Criminal Investigations and Network Analysis
A DHS CENTER OF EXCELLENCE

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Digital Holographic Acquisition, Storage, Retrieval and Analysis of Three-Dimensional Fingermarks Developed with the Nanoscale Columnar-Thin-Film Technique

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Forensics

SUMMARY

Latent fingermarks, or those that are not visible to the naked eye, are the most common type of fingermarks but also the most difficult to recover for forensic investigations. Investigators need a way to retrieve fingermarks that will provide the maximum amount of information possible for subject identification. This project works with 3-dimensional digital holography to provide fingermark images with much higher resolution than traditional techniques, build a portable database with information on 3D recognition of fingermarks, and develop a user-friendly interface for fingermark reading from holograms. These tools and techniques can be used to support the detection, analysis, monitoring, and dismantling of criminal activities.

PROBLEM STATEMENT

Fingermark analysis is probably the most common technique in forensic science for criminal justice due to the widely accepted individuality and persistence of fingerprints and the availability of fingermarks at crime scenes and other scenes of action. While patent and plastic fingermarks are visible and convenient to identify, latent fingermarks are not. Since latent fingermarks are the most common and the least visible, it is important to first develop them and then image them using a high-fidelity and robust technique for retrieval, examination, and in-depth analysis and identification by comparison against a reference repository of fingermarks. Whereas 2D images of fingermarks have been acquired and used for more than a century, these images lack depth (i.e., topographic) information which would be useful for identification of partial, environmentally stressed, and/or partial bloody fingermarks.

APPROACH

This project is aimed towards the digital holographic acquisition and storage of 3D fingermarks in a reference repository and subsequent retrieval for identification of persons present at a scene of action. Environmentally stressed and partial bloody fingermarks on a diversity of nonporous substrates will be developed by coating with nanoscale columnar thin films. 3D images of these samples will be acquired by digital holography and reconstructed. The quality of 3D information thereby acquired will be assessed. A novel hologram analysis through correlation is proposed for 3D fingermark identification.

ANTICIPATED IMPACT FOR DHS

3D fingermarks acquired holographically, stored digitally, and reconstructed optically will allow DHS investigators to examine impression evidence from diverse directions and thus greatly reduce identification errors associated with 2D partial fingermarks that can be distorted by environmental stress or accompanying blood. The proposed research will thus support and extend the detection, analysis, monitoring, and dismantling of criminal networks and activities.