Proc. of 3rd International Image Sensing Seminar on New Development in Digital Photogrammetry, Gifu, Japan, 2001, pp. 28-29

Human Face Modeling from Multi Images

Nicola D'APUZZO
Institute of Geodesy and Photogrammetry
ETH Zurich
ETH-Hoenggerberg, 8093 Zurich
E-mail: nicola@geod.baug.ethz.ch
SWITZERLAND

KEY WORDS: Surface measurement, face modeling, least squares matching, video images

ABSTRACT

An highly automated procedure based on multi-image photogrammetry for modeling the human face is presented. Five images taken from different directions are required to generate a realistic model of the face.

1. INTRODUCTION

In recent years, modeling and measurement of the human face has gained importance both for medical and computer animation purposes. While for the latter case, a qualitative measurement is sufficient, high accuracy is required for the former. The extensively employed methods to produce three dimensional computer models of the human face are laser scanning and coded light based triangulation. We present instead a highly automated procedure to measure the human face with multi-image photogrammetry.

2. METHOD

2.1 Image acquisition

Figure 1 shows the setup of the used image acquisition system. It consists of five CCD cameras arranged in front of the subject. In case of required high accuracy, texture in form of random pattern can be projected from two directions onto the face. The cameras are connected to a manual video switcher whose output goes to a frame grabber. The images are digitized sequentially switching through the five cameras.

An additional color image of the face without random pattern projection is acquired by a video camera placed in front of the subject. It will be used for the realization of a photorealistic visualisation.

The system is calibrated using a 3-D reference frame with coded target points, that are fully automatically recognized and measured in the images (Niederöst, 1996). The external orientation and the internal calibration of the five cameras are then determined with the bundle method.

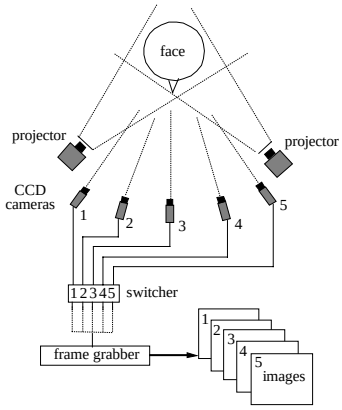


Fig. 1: Setup of cameras and projectors

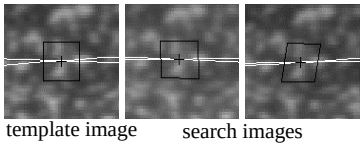


Fig. 2: Geometrical constrained LSM

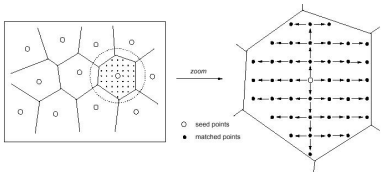


Fig. 3: Seed points Voronoi tesselation and search strategy

2.2 Matching process

The matching process (D'Apuzzo, 2000) is based on the adaptive least squares method (Grün, 1985) with the additional geometrical constrain of the matched point to lie on the epipolar line. Figure 2 shows an example: the black boxes represent the patches selected in the template image and the affine transformed in the search images, the white lines are the resulting epipolar lines. To produce a dense and robust set of corresponding points, the process start from few seed points. These can be generated automatically or defined in the template image by simple mouse clicks. The template image is then divided into polygonal regions according to which of the seed points is closest (Voronoi tessellation). Starting from the seed points, the set of corresponding points grows automatically till the entire polygonal region is covered (see figure 3). This process is repeated for each polygonal region to cover the entire image. Figure 4 shows 2 images of a face with random texture projection and the matched corresponding points established by the matching process on half of the face.

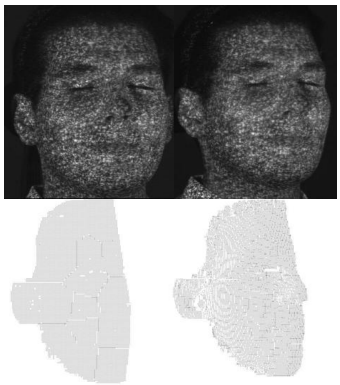


Fig. 4: Images of a face with random pattern projection and matched points

2.3 3-D point cloud

The three-dimensional coordinates of the matched points are computed by forward intersection using the results of the calibration process. The achieved mean accuracy is about 0.4 mm in the sagittal direction and about 0.2 mm in the lateral direction. As can be seen in figure 5, the point cloud is very dense (45’000 points) and some outliers are present. Gaussian filters (Borghese, 2000) are applied to the 3-D point cloud to remove the outliers. The data is afterwards thinned to reduce the number of points (see figure 6).

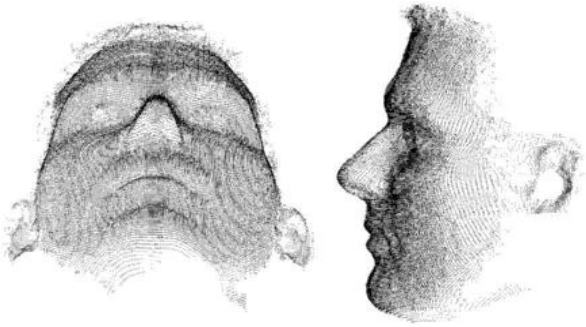


Fig. 5: 3-D point cloud (45'000 points)

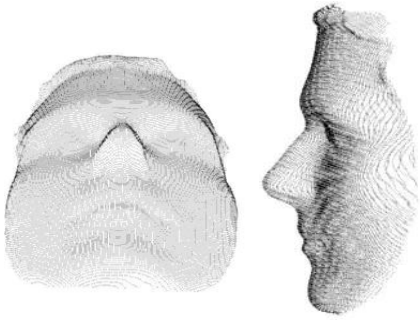
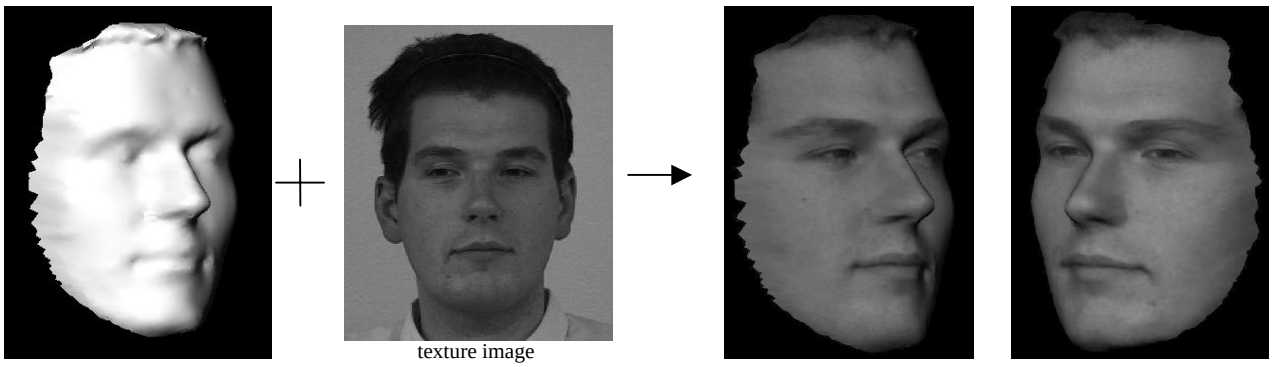


Fig. 6: Filtered and thinned 3-D point cloud (10'000

2.4 Modeling and realistic visualisation

The last step of data processing is the generation of a triangulated surface from the cleaned point cloud and the application of color texture. A meshed surface is generated from the 3-D point cloud by Delauney triangulation. To achieve a photorealistic visualization, the natural texture acquired by the color video camera is draped over the model of the face. Figure 7 show the surface model, the texture image and two views of the resulted face model with texture.



surface model

texture image

face model with texture

Fig. 7: Photorealistic visualisation of the face model

3. CONLUCSION

An highly automated procedure based on multi-image photogrammetry for modeling the human face was presented. The advantage of the method over laser scanning and coded light based triangulation methods is the acquisition of the source data in fraction of seconds, allowing the measurement of human faces with higher accuracy and even the possibility to measure dynamic events like the speech of a person. Moreover the developed software can be run on a normal home PC. Furthermore, the image acquisition can also be achieved using home digital cameras, reducing the price of the entire hardware system (PC included) under 2000 US$.

4. ACKNOWLEDGEMENT

We thank Alberto Borghese of the Laboratory of Human Motion Analysis and Virtual Reality, CNR, Milan for the gaussian filtering software.

REFERENCES

Borghese A., Ferrari S., 2000. A Portable Modular System for Automatic Acquisition of 3-D Objects. IEEE Trans. on Instrumentation and Measurement, Vol. 49, No. 5, pp 1128-1136

D’Apuzzo N. et al., 2000. Least Squares Matching Tracking Algorithm for Human Body Modeling. Int. Archives of Photogrammetry and Remote Sensing, Vol. 33, Part B5/1, pp 164-171

Grün A., 1985. Adaptive least squares correlation: a powerful image matching technique. South African Journal of Photogrammetry, Remote Sensing and Cartography, 14 (3), pp 175-187

Niederöst M., 1996: Codierte Zielmarken in der digitalen Nahbereichsphotogrammetrie. Diplomarbeit, Insitut für Geodäsie und Photogrammetrie, ETHZ, Zürich, 1996