PHOTOGRAMMETRIC EVALUATION OF HUMAN FACES FOR FACE RECONSTRUCTION PURPOSE

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1. Introduction
A multidisciplinary research study has been started in 2007 in the Budapest University of Technology and Economics. This study aims to support human morphologic measurements by photogrammetric methods. The face reconstruction is the process of reconstructing the mimetic muscles and the soft tissues, solely based on the morphology, structure and texture of the cranial bones. The muscles and the bones develop and change together during lifetime, so the morphology of the skull gives an opportunity to estimate the muscular system of the face. Additional aids for the he soft tissue estimation are the so-called median soft tissue datasets. These sets based on statistical measurements of the average soft tissue thickness of the face in several anthropological landmarks. This statistical method however carries some uncertainty. The goal of our research cooperation is to develop the face reconstruction method and create a face reconstruction software based on statistically sufficient samples (3D face and skull models of person) and guided by defined mathematical correlations between the anatomy of the skull and the face geometry.

2. Photogrammetric network design
The first phase of the project is targeted at finding the optimal measuring technology to collect geometric data of the human face. Medical imaging is a continuously developing science, and nowadays we can choose from several possibilities. We have reviewed some of them, and made an accuracy analysis of them, the results were published in the ISPRS XXI. Congress, Beijing, 2008. These results suggested that the high accuracy required by the anthropologist experts can be achieved by photogrammetry. The next step was the development of the photogrammetric capturing device that required the calculation and the design of the subject-specific photogrammetric network.

The main problem of the close range photogrammetric network design is to adapt the network for the network design constraints. The capturing device has to ensure the synchronous image gathering: the nature of the task requires solving the synchronous image capture, because the perfect standstill of living persons cannot be granted even for a short time. A computer-driven four-camera system was chosen, using PicSight P202B-GigE-AR cameras with N.E.T. L-SV2514MP lenses.

One of the most important constraint of the network design is called visibility constrain. The problem in an image-based framework, in which we use a limited number of images of an object taken from unknown viewpoints to determine which subsets of features might be simultaneously visible in other views. [1] The photogrammetric evaluation requires all the features visible on at least two images, so this constraint highly affects the positions and the directions of the cameras. A visibility modelling was performed to determine the ideal spatial arrangement of the cameras.

A 3D modelling software (Blender) was used to simulate an ordinary human face and the camera parameters (viewing angle, focal length etc.) The face model consist of approx. 6000 vertices, the aim of the modelling was to calculate the visible subset of these points from different angles. The modelling resulted a visibility map shown in Fig. 1.

3. Building and testing the capturing device
A measuring field with calibrated control points and the calibration of the cameras are necessitated by the task. A close-range
photogrammetric test field was built. The test-field itself consists of cylinders of various heights mounted on an alloy plate, where the points specified are represented by the holes located on the cover circles of the cylinders. The geometric features of the test field were determined by a Zeiss Opton 3D coordinate measuring machine. This instrument specifies the coordinates of vertices with sharpness within the 0.1 micron range and median error of less than one micron.

The mass-producing of the 3D face models is not feasible by manual processing, so the next phase of the study will be the examination of the automation possibilities.

4. Acknowledgements

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5. References