C40 Methods to Characterize 3D Scanners for Forensic Applications

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Learning Overview: After attending this presentation, attendees will better understand: (1) the issues in using 3D scanners for forensic applications; and (2) the National Institute of Standards and Technology's (NIST) efforts to develop procedures to evaluate 3D scanners.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by educating attendees about 3D scanning errors, scanning performance, and methods to measure performance. Such methods will lead to a greater confidence in scanner measurements.

Forensic photography has been one of the most valuable tools for investigators over many decades. Photographs preserve the history of the scene and provide a way for investigators to analyze the scene of interest. However, it is difficult to obtain any objective measurements with high confidence from such photographs.

3D scanning instruments such as Light Detection and Ranging (LiDAR)/Terrestrial Laser Scanners (TLS), Structured Light Scanners (SLS), and photogrammetry instruments digitize the scene of interest, offering a way for investigators to revisit the scene. Such a capability is crucial for investigators when access to the scene of interest and time may be limited when performing a thorough investigation. It is also possible that the scene itself may become polluted with the passage of time. These scanners enable investigators to obtain the scene information quickly and measure many features, such as a trajectory of a bullet, track width of a vehicle, etc.

The new generation of 3D scanners are portable, easy to use, and capture millions of points in a matter of seconds. Apart from capturing 3D data, these scanners also capture the intensity and/or color of the scene and provide a way to reconstruct the scene in any desired orientation. 3D scanners do suffer from some issues that can cloud the accuracy of their measurements. When used in forensic applications, such confusion can affect the standard of admissibility of evidence in judicial hearings, such as *Daubert* or *Frye* proceedings. The inaccuracies in these 3D scanners may come from their construction, data analysis procedures, calibration artifacts, or environment. Such inaccuracies must be characterized before using these devices the field.

To standardize the evaluation of a class of TLSs, the Dimensional Metrology Group (DMG) at the NIST has worked with instrument manufacturers, end users, and experts to develop a new documentary standard (ASTM E3125-17). This standard was developed under the auspices of the American Society for Testing and Materials (ASTM) and was published in December 2017. The NIST was a major contributing member of this effort and possesses unique expertise for such activities due to prior experience with other 3D measuring instruments. A considerable amount of research was conducted to unravel the sources of errors in these instruments and a variety of procedures and software algorithms were developed to minimize the effects of these errors on the data obtained. Over 20 publications were generated out of this activity, detailing various issues that affect the scanner performance and ways to minimize those issues.

In this talk, the errors and accuracy of TLSs and other efforts to characterize the performance of TLS systems to ensure that they meet the needs of the forensics community will be discussed.

Forensic 3D Scanning, Accuracies, Standards