D13 Physical Properties of Additive Manufacturing to Combat the Illicit Use of 3D Printing Technology

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Learning Overview: After attending this presentation, attendees will understand what physical factors of a 3D-printed object are significant for their forensic discrimination and classification.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by identifying systematic differences in the overall dimensions of a 3D-manufactured part due to the brand/type of printing machine, polymer filament material, software used to generate the printed file, and orientation of the printed part.

3D printing is becoming easily affordable and readily available. Available since the 1980s, 3D printers are used to create a range of objects, such as airplane and automotive parts, footwear, and medical prosthetics. The easiest way to begin the process of 3D printing is by using an existing computer model, which are available through open-source file-sharing sites. Criminals who take advantage of this technology can manufacture counterfeit parts, Automated Teller Machine (ATM) skimmers, firearms or their parts, and improvised weapons by the modification or replication of open source files. Additionally, there is little regulation for the manufacturing and ownership of 3D guns, which creates challenges in identifying parts and materials. The ability to associate a 3D-printed part to the printer that made it or the polymer from which it was made has the potential to be valuable in a forensic investigation. However, forensic research in additive manufacturing is lacking and, therefore, there are insufficiently validated test procedures.

The long-term goal for this research is to be able to associate a printed part with its source (e.g., the printer or the polymer). The potential for this type of association is based on the reproducible differences between different printers combined with consistency in the manufacturing of parts from a single printer. This research specifically evaluated the effect that different manufacturing parameters have on the physical dimensions of the resulting 3D-printed object. The manufacturing parameters that were tested included using different printers (same and different brands), polymer filament material, software used to generate the printed file, and orientation of the printed part. The hypothesis is that there are systematic differences at the macro scale that would enable differentiation of printed parts manufactured using different printers and parameters.

The MakerBot Replicator 5th Generation, MakerBot Replicator Plus, Stratasys Dimension Soluble Support Technology (SST) 1200es, and Sindoh 3Dwox were used to create rectangles, cylinders, and wedges using Acrylonitrile Butadiene Styrene (ABS), Polylactic Acid (PLA), and Tough PLA Material. Programs such as SolidWorks, and Fusion 360, AutoCAD were also tested on the 5th Gen, Plus, and Dimension. Measurements of mass and dimensions (x, y, z, inner and outer diameter) were taken of each generated part. The Analysis Of Variance (ANOVA) of the measured physical measurements indicated there are statistically significant differences (p-value less than 0.05) between 3D-printed parts that are manufactured with different printers, software, orientation, and material. As the database increases in size, there is a possibility of determining the discriminating potential of physical measurements for the identification and categorization of 3D printing characteristics, which ultimately has the potential to help trace a printed part to its source.

Additive Manufacturing, 3D Printing, Open Source Files

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