B14 Facial Comparison Using 3D Techniques

Arnout C. Ruifrok, PhD*, Netherlands Forensic Institute, Laan van Ypenburg 6, Den Haag, 2497 GB, NETHERLANDS; Chris van Dam, MSc, and Robin T.A. van Rootseler, MSc, University of Twente, Hallenweg 15, Enschede, 7522 NH, NETHERLANDS

After attending this presentation, attendees will understand the possibilities and limitations of the current biometric facial comparison techniques, facial comparison techniques using uncalibrated surveillance video footage, and some basic principles of 3D multi-frame approaches to facial comparison.

This presentation will impact the forensic science community by providing insight into current and new techniques for facial comparison and on how to optimize the use of image information in surveillance video for person identification based on facial images.

Although biometric techniques exist for facial comparison using image material, these techniques only show acceptable performance when using full frontal images of good quality in a controlled environment. As soon as the quality of the image material is gets below ISO 19794 requirements, the performance of the current biometric systems quickly deteriorates. As it is extremely rare that surveillance video footage material complies with the ISO 19794 requirements, automated biometric systems in practice are useless for forensic casework.

Current forensic facial comparison techniques using un-calibrated CCTV footage are based on visual comparison by human operators using 2D images. Forensic experts take only one or a few frames from a video on which they base a facial comparison with images or reconstructed video footage of a suspect. During this process, potentially valuable information from unused sub-optimal frames is discarded.

To improve the use of the available image information and to develop techniques to determine the evidential value of the surveillance video, the Netherlands Forensic Institute started a collaborative project with the University of Twente, The Netherlands, titled "Person Verification 3D."

Using a multi-frame approach, more of the available information can be used. In contrast to 2D image comparison, 3D model comparison is more reliable, because it doesn't suffer from changes in lighting conditions and/or pose. It also offers the possibility to combine the information in the multiple frames.

The main three techniques to reconstruct 3D facial models from 2D video footage are Structure from Motion, Shape from Silhouettes, and the use of Morphable Models. Each of these techniques has its own advantages and disadvantages. Shape from Silhouettes is robust against pose and lighting conditions resulting in easy and quick binary comparison for fitting but a PCA shape model is needed for accurate reconstruction. Structure from Motion is robust against lighting conditions but results in a relative sparse model. Morphable Models generate a dense 3D model based on shape and texture but are computationally expensive.

In evaluating existing techniques for building 3D face models from uncalibrated multi-frame video material this collaborative project aims to combine the complementary techniques to: determine the within and between variability of reconstructed 3D models; determine the influence of frame rates, resolution and amount of movement of a person on the

accuracy of a 3D model; compare the constructed 3D models with 2D and 3D reference material; and to quantify the evidential value of the available footage in terms of a Bayesian likelihood framework.

An overview of existing biometric techniques, visual comparison of CCTV footage, the techniques used to construct 3D models, the progress of the project, and initial results using CCTV footage of varying quality will be presented.

Facial Comparison, Surveillance Video, 3D Models