F13 The Relationship of Uniqueness and Resolution in Bite Mark Analysis

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After attending this presentation, attendees will know the extent of resolution loss of the human dentition once it is impressed in human skin.

This will impact the forensic community by demonstrating the limitations of skin as a recording medium and the tools used to record this transference.

Bite mark analysis may be simply described as the comparison of the dentition to a bite mark, both of which are in the form of a dataset, whether it be a photograph, scanned overlay, or 3D-dataset. With each of these means of recording the subjects there is an inherent transform factor that alters the data in some way.

The assumption behind this is that skin itself records the features of the dentition. While it has been stated that skin is a poor recording medium, many of the boundaries and limiting factors of this statement have not been clearly defined.

With a recording medium such as photographic film, the smallest object that can be resolved is determined by the camera's optics and ultimately by the grain size of the photographic emulsion. With digital recording devices the resolution is similarly dictated by camera optics but also by the physical size of each pixel sensor (not the total number of pixels). While the spatial resolution of photography is good, the limiting transform of photography in bite mark analysis is that the resulting record is two-dimensional.

The advent of 3D laser scanners is promising, especially in the presentation of data to a court, but costs can be prohibitive for high resolution scans. The transform in these datasets is in post-collection processing including data fusion and smoothing.

In bite mark analysis, the current and most often used method of comparing suspect dentition to bite mark is to generate a hollow volume overlay of stone dental casts using a flatbed scanner and image editing software. If the scanner is set to 300dpi, then each pixel has a dimension of 85x85 microns, therefore the smallest object that can be distinguished in the resulting image is 85 microns. If a line of single pixel width is used to create the overlay, then the human eye can readily resolve and follow the changing positions of the line that delineates the overlay. The human eye can typically resolve 80-micron particles, which enables us to visualize small detail.

The observer can resolve small differences by simple visual inspection of overlays from similar dentitions. Human pattern recognition capabilities enable us to conclude that the dentition is unique to at least a resolution of 85 microns. This conclusion, based on our visual acuity, supports the intuitive premise that the dentition is unique. However, a number of factors in the scanning process determine the boundaries of the overlay lines. There are transform factors inherent in the process of creating an overlay that effectively reduce the resolution of the representative dentition.

In a bite mark, the defining edges of the bite pattern are much more difficult to identify, even with clear indentations. This is further complicated by the fact that there is inevitable distortion due to the visco-elastic properties of skin and the 3-dimensional aspects of the teeth and skin. This second transform factor due to the skin can be greater than that of the scanning process and the two factors are additive, combining to reduce the effectiveness of the comparison. Thus when superimposing an overlay on a bite mark photograph the operator must mentally apply an arbitrary distortion correction in order to 'match' the dentition with the bite.

Human Subject Review Board exemption was granted for this project. In the course of performing bite mark research using human cadaver skin as the recording medium, situations were created which demonstrate the concepts stated above. This will be illustrated through comparisons of suspect dentitions and bite marks.

A loss of resolution on a millimeter scale can be anticipated once the representation of the dentition is transferred to skin. Under these circumstances, the level of uniqueness or resolution of measurement of the dentition (85 microns in this example) becomes tested. This prompts a reexamination of the oft-stated dual assumptions that the representative dental cast is unique and that that uniqueness is transferred to skin.

Bite Marks, Uniqueness, Resolution

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