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Section 11

Best Practices for Documenting Image Enhancement

INTRODUCTION

A fundamental goal of this and other Scientific Working Group on Imaging Technology documents is to ensure the production of quality forensic imagery for use as evidence in a court of law. The specific purpose of this document is to describe best practices for documenting image enhancement used in the criminal justice system and to provide laboratory personnel with instruction regarding the level of documentation that is appropriate when performing a variety of enhancement operations on still images, regardless of the tools and devices used to perform the enhancement.

Accurate documentation is necessary to satisfy the legal requirements for introducing forensic images as evidence in a court of law and to allow other professionals to understand the enhancement and produce comparable results.

The general principles and procedures used are the same regardless of the format or media in which the images are recorded. Therefore, in this document the word *image* refers to any image recorded on any media (e.g., conventional photographic, electronic, magnetic, or optical media, etc.).

Note: The Best Practices described below are predicated on the assumption that an original file/image that has been subjected to processing be preserved.

IMAGE ENHANCEMENT POSITION

Image enhancement has been used in forensic applications since the 1840s and is an accepted practice in forensic science, regardless of whether it is performed in a traditional wet chemistry darkroom or in a laboratory equipped only with electronic devices, such as computers, scanners, and/or video capture systems.

IMAGE CATEGORIES

The degree to which procedures used in image enhancement should be documented will depend on the intended end use of the image. Furthermore, the nature of such documentation will depend on the procedures used.

The Scientific Working Group on Imaging Technology recognizes two fundamental end uses for images encountered in the legal system.

Category 1

Category One images are used to demonstrate what the photographer or recording device witnessed but are not analyzed by subject matter experts. These can include, but are not limited, to the following:

- General crime scene or investigative images

- Surveillance images
- Autopsy images
- Documentation of items of evidence in a laboratory
- Arrest photographs, such as mug shots

Category 2

Subject matter experts use Category Two images for scientific analysis. These can include, but are not limited, to the following:

- Latent prints
- Questioned documents
- Impression evidence
- Patterned evidence
- Category 1 images to be subjected to analysis

ENHANCEMENT TECHNIQUES

Basic

Basic image enhancement techniques are those used to improve the overall appearance of the image. When one visually compares an original image to that same image after basic enhancement, a trained professional should be able to produce comparable results even in the absence of documentation of specific parameterization or software settings. These techniques can be applied over an entire image and in localized areas in an image. They include, but are not limited to, the following:

- Brightness and contrast adjustment, including dodging and burning
- Resizing (file interpolation)
- Cropping
- Positive to negative inversion
- Image rotation/inversion
- Conversion to grayscale
- White balance
- Color balancing and/or color correction
- Basic image sharpening and blurring (pixel averaging)

2 Best Practices for Documenting Image Enhancement

- De-interlacing

There can, of course, be both simple and complex ways of doing certain task. For example, there may be many ways to create grayscale representations of color images (“conversion to grayscale”). When complex techniques are used, they should no longer be considered “basic”.

Advanced

While advanced image enhancement techniques may also be applied to improve the overall appearance, they are often also used to extract specific information contained in the image. These techniques which are not easily approximated by a trained professional without documentation of specific parameterization or software settings. The techniques include, but are not limited, to the following:

- Frame averaging
- Fourier Analysis (including the use of FFT)
- Deblur
- Noise reduction
- Image restoration
- Color channel selection and subtraction
- Perspective control and/or geometric correction
- Advanced sharpening tools, such as unsharp mask

DOCUMENTATION – What is needed

Category 1 Images

When enhancing Category One images, one need only document the techniques with a standard operating procedure that describes the typical enhancement processes. If an original image previously treated as a Category One image is to be subjected to scientific analysis, it becomes a Category Two image.

Category 2 Images

The use and sequence of any enhancement techniques in Category Two images should be documented in every case.

Documenting image enhancement steps should be sufficient to permit a comparably trained person to understand the steps taken, the techniques used, and to extract comparable information from the image. Documenting every change in every pixel value is discouraged because it adds nothing of value to the analysis.

Exploratory enhancement operations not incorporated in the final image do not need to be documented. Test prints and/or intermediate images resulting from a variety of techniques not incorporated into the final image should be discarded.

Minimum requirements for documentation of advanced techniques include identifying the software application and/or techniques as well as the settings and parameters used. Automated processes, such as running user-defined macros, require only documenting usage if the process is defined in the agency documentation.

DOCUMENTATION – How to do it

Documentation can be recorded in a variety of ways including hand-written notes, electronic recording, or through the use of automated logging tools, or incorporated into the final report.

The following examples are intended to represent the documentation level appropriate for Category Two images. Following these recommendations will help fulfill the requirements for the admissibility of images in a court of law. In addition to the examples below, a sample SOP which includes the use of automated logging is provided in the appendix.

Examples:

Brightness and contrast and/or contrast adjustment

I printed the Q5 image using Kodabromide II grade 4 RC paper. The tread area was burned in to increase detail.

Unsharp mask (strength, distance, threshold)

In software application X, version N, I used unsharp mask at strength = 100%, with distance = 1.5 pixels, and threshold of 3 levels.

Multiple image averaging (number of images used, which images used, individual image weights)

I averaged 4 images (Q1_01.tif; Q1_02.tif; Q1_03.tif; and Q1_04.tif) with equal weighting

Fourier Analysis (Fast Fourier Transform – FFT) (Identify region of interest, and edits performed on spectrum, such as spike cut, spike boost, low pass filter and high pass filter)

Selected the region of interest to include the vehicle, performed a forward FFT operation, edited the spectrum, using spike cut on the repetitive signal, then performed the inverse Fourier transform.

Noise reduction (Type, such as despeckle, Gaussian blur)

I reduced noise in the image by applying an IIR Gaussian blur.

Color channel selection and removal

I removed the red channel by deleting it.

Perspective control and/or geometric correction (scale, rotation or degree, perspective, skew)

I rotated the image 90 degrees clockwise.

User-defined macro (macro name)

In Adobe Photoshop Version 7.0, I used Action Video Process 1 (defined in agency documentation).

**Appendix
SAMPLE
STANDARD OPERATING PROCEDURE**

Title: Latent Print Image Processing

Approval Date _____

Reviewer Signature

Technical Leader Signature

Forensic Services Director Signature

Purpose: To establish a list of actions to enhance latent print images requested by latent print analysts.

Procedures:

1. Log into the agency-approved software application for processing latent prints.
2. Select the case containing the images to be processed.
3. On the menu bar, click Image, Enhance. The program will make a copy (working image) of the original image and import the copy and the enhanced image history into the agency-approved enhancement software application.
4. Process the working image using enhancement techniques. All processes applied to the working image are recorded using the enhanced image history tool. Approved processing techniques for use on working images are those that have direct counterparts in traditional darkrooms including brightness and contrast adjustment, dodging and burning, and color balancing. The tools include Brightness/Contrast, Levels, Curves, Color Balance, Hue/Saturation, and Invert. Using Mode, Channels, and Fast Fourier Transform filters (FFT) are acceptable. The following tools are prohibited: Rubber Stamp, Airbrush, Paintbrush, Paint Bucket, Eraser, and Blur.
5. After the working image is processed and the processes are recorded, save the changes to the processed working image. Import the processed working image back into the latent print processing application.
6. The operator may now process additional images, export a processed image for printing, or exit the application.

Safety Considerations: None.

Limitations: Based on existing equipment and technology.

Quality Control: Perform appropriate equipment maintenance to ensure proper capacity and quality performance.

Literature References: User Manual.