ISSN : 0976-8491 (Online) | ISSN : 2229-4333 (Print)

A Survey of 3D Face Recognition Methods

[1]Sushil Gangwar, [2]Ritika Kansal
[1,2]FIET Bareilly, UP, India

Abstract
The main purpose of this survey is to describe the recent 3D face recognition algorithms and methods. The last few years more and more 2D face recognition algorithms are improved and tested on less than perfect images. However, 3D models hold more information of the face, like surface information, that can be used for face recognition or subject discrimination. Another major advantage is that 3D face recognition is pose invariant. A disadvantage of most presented 3D face recognition methods is that they still treat the human face as a rigid object. This means that the methods aren't capable of handling facial expressions. Although 2D face recognition still seems to outperform the 3D face recognition methods, it is expected that this will change in the near future.

Keywords
3D, Face Recognition, 2D, Algorithms

I. Introduction

One of the earliest face recognition methods was presented in 1966 by Bledsoe [1]. In one of his papers [2], Bledsoe described the difficulties of the face recognition problem: The main purpose of this overview is to describe the recent face recognition algorithms on still images. Previous face recognition surveys were presented by Samal and Iyengar [3], Chellappa et al. [4] and Zhao et al. [5]. However, they all are primarily focused on 2D face recognition. The last few years 3D facial models can be more easily acquired since the acquisition techniques have improved. Therefore, some face recognition methods originally developed for 2D face recognition have been extended for 3-dimensional purposes. Using 3D models one can deal with one main problem in 2D face recognition: the influence of the pose of the head. Also the surface curvature of the head can now be used to describe a face. A recent survey of 3D face recognition was recently presented by Bowyer [6]. Since that time new results with respect to 3D face recognition have been published. We describe the most recent approaches to the facial recognition challenge.

II. Surface Based Approaches

A. Local Methods

Suikerbuik [7] proposed to use Gaussian curvatures to find 5 landmarks in a 3D model. He could find the correct landmark point with a maximal error of 4 mm . Gordon proposed to use the Gaussian and cean curvature combined with depth maps to extract the regions of the eyes and the nose. He matched these regions to each other and reached a recognition rate of 97% on a dataset of 24 subjects [8]. Moreno et al. used both median and Gaussian curvature for the selection of 35 features in the face describing the nose and eye region [9]. The best recognition rate was reached on neutral faces with a recognition rate of 78%.

B. Global Methods

One global method on curvature was lately presented by Wong et al. [10]. The surface of a facial model was represented by an Extended Gaussian Image (EGI) to reduce the 3D face recognition problem to a 2D histogram comparison. The proposed measure was the multiple conditional probability mass function classifier (MCPMFC). Tested on a dataset of 5 subjects the MCPMFC has a recognition rate of 80.08% where a minimum distance classifier (MDC) reached a recognition rate of 67.40%. However a test on synthetic data showed that for both methods the recognition rate decreased with 10% when the dataset was increased from 6 subjects to 21 subjects. Papatheodorou and Rueckert proposed to use a combination of a 3D model and the texture of a face [11]. They also proposed some similarity measures for rigid alignment of two faces for 3D models and for 3D models combined with the texture. Their results showed an increase for frontal images when adding a texture to the model.

C. Modified PCA Methods

Omid Gervei*, Ahmad Ayatollahi**,Navid Gervei [12] proposed modified PCA method namely 2DPCA and bidirectional 2DPCA also known as (2D) 2 PCA.A preprocessing stage was implemented on the images to smooth them using median and Gaussian filtering. In the normalization stage we locate the nose tip to lay it at the center of images then crop each image to a standard size of 100*100. In the face recognition stage we extract the principal component of each image using both 2DPCA and (2D) 2 PCA. Finally, we use Euclidean distance to measure the minimum distance between a given test image to the training images in the database. We also compare the result of using both methods. The best result achieved by experiments on a public face database shows that 83.3 percent is the rate of face recognition for a random facial expression

D. Pose Invariant

Dayong Wang, Steven C.H. Hoi, and Ying He [13] proposed An Effective Approach to Pose Invariant 3D Face Recognition One critical challenge encountered by existing face recognition techniques lies in the difficulties of handling varying poses. In this paper, we propose a novel pose invariant 3D face recognition scheme to improve regular face recognition from two aspects. Firstly, we propose an effective geometry based alignment approach, which transforms a 3D face mesh model to a well-aligned 2D image. Secondly, we propose to represent the facial images by a Locality Preserving Sparse Coding (LPSC) algorithm, which is more effective than the regular sparse coding algorithm for face representation. We conducted a set of extensive experiments on both 2D and 3D face recognition, in which the encouraging results showed that the proposed scheme is more effective than the regular face recognition solutions.

E. 3D EIGENFACES

Chenghua Xu, Yunhong Wang, Tieniu Tan, Long quan, [14] proposed makes a new attempt to face recognition based on 3D point clouds by constructing 3D eigenfaces. First, a 3D mesh model is built to represent the face shape provided by the point cloud. Then, the principle component analysis (PCA) is used to construct the 3D eigenfaces, which describe each mesh model in a lower-dimensional space. Finally, the nearest neighbor classifier and K-nearest neighbor classifier are utilized for recognition. Experimental results on 3D_RMA, a likely largest 3D face database available currently, show that the proposed algorithm has promising performance with a low computational cost.

F. A Refined Method for Producing a Composite Image

NOEL T GOLDSMITH [15] proposed techniques to improved focal depth in light microscopy.

In an attempt to produce a smooth depth image was smoothed by repeatedly applying a median filter until the image no longer changed. This image was indistinguishable from the image at 4.6. As the depth image shows the place in each image where focus is best, a new procedure was developed to make the in-focus composite image. The images are processed using a 3×3 calculation area, to produce the composite in focus image and the depth image. The depth image is then smoothed by repeatedly applying a median filter until the image no longer changes.

Each grey level in the smoothed depth image is used to produce a binary mask which is then applied to the corresponding source image to copy the original pixels under the mask and these pixels are then pasted into the final composite image. The result of this operation is a composite deep-focus image made from areas from each of the original images, noise is only present if it exists in an in focus area.

III. Conclusion

It is hard to compare the results of different methods to each other. Some authors presented combinations of different approaches for a face recognition method and these performed all a little better than the separate methods. Most interesting for this survey were the studies that presented method comparisons. Important conclusion from this survey was that the recognition rates of all methods improved over the years. Although 2D face recognition still seems to outperform the 3D face recognition methods, it is expected that in the near future 3D face recognition methods outperform 2D methods. 3D models hold more information of the face, like surface information, that can be used for face recognition or subject discrimination. Another major advantage is that 3D face recognition is pose invariant. Therefore, 3D face recognition is still a challenging but very promising research area.

References

[1] Bledsoe, W.W.,"The Model Method in Facial Recognition. Technical Report PRI-15", Panoramic Recsearch Inc. Califormia, 1966.

[2] Bledsoe,W.W.,"Man-Machine Facial Recognition: Report on a Large-Scale Experiment", Technical Report PRI- 22. Panoramic Recsearch Inc. Califormia, 1966.

[3] Samal, A., Iyengar, P.A.,"Automatic Recognition and Analysis of Human Faces and Facial Expressions", Pattern Recognition. 25, 1992, pp. 65– 77.

[4] Chellappa, R., Wilson, C.L., Sirohey. S.,"Human and Machine Recognition of Faces: A survey", Proceedings of the IEEE, 83 1995, pp. 705–740

[5] Zhao, W.Y., Chellappa, R., Phillips, P.J., Rosenfeld, A.,"Face Recognition: A Literature Survey", ACM Computing Surveys, 35, 2003, pp. 399–458

[6] Bowyer, K.W., Chang, K., Flynn, P.J.,"A survey of approaches to three-dimensional face recognition", International Conference of Pattern Recognition, Vol. 1, 2004, pp. 358–361

[7] Suikerbuik, C.A.M., Tangelder, J.W.H., Daanen, H.A.M., Oudenhuijzen, A.J.K.,"Automatic feature detection in 3D human body scans", Proceedings of the conference ”SAE Digital Human Modelling for Design and Engineering, 2004.

[8] Gordon, G.G.,"Face Recognition Based on Depth Maps and Surface Curvature", Proceedings of the SPIE Geometric Methods in Computer Vision, Vol. 1570, 1991, pp. 108–110

[9] Moreno, A.B., S´anchez, A., V´elez, J.F., D´_az, F.J.,"Face Recognition using 3D Surface-Extracted Descriptors", Proceedings of the Irish Machine Vision and Image Processing Conference. 2003.

[10] Wong, H.S., Chueng, K.K.T., Ip, H.H.S.,"3D head model classification by evolutionary optimization of the extended Gaussian image representation", Pattern Recognition, 37, 2004, pp. 2307–2322

[11] Papatheodorou, T., Rueckert, D.,"Evaluation of automatic 4D Face recognition using surface and texture registration", Proceedings of the IEEE International Conference in Automatic Face and Gesture Recognition, 2004, pp. 321–326

[12] Omid Gervei, Ahmad Ayatollahi, Navid Gervei,"3D Face Recognition Using Modified PCA Methods Proceeding of the World Academy of Science, Engineering and Technology 63 2010.

[13] Dayong Wang, Steven C.H. Hoi, Ying He,"An Effective Approach to Pose Invariant 3D Face Recognition", The 17th International Conference on Multimedia Modeling (MMM2011)School of Computer Engineering, Nanyang Technological University,Singapore {S090023, chhoi, yhe}@ntu.edu.sg

[14] Chenghua Xu, Yunhong Wang, Tieniu Tan, Long Quan,"A New attempt to Face Recognition using 3D Eigenfaces", NOEL T GOLDSMITH Image Anal Stereol 2000, 19, pp. 163-167.

Sushil Gangwar received his B.E Degree in computer science from S.R.M.S. CET Bareilly in 2001, the M.Tech In Information Technology from KSOU Mysoor. He was teaching lecturer with department computer science ,SRMS CET BAREILLY since 2004-2010. He is Assistant Professor with department computer science, FIET Bareilly. His research interests include digital signal processing,

Ritika Kansal received Her B.Tech degree in Information Technology from S.R.M.S.C.E.T. Bareilly In 2008, the M.Tech in Computer Science from MMEC Gorakhpur. She was techning lecturer with department computer science and presently working as a assistant professor with department Information Technology, FIET Bareilly. Her research interests include digital signal processing.