

# Automated measurement of human faces

## First step: the face mask

N. D'Apuzzo

Institute of Geodesy and Photogrammetry, Swiss Federal Institute of Technology  
Zurich, Switzerland  
E-mail: nicola@geod.ethz.ch

### 1. Introduction

In order to evaluate the anatomic changes occurring with maxillo-facial and plastic surgery, knowledge of the shape and size of the patient face prior to the operation is required. For this purpose we are developing a robust photogrammetric method to measure the surface of human faces. A further field of application of face measurement techniques is computer animation.

### 2. Method

The method employed is multi image matching. At this early stage of research, a still human face substitute is used. The stillness of the face mask simplifies the image capture process in the way that only one camera is needed: multiple images are obtained moving a single camera to five different stations. Texture in form of random pattern is projected on the mask from two different directions. The images acquisition of the left and right side of the mask is done at two steps separately, three images for each side are obtained (fig. 1)

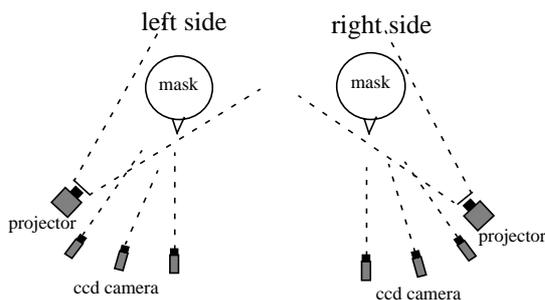


Fig. 1: Setup of camera and projector

The stereo matching process is based on a least square algorithm which establishes correspondences by minimizing the sum of the square of the differences between the grey levels in patches of the images. The projection of an artificial texture is required to obtain sufficient grey level differences on the surface (see figs. 2, 3).



Fig. 2: Face mask



Fig. 3: Mask with random pattern projection

A few reference points have to be manually selected in each image. This points are used to derive initial camera orientation and calibration parameters by bundle adjustment. The points are also used as seed points for the matching strategy.

The 3D coordinates can be determined combining the calibration results and the matched points data set. A triangulated surface is then generated with the set of 3D points.

### 3. Results

The described method was tested on a plastic face mask of Madonna. About 12000 corresponding points are matched with a mean stand-

ard deviation of about 150  $\mu\text{m}$  in the sagittal direction and about 50  $\mu\text{m}$  in the lateral direction.

The results can be visualized as an isoline plot (fig. 4) or as a photorealistic visualisation by overlapping the texture of an original image on a 3D mask model (fig. 5).



Fig. 4: Isoline visualisation

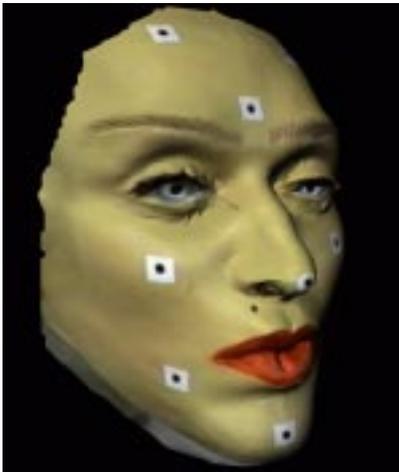


Fig. 5: Photorealistic visualisation

#### 4. Conclusion, future work

As earlier mentioned, the research is at the beginning stage. Refinements of the matching process have to be implemented and also the use of six (or three by 2) synchronised cameras is planned to test the method on real human faces.

#### References

Gaebel H. et al., 1996: Photogrammetric quantification of changes of soft tissue after skeletal treatment of the facial part of the skull, Interna-

tional Archives of Photogrammetry and remote Sensing, 31(B5), pp 188-193

Koch R. M. et al., 1996: Simulating Facial Surgery Using Finite Element Models, SIGGRAPH 96 Conference Proceedings, New Orleans 1996

Thomas P. R. et al., 1996: Evaluation of a low cost digital photogrammetric system for medical applications, International Archives of Photogrammetry and remote Sensing, 31(B5), pp 405-410