D15 SWGIT Presents: Part 2 - Forensic Image Processing, Repeatability, and the Myth of Bit-for-Bit Duplicates

Richard W. Vorder Bruegge, PhD, Federal Bureau of Investigation, ITD, Forensic Audio, Video, and Image Analysis Unit, Building 27958A, Quantico, VA 22135*

After attending this presentation, attendees will provide guidance to the forensic community regarding issues relating to image processing activities and to provide examples regarding how multiple techniques may be used to generate the same result.

This presentation will impact the forensic community and/or humanity by demonstrating to forensic community digital image processing need not be replicated on a bit-for-bit level for purposes of repeatability. Since different techniques may be applied to images to extract the same information, and since differences in display techniques (i.e., prints versus video monitors) do not alter the information content of an image, quality assurance guidelines need not be set to require bitfor-bit duplication of processing steps.

The Scientific Working Group on Imaging Technologies (SWGIT) was created in 1997 by the Federal Bureau of Investigation to provide guidance to the law enforcement community by developing recommendations for good practices in the use of imaging technologies within the criminal justice system. It consists of more than forty imaging professionals drawn from federal, state, and municipal law enforcement organizations, as well as academic institutions. SWGIT work products are not intended to represent the formal policy of any one agency, but, instead, represent a consensus opinion developed by individual experts from a broad sampling of agencies and experiences.

The American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB) recently voted to recognize “Digital Evidence” as a discipline under which forensic laboratories may be accredited. Included within this discipline was a subdiscipline identified as “Video and Imaging.” This fact, along with the ubiquity of digital cameras in general, has led some to assume (wrongly) that all imaging functions can and should be performed using computers. What is worse, this has led some in the forensic community (including some laboratory quality assurance personnel) to assume that, because a computer is used, one should be capable of duplicating every image produced in a bit-for-bit fashion. The purpose of this paper is to demonstrate the fallacy of such an argument and to provide guidance regarding the meaning of “repeatability” in an image processing environment.

During a recent murder case in Broward County, Florida, a latent palm impression on a piece of duct tape that had been photographed in 1996 was at issue. When originally examined, the latent impression could not be identified. In 2001, however, after processing of the original film negative using commercially available digital image processing software, the palm impression was identified as belonging to a suspect who was subsequently charged with the murder. In hearings before and during the trial, the defense challenged the use of digital image processing in this case as “junk science” because the technique utilized did not lend itself to an exact, bit-for-bit, pixel-for-pixel duplication. Fortunately for the forensic science community at large, and the forensic imaging community in particular, the judge in this case denied the defense motion to exclude the palm print evidence and upheld the use of the technology and the technique in this case.

The specific technique utilized in this case was a digital version of the “dodge and burn” technique that has been utilized in traditional photographic darkrooms (including crime laboratory photographic darkrooms) since the creation of negative films over a century ago. The technique relies upon the selective underexposure (“dodging”) or overexposure (“burning”) of areas that would otherwise be too bright or dark on the final print. There are actually numerous techniques that can be applied to produce adjustments to the relative brightness and contrast within an image. For example, most traditional photographic darkrooms have the ability to adjust the contrast of an image simply by using specially sensitized photographic papers and different filters. Likewise, most digital image processing software packages offer several different tools or operations which can be used to adjust the brightness and contrast of an image. In fact, in the Broward County case above, the FBI Laboratory utilized a straightforward brightness adjustment to raise the latent impression, after which an examiner made an independent identification of the suspect’s palm.

The key factor in this situation is that despite the different approaches used to process the latent impression, the same result was achieved - an identification of the suspect. In other words, the result of the processing - the ability to perceive features necessary to identify the suspect - was repeatable, even though different procedures were utilized. This is a critical issue for photographers, imaging scientists, and laboratory quality assurance personnel to recognize when implementing procedures within their own laboratories.

In general, forensic image processing activities are undertaken to permit the viewer of the image to extract information from the scene that was less apparent prior to the enhancement. For example, a dark image depicting the back of an automobile may be lightened to permit one to read the license plate number. Likewise, an overly bright image of a bank robber’s shirt may be darkened to allow one to read the writing on his T-shirt. If it is possible to process such images to reveal details not immediately observable in the original image

 ** Presenting Author*

(as in the Broward County case above), then there are probably multiple ways in which one can do so. In such cases, the specific techniques selected by the imaging expert to process the image will most likely depend upon the expert's knowledge, training, and experience. Furthermore, the resulting images will not be precise bit-for-bit duplicates of one another, but will differ from one another in easily measurable ways. This paper will provide multiple examples to demonstrate this.

Other factors, such as fundamental differences between display monitors and printers, should also be considered when addressing the issue of repeatability in image processing activities. One can recognize that a digital image displayed on a monitor contains the same information as a printed version of that image. This is despite that fact that, from a physical sciences standpoint, the two images are completely different. It is not insignificant to note that many court rooms in the United States today are equipped with devices that permit the jury to view projected versions of printed photographs rather than look at the image directly. Furthermore, the Federal Rules of Evidence has long accepted the position that a photographic print made from a film negative is to be considered an original - identical to the negative. Given these observations, laboratory mangers should take care when preparing quality assurance requirements lest they unnecessarily restrict the flexibility of their individual experts to perform image processing operations and related functions.

Forensic Photography, Image Processing, Forensic Image Analysis

 ** Presenting Author*