D33 3D Surface-Scanning Techniques: Current Use, Limitations, and Improvement Propositions

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After attending this presentation, attendees will understand the role of different 3D surface-scanning technologies in investigating various types of cases. Attendees will also learn the limitations and problems linked to these technologies and will understand the necessity of developing and evaluating a suitable and robust methodology for the 3D comparison of marks and objects.

This presentation will impact the forensic science community by explaining the issues linked to the current use of the different 3D technologies in forensic medicine. Studies planned to answer the methods needed for the analysis and comparison of wounds and blunt objects using 3D surface scanners will also be presented.

Recent developments in forensic imaging led to an increasing use of 3D surface-scanning techniques, especially for traffic accident reconstruction and the physical correlation between resulting injuries and causative instruments. Although different 3D technologies, such as laser scanning, surface-scanning and photogrammetry, have great potential for such use in forensic investigations, they have limits as will be exemplified in the following case study.

A traffic accident victim, treated at the University Centre of Legal Medicine in Lausanne two years ago, highlights some of the methodological shortcomings regarding the means by which analyses and comparisons are actually conducted using 3D surface- scanning technologies. Regarding this victim, an accident-relevant mark on the victim's face and neck was documented using a 3D surface scanner and photogrammetry. Tires of the vehicle involved were scanned and a morphometric comparison was produced between the resulting different 3D models. Only a partial superimposition of the patterns was observed; however, the implication of the car was proven and this should have led to a complete superimposition. An explanation for this discrepancy is that the mark on the victim's face was deformed due to massive lesions of the facial bones. This case raises questions like: Would one have excluded the tire as being the object that left the trace if one were not sure about it, in which cases can one exclude that an object has produced a mark, and what level of certainty can one reach for a conclusion in cases in which there is an imperfect correspondence between the patterns and the object?

To address these questions, research was conducted to study the use of a fringe-light 3D surface scanner to determine whether an incriminated object could have caused a certain wound. Seven volunteers inflicted a total of 23 "injuries" on watermelons using 15 different blunt objects. Then, 3D models of the injuries and the instruments were acquired using a GOM ATOS Compact Scan 5M. An operator experienced in 3D surface-scanning and blinded to the origin of the experimentally created "injuries" scanned the test watermelons, then compared the resulting 3D models following the Analysis Comparison Evaluation–Verification (ACE-V) methodology widely used in forensic science. In 57 % of the cases, a correct non-exclusion of the injury-causing object was made, but in 26% of the cases, the exclusion was wrong.

The actual case example and the accompanying laboratory study exemplify the difficulties involved when 3D models are used to reconstruct a wound and perform a correlation with the object that produced the wound. This highlights the need to develop and assess a suitable and robust methodology. Further research is needed to address these issues and to strengthen the scientific basis of 3D comparison of marks and objects. A collaborative effort has been established between the University Centre of Legal Medicine in Lausanne and the School of Criminal Justice. This effort seeks to formalize and study the different steps of the comparison process, following an ACE-V approach already employed for comparison purposes in forensic science (fingerprint comparison, footprint comparison, etc.). This methodology strongly emphasizes the importance of the analysis phase that enables the expert to assess the informative value conveyed by the mark before any comparison is made. Based on this approach, the strength of

the conclusion that can be expected from further comparisons (exclusion, identification, etc.) can be quantified. The goal is to develop a methodological framework for the study of object marks on the body, encompassing 2D and 3D surface technologies, and for the comparison of questioned marks with reference features produced by suspected objects.

Forensic Imaging, Morphometric Comparison, Methodology