



### F25 Contrast Enhancement of Bitemark Images Using the Greyscale Mixer in ACR in Photoshop®

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After attending this presentation, attendees will have an understanding of the method employed in this experimental image enhancement technique and be aware of the limitations in use as evidence.

This presentation will impact the forensic science community by helping investigators research the benefits and limitations of image enhancement techniques in analysis of bitemarks and patterned bruises.

Forensic odontology can best be defined as the overlap that represents the dental and legal professions. Bitemark analysis is one aspect in which a forensic dentist can assist the courts. Teeth are often used as weapons, and the resultant bitemark can aid forensic odontologists to exclude or otherwise appraise a suspect's dentition. Claims that the size, shape, and pattern of the biting edges of the upper and lower anterior teeth are specific to an individual have recently been challenged, leaving the question of uniqueness of the dentition unresolved.

Analysis of bitemarks for the purpose of identifying a perpetrator is further compounded by distortion introduced into the bitemark and its record from the moment of infliction. Researchers have recently revisited the concept that skin is a poor impression material and the resultant difficulties that this imposes on bitemark analysis. Movement during infliction and the lapse of time also introduce distortion, which complicates further the interpretation of a diffused patterned bruise.

In recent years, the advent of digital photography has, among other things, made possible the application of digital enhancement to an image, thereby increasing the possibility of achieving better edge definition for analysis. A number of studies have demonstrated such use of computer software to enhance the edge definition of patterns within images in various forensic applications. Some examples include color separation, which uses algorithms within Adobe® Photoshop® for removal of distracting background patterns from fingerprint and handwriting evidence, and Red, Green, Blue (RGB) channel extraction, which removes one or more of the three RGB channels to decrease background interference in a variety of crime scene images. A similar method is used in footmark analysis where details are extracted and the background information is reduced by viewing the image separated into RGB and Cyan, Magenta, Yellow, Black key (CMYK) color channels. The layers containing information or distractions can be identified and, following a mixture of blending and removing color layers, the subject can be made clearer.

In an attempt to apply more subtle and precise enhancement methods to the analysis of bitemark images, a novel contrast enhancement technique based on the adjustment of the brightness pixel values, similar to that attained by the level or curves function in Photoshop® was developed. This studies goal was to acquire initial data on the end user's preference for either RGB color, greyscale, or the grayscale-enhanced images in order to validate the benefit of this contrast-enhancement technique. With the understanding that there are other inherent problems affecting bitemark analysis, which will not be overcome by applying edge-definition enhancement. The suggested technique goal is to widen the range of tools available to the expert when looking to undertake bitemark analysis.

Enhanced images may improve bitemark edge definition, assisting forensic analysis. Current contrast enhancement involves color extraction, viewing layered images by channel. A novel technique, producing a single enhanced image using the greyscale mix panel within Adobe® Camera Raw®, has been developed and assessed here, allowing adjustments of multiple color channels simultaneously. Stage 1 measured RGB values in 72 versions of a color chart image; eight sliders in Photoshop® were adjusted at 25% intervals, all corresponding colors affected. Stage 2 used a bitemark image, and found only red, orange, and yellow sliders had discernible effects. Stage 3 assessed modality preference between color, greyscale, and enhanced images; on average, the 22 survey participants chose the enhanced image as better defined for nine out of ten bitemarks. The study has shown potential benefits for this new technique; however, further research is needed before use in the analysis of bitemarks.

**Bitemark Analysis, Contrast Enhancement, Adobe® Photoshop®**