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RESEARCH ARTICLE

A Study on Facial Feature Extraction and Facial Recognition Approaches

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ABSTRACT

Face Recognition is having the importance to provide biometric authentication with easy image acquisition that can be used for online and offline applications. There are number of existing approaches for biometric facial recognition and classification. In this paper, some of the common and reliable approaches for facial recognition are explored. These approaches include PCA, LDA, KDA, Neural Network etc. The paper has also discussed the basic model of facial recognition and explained each stage of this model. It also includes different methods of feature extraction to describe the facial components.

Keywords: Biometrics, SIFT (Scale Invariant Feature Transform), SURF (Speeded-Up Robust Features)**,** Face recognition, recognition Rate

1. INTRODUCTION

A. Biometric Recognition

Biometrics are automated methods of recognizing a person based on a physiological or behavioral characteristic. Among the features measured are: face, fingerprints, hand geometry, handwriting, iris, retinal, vein, and voice. Biometric technologies are becoming the foundation of an extensive array of highly secure identification and personal verification solutions. As the level of security breaches and transaction fraud increases, the need for highly secure identification and personal verification technologies is becoming apparent.

Biometric-based [1] solutions are able to provide for confidential financial transactions and personal data privacy. Enterprise-wide network security infrastructures, government IDs, secure electronic banking, investing and other financial transactions, retail sales, law enforcement, and health and social services are already benefiting from these technologies. Utilizing biometrics for personal authentication is becoming convenient and considerably more accurate than current methods (such as the utilization of passwords or PINs).

a. Biometric System

A biometric system is essentially a pattern recognition system that operates by acquiring biometric data from an individual, extracting a feature set from the acquired data, and comparing this feature set against the template set in the database.

b. Major components of a biometric system are:

- Data collection to build the Database
- Pre-Processing of Data
- Creation of Database
- Matching Process
- Identification Process

B. Face Recognition

Face Recognition is one of most used and the challenging biometric recognition and authentication system. One of the most challenging phenomenons associated with facial recognition is the accuracy for the real time images. With the time, the face recognition is also integrated with number of associated challenges. These challenges include the incompleteness

of images, noise, distortion etc. One of such common problem identified in these days is morphed images. A morphed image is the edited image using some image processing software or tool. These morphing can be done in terms of inclusion of some effect, merging two images, changing the hair cut etc. Because of this, the detection of person in these morphed images is a challenge. So that, an improved SIFT (Scale Invariant Feature Transform) is required to improve the recognition rate on morphed images. SIFT is the approach that uses the location descriptor as the key feature points to generate the dataset and to perform the recognition over the images. In this work, the complete image will be divided in several sub images based on the locational features. These features include eyes, nose, mouth etc. Once the locational segmentation will be performed, the next work is to apply the SIFT on each location segment to extract the key features over it. At the final stage, the distance level analysis over the images will be performed to recognition. The work is about to improve the recognition rate.

C. Four Stage Model

Stage 1: Filtration

This stage will basically handle the most common problem of real time images. The problems include the noise problem, un-equal brightness problem etc. The work will perform the filtration against different kind of noise as well as verification by using the statistical method so that the identification of the effective filtration of image will be performed.

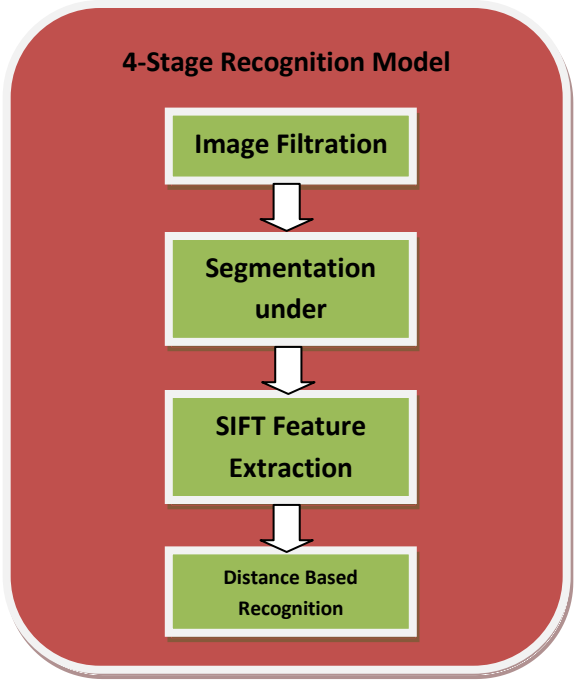

Figure 1: 4-Stage Model

Stage2: Segmentation

The second stage of the work is to identification of the physical features from the face image. These features include the eyes, nose, lips etc. The positional analysis approach will be implemented to identify these features from the face image.

Stage 3: SIFT Feature Extraction

The SIFT is here been applied to extract the features over the facial images. The location descriptor is been used to extract such features.

Stage 4: Distance based Recognition

In this stage, the recognition process will be performed on individual feature by using distance based analysis. This recognition process will be applied on individual region and then combined to generate the total recognition rate.

D.Challenges

a) **Deformations**- These are the result of injury or accident on the face.
b) **Expressions**- This shows the mood of the person. From expressions it is easy to determine whether the person is happy or sad.
c) **Aging**- With age wrinkles appears on the face. The wrinkles change the formation of the face to a great extent.
d) **Facial hairs**- Man have moustaches and beard which change the look of the face when shaven.
e) **Cosmetics**- Cosmetic surgery has become one of the widely used techniques to enhance your facial features.

2. RELATED WORK

Anil K. Jain, Arun Ross and Salil Prabhakar [1] designed a Biometric Recognition system using the four main modules:

1. *Sensor module*, which captures the biometric data of an individual.
2. *Feature extraction* module, in which the acquired biometric data is processed to extract a set of salient or discriminatory features.
3. *Matcher module*, in which the features during recognition are compared against the stored templates to generate matching scores.
4. *System database* module, which is used store the biometric templates of the enrolled users.

Arun Ross, Anil Jain [2] proposed Multibiometric system which seeks to alleviate some of drawbacks of single biometric system by providing multiple evidences of the same identity. These systems help to achieve an increase in performance that may not be possible using a single biometric indicator. Multibiometric systems provide anti-spoofing measures by making it difficult for an intruder to spoof multiple biometric traits simultaneously. The authors proposed Fusion in biometrics with certain levels.

Madalin Tefan Vlad, Razvan Tatoiu, Valentin Sgarciu [3] proposed an integrated system for automatic identification, using smart card and fingerprint features. The goal is to do both a biometric verification and identification, with the personal data stored on the smart card. The first important step is considered to be the enrollment. Therefore, a new user, who will be involved in the system, comes to an authority and gets his finger scanned for several times (usually 3-5 times), in order to get the best fingerprint. From the images captured by the biometric sensor, the features are extracted, and the best feature string, with maximum number of minutiae will be stored on the smart card. Sending and storing the minutiae string on the smart card are done in a secure way, with several mechanism of authentication, in order for the personal data to be perfectly protected.

Jun Ou，Xiao-Bo Bai Yun Pei ,Liang Ma, Wei Liu[4] presents a system that uses 28 facial feature key-points in images detection and Gabor wavelet filter provided with 5 frequencies, 8 orientations. In according to actual demand, It can extract the feature of low quality facial expression image target, and have well robust for automatic facial expression recognition.

Experimental results show that the performance of the proposed method achieved excellent average recognition rates, when it is applied to facial expression recognition system.

In Year 2012, Madhu performed a work," A Novel Approach to Face Recognition under Various facial expressions, Occlusion and Tilt Angles". The proposed method on face recognition have been focused on color co-occurrence matrix approach & principal component analysis — applies PCA only on CCM classified Images. In comparison with the traditional use of PCA, the proposed method gives better recognition accuracy and less computational time for different facial expressions.

In Year 2013, Xingjie Wei performed a work," ROBUST FACE RECOGNITION WITH OCCLUSIONS IN BOTH REFERENCE AND QUERY IMAGES". In this paper, Author summaries three occlusion cases that a realistic FR system should take account of. Author presents a novel non-parametric classification method to handle the occlusion related problems. Presented method represents a face image as a sub-patch sequence which maintains the inherent structure information of the face.

In Year 2014, S.Jenifer performed a work, "Face Identification from Manipulated Images using enhanced SIFT and SURF". In this paper, the extraction of the recognition of morphed images is been done using SIFT based feature analysis approach. The SIFT is here applied on whole image as the location descriptor. This feature dataset will be used for the recognition.

3. APPROACHES

The method for acquiring face images depends upon the underlying application. For instance, surveillance applications may best be served by capturing face images by means of a video camera while image database investigations may require static intensity images taken by a standard camera.

EXISTING approaches for face recognition (FR) mainly deal with issues such as variation in expression, lighting, pose, and acquisition time, but none of them is free from limitations.

Main Approaches are classified as linear methods and non-linear methods.

Some Linear methods are:-

a. Eigenfaces: This is a linear method. This is fast, simple, and practical technique, but they are not invariant to changes in illumination, pose, and scale. Neural networks are attractive

because their feature extraction step is more efficient than the Karhunen–Loève transform, but the computation complexity increases with the number of enrolled persons, and the recognition rate (RR) decreases when the number of classes becomes too high.

b. Principal component analysis (PCA): This is a linear method and widely used in the appearance-based approaches for FR (Face Recognition). This approach aims at solving the recognition problem within a representation space of lower dimension than image space.

c. Linear discriminant analysis (LDA):

This is also a linear method. And this aims at solving the recognition problem within a representation space of lower dimension than image space. In general, LDA based algorithms outperform PCA-based ones, but they suffer from the so-called *small-sample-size problem* (SSS) which exists in high-dimensional pattern recognition tasks.

d. Combining PCA and LDA: By combining PCA and LDA, some discri-minate information is discarded together with redundant one.

A possible alternative to linear methods is provided by the class of nonlinear ones.

a. Kernel-machine-based discrimi-nant analysis (KDA):

It deals with the nonlinearity of the face

pattern distribution and can be seen as an enhanced kernel D-LDA method. It first nonlinearly maps the original input space onto an implicit high-dimensional feature space, where the distribution of face patterns is hoped to be linearized and simplified. Then, solving the SSS problem, it derives a set of optimal discriminant basis vectors in the feature space.

b. Neural Network:

Another nonlinear solution to the FR problem is given by the neural networks, largely used for pattern recognition problems, and readapted to cope with the people authentication task. The advantage of neural classifiers over linear ones is that they can reduce misclassifications among the neighborhood classes. The basic idea is to consider a net with a neuron for every pixel in the image. Nevertheless, because of the pattern dimensions (an image has a dimension of about 112 × 92 pixels), neural networks are not directly trained with the input images but with images obtained from them using some dimensionality reduction technique.

c. Hybrid approach:

In this approach PCA and neural networks are jointly used. In general, neural-network-based approaches encounter problems when the number of classes increases. Moreover, they are not suitable for a single-model-image recognition task, because multiple model images per person are necessary in order for training the system to "optimal" parameter setting.

Two other most widely used approaches are:

a. SIFT (Scale Invariant Feature Transform):

In 2004 Lowe, invents SIFT [7] descriptor which is invariant to scale, rotation, affine transformation, noise, occlusions and is highly distinctive. SIFT features consist of four major stages in detection and representation; they are (1) finding scale-space extrema; (2) key point localization and filtering; (3) orientation assignment; (4) key point descriptor. The first stage is to construct the key points of images by using Difference-of-Gaussian (DoG) function. The second stage, candidate key points are restricted to sub-pixel accuracy and removed if found to be unreliable. The third stage represents the dominant orientations for each essential point of the images. The final stage constructs a descriptor for each key point location depends upon the image gradients in its local neighborhood. Then the SIFT descriptor is accepting the 128-dimensional vector which used to identify the neighborhood around a pixel.

The SIFT extracts the key points (locations and descriptors) for all the database images. Then given an altered image SIFT extracts the key point for that image and compares that point to the dataset.

b. SURF (Speeded-Up Robust Features):

The SURF [7] also extracts the key points from both the database images and the altered images. This method matches the key points between altered image and each database image.

In 2008, H. Bay invents SURF descriptor which is invariant to a scale and in-plane rotation features. It consists of two stages such as interest point detector and interest point descriptor. In the first stage, locate the interest point in the image. Use the Hessian matrix to find the approximate detection.

4. CONCLUSION

The paper has discussed different approaches for facial recognition and classification. These approaches are feature based approaches derived from weighted analysis applied to obtain the image features and to perform effective recognition of facial image. The paper also presented improved SIFT approach will use the segmented approach for feature extraction so the accuracy of work will be improved.

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