F14 Use of 3-D Imaging and Mathematics in Assigning the Probability of a Match Between a Dental Model and a Bite Mark

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After attending this presentation, attendees will be briefed on a way to determine an objectively-based probability of a match of a bite mark to a 3-D dental model.

This presentation will impact the forensic community by serving as a key aspect of forensic odontology methods for identification based on bite marks.

The process anticipated with this method is for the forensic odontologists to prepare dental molds of the mouth of the suspect and perform a physiological analysis based on observation and normal 2D photography. In cases where it is believed that a match has been found, and in which the bite mark has some definition, an additional test can be conducted to estimate the probability that the proposed identification is warranted. This is where the methods described in the current paper come into the process.

Using a suitable 3D camera, a computer-resident model is made of the suspect's teeth. At first the model comprises several partial representations of the full 3D object. Afterwards the separate partial models are stitched together to give a full model of the top and all sides of the model. A 2D rendition of the bite mark is also transferred to the computer. The computer is then used to calculate the optimal alignment of the bite marks to a cross section of the 3D dental model based on a "distance" measurement which is a goodness of fit measure. The process repetitively intersects the model with a plane at different depths, angles of attack, and angles of rotation calculating the distance in each instance. Optimality is defined by a distance measure that is minimized over all possible cross-sections as well as all possible rigid 2D alignments (translations and rotations) of the 2D bite marks contours and 2D cross-sections from the 3D model. The distance measure is then used to estimate the probability distribution using a logistical model. The end result is an estimate of the probability that the given teeth/mouth (as represented by the dental mold) could have made the subject bite mark.

For this early phase study, dental molds of unknown "suspects" were used. Artificial bite marks were created and photographed. These images were then intentionally distorted digitally to represent various levels of clarity typically seen in bite marks. The methods used to create the images and collect the data will be described. In addition, the methods of 2D-3D bite mark matching will be developed and detailed. The statistical analytical techniques used in computing the probability of correct match will be described and specified.

Finally data will be shown comparing the findings of forensic odontologists and the computed probabilities. In 88% of the cases the computed data was correct in assigning a relatively high probability. Only one situation resulted in a bad assignment and that has been traced to the way the distance measurement was made. Other than this instance, the analytical methodology worked well and it is reasonable to expect that such a process could be addend to bite mark evaluations to increase their credibility to juries.

This was an early phase study and as a result, most of the effort went towards developing the methodology. Only a limited sample of molds and bite marks were available. It also relied on artificially produced bite marks. Future work should include larger samples and actual bite marks. Further work should also address improving the distance measurements.

Bite Mark Identification, Odontology, Probability

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