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3D Face Reconstruction by KLT Feature Extraction and Model Consistency Match Refining and Growing

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***Abstract*—In this paper a new method for the reconstruction of 3D face model is proposed. The method starts with corner extraction and matching using KLT (Kanade-Lucas-Tomasi) approach. Then we apply special algorithm to find and refine erroneous matches. The proposed refining algorithm is a two stage algorithm. In the first stage, we find incorrect matches by sorting displacement vectors. The second stage of the refining process is performed by calculating affine model between two stereo images. In this stage the match points which are not consistent with affine model are considered as incorrect matches. To find match points for the remaining pixels of stereo images, we used match point growing algorithm which uses the refined points and their matches as seed in recursive method. When the match points are obtained, they are used for 3D face model extraction. To remove noise in the reconstructed 3D image, we used adaptive Gaussian filter. Experimental results showed the promise of the algorithm.**

Keywords- 3D Reconstruction; 3D face image; affine model; KLT algorithm; match growing

I. INTRODUCTION

Modern world may be named the world of 3D equipments, because most of the 2D equipments in the past, nowadays are changing to 3D. 3D camera, 3D TV and 3D plays confirm this acclaim. Therefore, researchers always considered studying 3D object reconstruction and analysis. One of the important issues in this area is the 3D reconstruction of human face. 3D face imaging are utilized in different applications like human identification, recognition of face expression, detection of face pose, 3D human tracking and so forth. Different methods are suggested to construct human 3D face model [1]. It is possible to perform reconstruction using single image [2] [3]. This reconstruction is mostly based on the information of image shadow and special hypothesis is used for this purpose. Therefore, the method doesn't show and include high generalization. In [4] multiple cameras have been used for 3D face reconstruction to increase accuracy with the cost of more calculation and complexity. In [5], video images are used to reconstruct 3D face however due to the error accumulation during frames; the method doesn't show high accuracy. A lot of instruments like laser range scanners, light range finders can be utilized to obtain 3D reconstruction of different objects, but these instruments are very expensive and complex and less flexible. In [6] stereo imaging is used for 3D face reconstruction. The algorithm employs SIFT feature [7] to find match points between two stereo images. Although the SIFT feature are robust against image rotation and orientation, the match points are less accurate in images with symmetry like face images. Additionally SIFT method has high computation cost specially in large images. In [4] some seed points are chosen manually to begin reconstruction process. One of disadvantages of the method is the need for skilled persons to select initial points. In the case of selecting unsuitable points, the resultant reconstruction shows weak quality.

In this paper we propose a new method for 3D face reconstruction using stereo imaging. Our method starts with the extraction of feature point in left image and finding their matches in the right image. Then we apply special algorithm to find and correct erroneous matches. Subsequently we utilize match point growing to obtain the stereo matching for all points of the face images. Then 3D face model is extracted using the stereo imaging rules. The obtained 3D face model is then processed to remove noise and outliers.

The structure of this paper is as follows. In the next section the algorithm for obtaining initial match points and correction using model consistency method will be explained. In section 3, match points growing based on the initial match points will be explained. Section 4 describes the method for the reconstruction of 3D face model. The experimental results appear in section 5 and we conclude the paper in section 6.

II. INITIAL MATCH POINTS CALCULATION

To construct 3D model for human face using stereo imaging it is necessary to obtain match points for all pixels in two stereo images. However because of aperture problem the matches have not enough accuracy in low contrast pixel. Feature matching algorithm is a proper method to handle the aperture problem. Corners are proper features in the human face for matching. We used KLT (Kanade-Lucas-Tomasi) approach for corner extraction and matching [8]. In this approach the corner points are extracted in the left image of stereo pairs using the eigen values of the following matrix:

$$A = \begin{bmatrix} I_x^2 & I_x I_y \\ I_y I_x & I_y^2 \end{bmatrix} \quad (1)$$