A Survey Paper on 3D face Recognition Techniques
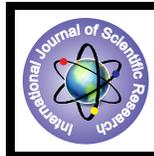
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ABSTRACT
Many researches in face recognition have been dealing with the challenge of the great variability in head pose, lighting intensity and direction, facial expression, and aging. The main purpose of this overview is to describe the recent 3D face recognition algorithms. 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.

INTRODUCTION

Now a days with the network world, the way for crime is become easier than before. Because of this reason, network security has become one of the biggest concerns facing today's IT departments.We heard a lot about hackers and crackers ways to steal any password or pin code, crimes of ID cards or credit cards fraud or security breaches in any important building and then reach any information or important data from any organization or company. These problems allow us to know the need of strong technology to secure our important data. This technology is based on a technique called "biometrics". Biometric is a form of bioinformatics that uses biological properties to identify people. Since biometric systems identify a person by biological characteristics, they are difficult to fake. Examples of biometrics are iris scanning, signature authentication, voice recognition and hand geometry. Face recognition is one example of biometric [1, 2] and it is use the character of the face to identify a person. Face recognition has drawn attention in computer vision at 1970 and the rest time the system of face recognition used was at 2001 for the purpose of reducing the crimes but this system fails to recognize the clear picture of any thief because the thieves were wearing a mask. Face recognition techniques can be broadly divided into three categories based on the face data acquisition methodology: methods that operate on intensity images; those that deal with video sequences; and those that require other sensory data such as 3D information or infrared imagery.

LITERATURE SURVEY

Alexander M. Bronstein, Michael M. Bronstein and Ron Kimmel presented an expression-invariant 3D face recognition approach. Their basic assumption is that facial expressions can be modelled as isometries of the facial surface. This allows to construct expression-invariant representations of faces using the canonical forms approach. The result is an efficient and accurate face recognition algorithm, robust to facial expressions that can distinguish between identical twins. They demonstrated a prototype system based on the proposed algorithm and compared its performance to classical face recognition methods. The numerical methods employed by their approach do not require the facial surface explicitly. The surface gradients field, or the surface metric, is sufficient for constructing the expression-invariant representation of any given face. It allows to perform the 3D face recognition task while avoiding the surface reconstruction stage.

This approach naturally incorporates the non-rigidness of the facial surfaces and allows to cope with facial expressions. The isometric model reduces the problem of comparing faces in the presence of facial expressions to the problem of isometric surface matching. The authors used the isometric embedding as a method to construct isometry-invariant representation of facial surfaces, which gives an expression-invariant representation

of the face. An implementation of 3DFACE algorithm shows high recognition accuracy, significantly outperforming standard 2D and 3D approaches, and works favorably even in the presence of very strong facial expressions. The main advantage of the 3DFACE algorithm is definitely when a large variability of facial expressions is present. The significance of it is first of all in commercial applications, which can never assume collaborative users, and especially in cases when the face recognition is assumed to work in a natural environment. Ideally, the user will be unaware of being scanned and recognized, which implies that the variability of his facial expressions can be significant. Yet, the results suggest that canonical forms are useful not only when extreme facial expressions are present, but also in cases where the faces seem to be completely expressionless. The explanation is the fact that an absolute "neutral expression" does not exist, such that even when apparently without expressions, the use of canonical forms can still be beneficial. Besides being insensitive to expressions, canonical forms conceal some other favorable properties. First, the obtained representation is irreversible. Therefore, given the canonical form it is impossible (or at least very hard) to find the underlying original facial surface. Thus, the canonical form in some sense "hides" the actual identity of the subject stored in the gallery. This is significant in commercial systems where the security of the biometric data is an important issue. Secondly, canonical forms provide an intrinsic parametrization of the facial surface, which leads to an easy registration of the facial images, and consequently, to an easy fusion of 2D and 3D information. Thirdly, embedding has a "regularization" effect on the facial surface: small local artifacts lead to fluctuation of all geodesic distances. The fluctuations in the canonical forms are no more local, but rather "spread" among all points of the canonical form. As a consequence, the canonical forms are less sensitive for example to acquisition and processing artifacts than the original surfaces.

Alexander M. Bronstein, Michael M. Bronstein , and Ron Kimmel presented a novel 3D face recognition approach based on geometric invariants. The key idea of the proposed algorithm is a representation of the facial surface, invariant to isometric deformations, such as those resulting from different expressions and postures of the face. The obtained geometric invariants allow mapping 2D facial texture images into special images that incorporate the 3D geometry of the face. These signature images are then decomposed into their principal components. The result is an efficient and accurate face recognition algorithm that is robust to facial expressions.

The authors proposed an algorithm capable of extracting the intrinsic geometric features of facial surfaces using geometric invariants, and applying eigen decomposition to the resulting representation. They obtained very accurate face recognition

results. The use of bending-invariant canonical representation makes their approach robust to facial expressions and transformations typical of non rigid objects. Experimental results showed that the proposed algorithm outperforms the 2D eigenfaces approach, and the straight forward incorporation of range images into the eigenfaces framework. Particularly, it was observed that even very significant deformations of the face does not confuse their algorithm, unlike conventional approaches.

Alexander M. BRONSTEIN, Michael M. BRONSTEIN, Ron KIMMEL and Alon Spira presented a 3D face recognition approach based on geometric invariant signatures. The key idea of the algorithm is a representation of the facial surface, invariant to isometric deformations, such as those resulting from facial expressions. One of the crucial stages in the construction of the geometric invariants is the measurement of geodesic distances on triangulated surfaces, carried out by fast marching on triangulated domains (FMTD). The authors proposed a method, which uses only the metric tensor of the surface for geodesic distance computation. When combined with photometric stereo used for facial surface acquisition, it allows constructing a bending invariant representation of the face without reconstructing the 3D surface.

The authors showed how to perform 3D face recognition without reconstructing the facial surface. 3D face recognition based on bending-invariant representations, unlike previously proposed solutions, makes face recognition robust to facial expressions, head orientations and illumination conditions. Their approach shows here an efficient use of simple 3D acquisition techniques (e.g. photometric stereo) for fast and accurate face recognition. Experimental results demonstrate superiority of their approach over straightforward rigid surface matching.

Afzal Godil, Sandy Ressler and Patrick Grother in their paper, investigated the use of 3D surface geometry for face recognition and compared it to one based on color map information. The 3D surface and color map data are from the CAESAR anthropometric database. They found that the recognition performance is not very different between 3D surface and color map information using a principal component analysis algorithm. They also discussed the different techniques for the combination of the 3D surface and color map information for multi-modal recognition by using different fusion approaches and showed that there is significant improvement in results. The effectiveness of various techniques is compared and evaluated on a dataset with 200 subjects in two different positions.

In this study they showed that it is possible to use facial surface and color map information from the CAESAR database for face recognition. The performance based on color map signature is slightly better than that based on 3D facial surface signature. They also showed that fusion of the two biometrics gives higher performance than individual biometrics. The results show that the performance of fusion at score level is higher than of fusion at image level. They suspected that this is due to a scaling problem in the 3D and color map data. The quality of 3D surface data is not as good as the 2D colored images from a digital camera. The 3D data usually have missing data or voids in the concave area of a surface, eyes, nostrils and areas of facial hair that does not happen with a digital camera. The facial surface data available to them from the CAESAR database was also coarse (~4000 points) compared to a 2D image (3 to 8 million pixels) from a digital camera and also compared to other 3D studies where they had around 200,000 points on the facial surface area. The cost of a 3D scanner is also much higher than a digital camera for 2D images.

Xuebing Zhou and Helmut Seibert and Christoph Busch and Wolfgang Funk presented an automatic face recognition ap-

proach, which relies on the analysis of the three-dimensional facial surface. The proposed approach consists of two basic steps, namely a precise fully automatic normalization stage followed by a histogram-based feature extraction algorithm. During normalization the tip and the root of the nose are detected and the symmetry axis of the face is determined using a PCA analysis and curvature calculations. Subsequently, the face is realigned in a coordinate system derived from the nose tip and the symmetry axis, resulting in a normalized 3D model. The actual region of the face to be analyzed is determined using a simple statistical method. This area is split into disjoint horizontal subareas and the distribution of depth values in each subarea is exploited to characterize the face surface of an individual. Their analysis of the depth value distribution is based on a straightforward histogram analysis of each subarea. When comparing the feature vectors resulting from the histogram analysis they applied three different similarity metrics. The proposed algorithm has been tested with the FRGC v2 database, which consists of 4950 range images. Their results indicate that the city block metric provides the best classification results with their feature vectors. The recognition system achieved an equal error rate of 5.89% with correctly normalized face models.

The authors focused on face recognition based on pure 3D shape information. A precise normalization algorithm as well as an efficient histogram-based feature extraction algorithm were introduced. The feature extraction algorithm is computational efficient and to a certain extent tolerant to typical 3D capturing errors like holes and spikes. The experimental evaluation results of the proposed algorithm based on the FRGC database v2.0 were presented. The simulation results have proved the feasibility of the histogram-based algorithm for 3D face recognition. The performance of the proposed feature extraction algorithm currently lies within the accuracy range of their normalization algorithm. The robustness of the proposed feature extraction algorithm to strong expression variation was evaluated.

Kakadiaris G. Passalis, G. Toderici, N. Murtuza, T. Theoharis in their paper, presented a new 3D face recognition approach. Full automation is provided through the use of advanced multi-stage alignment algorithms, resilience to facial expressions by employing a deformable model framework, and invariance to 3D capture devices through suitable preprocessing steps. In addition, scalability in both time and space is achieved by converting 3D facial scans into compact wavelet metadata. They presented results on the largest known, and now publicly-available, Face Recognition Grand Challenge 3D facial database consisting of several thousand scans. Their approach achieved the highest accuracy on this dataset.

The authors presented algorithmic solutions to most of the challenges faced by 3D facial recognition systems. By utilizing a deformable model they mapped the 3D geometry information onto a 2D regular grid, thus combining the descriptiveness of 3D data with the computational efficiency of 2D data. A multistage fully automatic alignment algorithm and the advanced wavelet analysis resulted in robust state-of-the-art performance on the publicly available FRGC v2 database.

Kyong I. Chang Kevin W. Bowyer Patrick J. Flynn examined the value of multi-modal biometrics with 2D intensity and 3D shape of facial data in the context of face recognition in a single probe study and a multiple probe study. This was the largest experimental study (in terms of number of subjects) that to investigate the comparison and combination of 2D and 3D data for face recognition. In their results, each modality of facial data has roughly similar value as an appearance-based biometric. The combination of the face data from both modalities results in statistically significant improvement over either individual biometric. In general, their results appear to support the

conclusion that the path to higher accuracy and robustness in biometrics involves use of multiple biometrics rather than the best possible sensor and algorithm for a single biometric. They also investigated the effect of spatial and depth resolution on recognition performance. This was done by producing successively coarser versions of the original image. The original image had a depth accuracy at 0.35mm. They found that performance drops only slightly in going to a depth resolution of 0.5mm, but begins to drop drastically at 4mm. The pattern of results suggests that it would be interesting to determine a sensor accuracy level needed to meet a specific requirement of face recognition tasks. The accuracy requirement might vary under different conditions of subjects, such as facial muscle movement, or imaging condition changes. This initial investigation in resolution variation would bring a more explicitly decided resolution level for further experiments. The overall quality of 3D data collected using a range camera is perhaps not as reliable as 2D intensity data. 3D sensors in the current market are not as mature as 2D sensors. Common problems with typical range finder images include missing data in eyes, cheeks, or forehead as well as several types of noise. These problems would lower the 3D recognition rate in general even though there exist ways of recovering some data in such areas. The criteria used to decide which combination of eigenvectors to keep is the rank-one recognition rate on the gallery and probe images. So, in a way, the gallery and probe images are used in deciding what eigenvectors to use for the space, and then the results are also reported on the gallery and probe images, thereby "testing on training data". This can be addressed by having a validation set of images to determine the set of eigenvectors to be used during the identification process so that eigen vectors to keep before the performance on the gallery and probe images are obtained. It is generally accepted that performance estimates for face recognition will be higher when the gallery and probe images are acquired in the same acquisition session, compared to performance when the probe image is acquired after some passage of time. Most envisioned applications for face recognition technology seem to occur in a scenario in which the probe image would be acquired sometime after the gallery image. In this context, it is worth noting that the dataset used in their paper incorporates a substantial time lapse between gallery and probe image acquisition.

CONCLUSION

As you can see, face recognition system is very important in our daily life. It is possesses a really great advantage. Among the whole types of biometric, face recognition system is the most accurate. Research has been conducted vigorously in this area for the past four decades or so, and though huge progress has been made, encouraging results have been obtained and current face recognition systems have reached a certain degree of maturity when operating under constrained conditions; however, they are far from achieving the ideal of being able to perform adequately in all the various situations that are commonly encountered by applications utilizing these techniques in practical life. The ultimate goal of researchers in this area is to enable computers to emulate the human vision system. To attain this objective, "Strong and coordinated effort between the computer vision, signal processing, and psychophysics and neurosciences communities is needed".

REFERENCE

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