C61 Photogrammetry and 3D Laser Scanning Used for Facial Recognition

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The goal of this presentation is to present to the forensic community how photogrammetry can help in facial recognition. It shows the results of photogrammetric calculations to indicate how accurate facial comparisons can be done.

This presentation will impact the forensic community and/or humanity by demonstrating to the forensic society a mathematical tool for facial recognition, in order to avoid subjective comparisons.

Comparisons between two different faces are best performed when both are looking in the same direction. However, photographs of a perpetrator and the suspect are often taken from a different point of view. In case the suspect is willing to co-operate with the police, a photograph can be made using the three-point method, described in [Aarts, 2001]. However, the procedure is time consuming and estimations about the accuracy cannot be given. It's easier to make a 3D laser scan of a suspect's head, taking about 10 seconds, and use this model to reconstruct the position of the perpetrator's face using photogrammetry. This reconstruction can be done, with certain accuracy, and error estimates can be calculated. The most important advantage of this method is that the accuracy may give information about whether the suspect is the same person as the perpetrator, in order to avoid subjective comparisons. This research will present the results of this method.

To view the 3D-model of the suspect from the same position as the face of the perpetrator on the photo, the parameters of the camera used need to be known. Since this information is never available, these parameters have to be approximated by using the information given: the photo and the 3D-model. Photogrammetry provides the mathematical equations needed to calculate camera parameters using a photo and the dimensions of the object seen on this photo. A camera match algorithm is derived that needs a minimum of four identical points present in the photo and 3D model, the so-called match points. To calculate the camera parameters an iterative process is used based on least-squares adjustment. The accuracy for parameter calculation is presented for different situations.

For the first experiment, a photo and 3D model of a cube was used. The photo was taken with a camera with known parameters. From the eight corners of the cube the co-ordinates in 3D were given and the corresponding photo co-ordinates were read from the photo. With this information, the camera parameters were derived and compared with the known parameters. Statistical information about the remaining errors in the mathematical model was calculated as well. In the second experiment a photo and 3D model of the same face were used. The points on the 3D model used as match points were also unequivocally visible on the photo, so no mistakes were made in the identification of points. In the case of the cube, the cube-corners were also unequivocally identified. In the third experiment the same photo and 3D model were used as in the second experiment, only the match points used in the 3D model were not unequivocally given in the photo. This simulates the real situation in which the suspect is the same person as the perpetrator. The fourth experiment used the same photo as in the former experiments but the 3D model was of a different face. This is the case when the suspect and the perpetrator are not the same.

The results for these four experiments are given for the camera match algorithm. It shows the differences in estimation of the camera parameters in the mathematical model depending on experimental setting. Further research is necessary to study the flexibility of this algorithm for the application of facial recognition in the future. Furthermore, some other aspects that have to be taken into account, e.g., resolution of the photo and the size of the face in the photo, will be discussed. Aarts, Prof Dr J.M., *Mathematical Analysis of Forensic Photo Identification*. Faculty ITS, TUDelft. November 2001.

Photogrammetry, Facial Recognition, 2D-3D Registration

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