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Optimization of 3D Fingermark Images for Use in FBI's Universal Latent Workstation (ULW)

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After the release of the National Academy of Science's (NAS) report in 2009 and its criticisms of many forensic disciplines—especially friction skin ridge pattern analysis—scientific research has skyrocketed. One of many focuses has encompassed the estimation of the "age" of latent fingermarks, also referred to as "time since deposition" [1]. One technique proven viable to examine and distinguish "age" is a 3D analysis via an Optical Profiler (OP) [2] and the metrics it provides.

Ideally, a properly examined (latent) fingermark should first be assigned a quality score (QS) manually as well as an automatic quality metric using the FBI's Universal Latent Workstation (ULW), or equivalents. Despite its great performance with 2D images, ULW is inconsistent when recognizing ridge patterns captured in 3D. The main hypothesis as to why this occurs is that ULW software cannot properly differentiate ridges from furrows in the default 3D image format. The software tends to consider the outline of the ridges as two separate ridges rather than one, possibly because the inner areas of the ridges are not dark enough compared to the background.

In this research project, several combinations of image enhancements were created and tested with ULW. A total of 720 fingermark images in 3D were edited and examined from six donors, three males, and three females. These were originally deposited onto plastic and glass microscope slides and exposed to natural light and complete darkness for a three-month aging period. QS values and ULW metrics on the visual quality, including the surface area extension of "*BlueGreen*" coded regions [3] were collected. "*BlueGreen"* depicted the physical region considered suitable for identification. The binarization option in ULW was able to reveal the accuracy of (ridge) areas that the software was recognizing. The enhancement process that provided the most correct ridge flow and best quality metrics, once the images were binarized, was re-sizing to 3 x 1.5cm; inverting the original colors; modifying resolution to 250 ppi; editing to greyscale; re-adjusting the color contrast to positive 50 for both brightness and contrast and applying "blur", all edited in Photoshop®. Once the images were optimized, they were re-examined with ULW at 1000ppi, and metrics obtained. Data collected from ULW included quality/clarity scores and extension of "*BlueGreen*" areas. Results have shown that the "*BlueGreen*" metric aligned well with the QS values after enhancements were completed, proving the optimization process. Further analyses revealed that fingermarks placed on the plastic substrate were affected by the light conditions, whereas fingermarks on the glass were not. A theme noticed throughout, was fingermarks deposited by males scored higher than females, no matter the substrate or light condition. This could be explained by males having less densely compacted ridges compared to females.

References

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