenticity questions arise out of its manufacture.

Instrumental Analysis of Edited Tapes

With the advent of more sophisticated analog and digital editing devices, it is possible that detection of intentional edits will become more difficult if not impossible to identify. To aid the forensic expert in the detection process, a variety of instrumental tools are available. These include a cross-pulse monitor, frequency generators, video signal generators, oscilloscopes, waveform monitors/vectorscopes, alignment tapes, and magnetic developing solutions.

The waveform analyzer/vectorscope can assist in troubleshooting problems involving luminance, chrominance and audio stages of the VCR that allegedly were used to record the original tape. For example, certain waveform monitors can measure anomalies in the servo motors; detect capstan speed errors; measure capstan jitter; drum speed errors; and calculate inconsistencies in the drum speed movements (i.e. drum jitter). If the camcorder is available for inspection, additional video analyzing devices allow for measurement of deficiencies in the camera's video signals, (luminance and chrominance) and also color aberrations. Additional tests include the measurement of power adapter/power supply problems, video and chroma (noise) artifacts, "burst frequency," and "frequency error problems."

Legal Issues

Material alterations to videotape can be done either intentionally or accidentally. Authorized judicial "editing" of the tape often involves the removal of irrelevant or prejudicial content materials, privileged and confidential conversations; and enhancing the image for jury review. If the editing is accomplished intentionally or surreptitiously, then it is within the discretion the trial judge to allow the evidence, although many courts are viewing this type of evidence more and more unfavorably (IBID #6).

If the original recording equipment and tape is available for examination, the expert should be able to make the following determinations:

1. If the recording is an original or copy
2. Which record buttons were depressed in the process of making the recording and where they are relative to the video images being presented.
3. If part of the original recording was masked by over- recording.
4. If the recorder presented is actually the one used to make the tape evaluated.
5. Which of a limited number of recorders was used to make a video recording.
6. Other case-specific questions that may be appropriate.

As the ability to manipulate video/audio evidence becomes more widespread and effective, the historical admissibility standards will be rendered inadequate. Likewise as "undetectable" video editing becomes more prevalent, it is likely that future video evidence may be excluded if the slightest hint of falsifications exists (IBID #6).

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About the author

Mr. Steve Cain served 22 years as both a Special Agent and a forensic specialist with the U.S. Secret Service and IRS National Crime Laboratories before founding Applied Forensic Technologies Intl., Inc. (AFTI) in Lake Geneva, Wisconsin. A majority of his business concerns the identification of questioned voice recordings or issues relating to audio or video tape recording authenticity or Questioned Documents Examinations.

Mr. Cain received his bachelor's degree at the USAF Academy in 1967 and later completed two Masters of Forensic Science degrees at George Washington University and Antioch School of Law. He has completed two years of a Ph.D. in Criminology at the University of Maryland. He has attended numerous specialized courses of instruction in forensics throughout the U.S. and is both board certified and court qualified (federal and state) in a variety of disciplines. Mr. Cain has published more than twenty articles in forensic, investigative, and legal journals and has been a guest speaker at numerous national/international conferences regarding forensic examination techniques.

He has testified in over 40 states, Hong Kong, Puerto Rico, and Canada in both criminal and civil cases. He is presently on the Advisory Board for the American Board of Recorded Evidence.

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