A Framework for Image Based Face Recognition System Using Different Transformation and Neural Network

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Abstract

Biometrics is one of the widely used and important technologies being used by many organisations for the security reasons and other authentication and verification purpose. From the last few decade's biometrics and its various other methods are expanding worldwide due to the amazing feature of uniqueness and also the secure authentication. Biometrics comprises various techniques like palm print recognition, voice recognition, iris scan, retina scan, also hand scan, face recognition, signature recognition and various other techniques. Each technique or method has its own merits and demerits in variety of fields or application. This dissertation is concerned about one of these biometric technique that is: image based biometric that is Face Recognition. This Face recognition is the most effective and natural technique to identify a person. First of all various methods and techniques for the purpose of face detection and feature extraction is discussed and then a methodology is developed to find a better recognition rate for face recognition. This dissertation also introduces a new method or technique to recognize human face artificially using Discrete Cosine Transform (DCT), Principal Component Analysis (PCA) and Self Organize Map (SOM) neural network. Principal component analysis (PCA) is one of the classical and also successful method of the dimension reduction. And Discrete Cosine Transform (DCT) is a well known compression technique and Self Organize Map (SOM) act as a classifier and has been used for face space representation.

Keywords: Biometrics, Methodology, Discrete Cosine Transform, Principal component analysis

1. Introduction

Our primary focus of attention in social intercourse is a face which plays a major role in conveying identity and emotion of a person. The human ability to recognize faces is remarkable. We can recognize thousands of faces throughout our lifetime and even after years of separation human identify familiar faces at a glance. It has been an active and interesting research area and studied by scientists from different areas and fields of psychophysical sciences and those from different fields of computer sciences in last 30 year. Engineers studying on machine recognition of human faces whereas psychologist and neuroscientists deal with the human perception of image of video based face recognition. The main reason of active research in the area of face recognition is due to its applications in various fields around the world.

Face recognition application has been categorized in two main parts: law enforcement area and commercial application. Face recognition technology is primarily used in law enforcement field, especially in CCTV control, advance video surveillance, base portal control. Under the commercial applications matching of photograph on credit cards, Debit cards, passports, driver's licenses, ATM

cards, National ID has come. A first formal method of classifying faces in 1888 was proposed by Francis Galton [1]. During the period of 1980's work on face recognition technology remained largely quiescent but after this period in 1990's, the research interest in face recognition technology has grown widely as a result of the following facts:

1. The increase in emphasis on civilian and commercial research work projects.
2. The re-emergence of neural network classifiers with emphasis on real time computation and adaptation.
3. The easy of availability of real time hardware.
4. The growing need for surveillance related applications due to criminal verification or identification and scanning airport for drug trafficking, terrorist, etc.

Although it is clear that face recognition technology is the technique which human can do better effortlessly. For computer vision this task is not that easy as human can do. It is quite tuff to deploy or develop computational model of face recognition just because faces are little complex and multi-dimensional surface. Facial feature extraction has some problem like small or big orientation and small variation processing of face size can affect the result. Sometime images are different in brightness, clearances and shadows which can be failed the process and feature may be covered by other things, such as a hand, a hat, hairs or glasses. The main problem in face recognition is classification problem, in which the system is trained with images from known individual faces and classifying the newly coming test images into one of the classes. Recent research in image analysis and pattern recognition opens up the possibility of automatic detection and classification of conversational and emotional facial signals.

Human face identification or verification starts with the relevant feature extraction step from various facial images. It is been shown in researches that feature extraction importance cannot be overstated in face recognition. Neurophysiologic research and studies have determined that the most important features for face recognition are eyes, mouth, and nose. Most facial feature extraction methods are sensitive to various non-idealities such as noise, orientation, time consuming, variations illumination and color space used. A good feature extraction will improve the performance of face recognition system. There are various methods or techniques have been developed for feature extraction in last few years and these techniques can be divided into these three categories: First is Geometry based, Second is template based and third is color segmentation based [2]. Researcher conducted numerous studies comparing various feature extraction techniques and their robustness to facial feature appearance changes.

There are three different approaches of the face recognition problem and first approach has dealt with various facial characteristics which are used by human beings in recognizing several individual faces. Second approach among above performs human face identification based on feature vectors extracted from profile silhouettes. Third approach among above uses feature vectors extracted from a frontal view of the image or face. Basically there are mainly two methods from which above three approaches arise. The very first method is based on the concept of information theory, in this concept the most relevant and important information that describe a face is derived from the entire face image. M. Kirby and L. Sirovich [12] based on the Karhunen-Loeve expansion in pattern recognition, have shown that any particular face could be economically represented in terms of the best coordinate system that they termed "Eigen faces". Later, M. Turk and A. Pent land based on the Eigen faces approach have proposed a face recognition technique or method. L. Yuille and S. Cohen played a

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great role in adapting other second method to extract feature.

Keywords: Biometrics, Eigen faces, Discrete Cosine Transform, Principal component analysis

[1] In past decade's importance of security and organization, identification and authentication methods have gradually increased. There are several areas where security is required: access control for computers in general, entrance control in buildings, or for automatic teller machines in general, daily jobs like withdrawing money from a bank account, [2] Biometric identification is an important and interesting technique of automatically identifying or verifying an individual by a personal trait or physical characteristic. The term "automatically" means the biometric identification system have to identify or verify a human trait or feature quickly with some little or no intercession from the user.

2. Literature Review

Face Recognition (FR) is one of the most applicable applications of image analysis. Face Recognition system is a process of automatically verifying or identifying a person's face from a given database of digital images. One of the ways to do this recognition is by comparing the selected facial features from a particular image and after then comparing them with the given facial database. It is a true challenge to build an automated generated system which equals the ability of the human to recognize the faces. Since humans are quite good at identifying known faces but not very skilled when they have to deal with a large number of faces. Computers, with almost limitless memory and high computational speed can overcome human's limitations to a greater extent. From past two decades FR has got a lot of attention by researcher due to its large range of application.

Bledsoe *et al.* [10] researched on programming computers to recognize human faces. Bledsoe was the first who developed a semi-automated face recognition system. In this, system extracts the coordinates of a given set of features from the images or photographs which actually used by the system of computer for the purpose of recognition.

Here we can say that much of the work in the field of face recognition has been focused on detecting the individual features of the facial image (which includes the nose, mouth, eyes and head outline) and also to define a face model by the size, position, and relationships among these features. After then The operator will extract the coordinates of the features such as the center of pupils, and the outside corner of eyes, and the inside corner of eyes, and the point of widow's peak, etc. From these of the mentioned coordinates a list of 20 or more distances such as the width of eyes and width of mouth, pupil to pupil, are computed. The paper entitled "Identification of human faces" by Goldstein *et al.* [12] described a vector to recognize faces using pattern classification techniques which were containing 21 subjective features like ear protrusion, eyebrow weight or nose length. For this vector three classes of experiments were used: i) Gathering, analysis, or and also the assessment of face-feature data for the database of 256 faces, ii) Computer identification-studies, and iii) Human identification- studies. 256 persons photograph in three different views full face, 3/4view, and profile were taken with carefully arranged technique. From the main set of 34 features, only 22 features were evolved and rest of them were excluded to provide significant, inbred, self-sufficient measures which could be judged by judges reliably. Computer studies represent the behavior of person in a face-identification task.mponents attained. Kenade [18] was the first person who developed a fully automated Face Recognition system in 1973 and described his research in the paper entitled with the name "Picture Processing System by Computer Complex and Recognition of Human Faces". In which all steps were automated and algorithm detect 16 facial parameters from a single face image and use a pattern classification technique to match the face from a known set. Canada

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worked solely with gray scale images. In his algorithm, the gray scale image was filtered with a Laplacian operator to extract edges. Then the head top, face sides, nose, mouth, chin, chin contour, and eyes were detected, in that order, by analysing horizontal and vertical integral projections.

3. Problem Statement &Methodology

The aim of this research is to present and identify design and develop efficient face recognition system in MATLAB

- To design a new model for an ideal facial recognition system.
- To enhance the model for a high-speed facial recognition system.
- To develop a program based on the designed model in MATLAB.
- To create a database of face images.
- To test and validate the facial recognition system.

To perform tests for program optimization and accuracy.

Face recognition has become a popular and useful area of research in computer vision from last one or two decades, mainly due to increasing security demands and its commercial and potential and law enforcement applications in various fields. After a extensive research of 40 year still face recognition is a very challenging problem and up to date and there is no technique that provides a robust solution to all situations and different applications that face recognition may encounter. This dissertation focuses on developing a technique that provides a solution for an efficient high-speed face recognition system in different applications.

All these biometric technologies stated above cannot be work in environment where human interaction is low with security system. They work best in high security applications where human interaction is present but actually they are the opposite of what is required when building a store that recognizing its customers or we can say best customers, or a house that knows the persons who live there. A well-known biometric technique is face recognition which is non-intrusive and highly useful for human surveillance. It would allow user to be identified by simply walking past a surveillance camera. Facial recognition technology is one of the fastest growing fields in the biometric industry, is being used to improve human efficiency when recognizing faces. Interest in facial recognition is being fuelled by the ever-increasing number of video cameras being placed in the workspace, the availability and low cost of video hardware, and the non-invasive aspect of facial recognition systems. Although the face recognition system is still in research phase and with our dissertation we will step further in this research phase.

4. Implementation

This chapter gives a detailed explanation of the SOM neural network testing for a variety of trained and untrained inputs and the experimental work carried out for optimal efficiency and to attain a high-speed design. For neural network validation testing different tests were carried out with both trained and untrained input face images for different subjects with different facial expressions leading to the validation of the SOM neural network.

An initial test was carried out on the SOM neural network to test its validity. The training database, consisting of 5 subjects is shown in Figure 4.1. The trained input face images are shown in Figure 4.2.

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Fig 4.1 Training Database of 5 Subjects

Fig 4.2 Test Database of 5 Subjects

The SOM neural network generated correct answers for all trained input images in Figure 4.2, except for Figure 4.2 (e), which is not present in the training database set. For this case the classification section generated an error. This error can be corrected by adding an extra *else* statement which will display, "subject not found in database".

A number were tests were carried out for untrained face images. Firstly a modified training database similar to the trained face images in Figure 4.3 was trained.
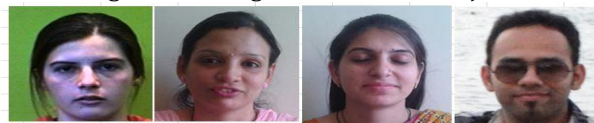

Fig 4.3 Training Database of 5 Subjects

Fig 4.4 Untrained Input Face Images

The SOM neural network generated correct answers for all untrained input images except for Figure (e) which is not present in the training database set. This validated the accuracy of the SOM neural network for face images with different subjects. For further testing and SOM neural network validation untrained face images with different facial expressions were used as shown in Figure 4.5, while the training database remained the same as shown in above figure 4.4.

Fig 4.5 Untrained Input Face Images with Various Facial Expressions

The SOM neural network generated correct answers for all untrained input images with various facial expressions in Figure 4.5. The subject in the untrained input images matched correctly with the same

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subject training database under a different facial expression. For advanced SOM neural network validation a final training database of 16 face images with different facial expressions was constructed.

5. Conclusion

Automatic face recognition of people is a challenging task which has been receiving much of the attention during some last recent years due to its various applications in various different fields. There are various hurdles that come during face recognition like skin color, age's effect, color and gender. This hurdles become more complicated when facial expression and background condition, facial furniture has come during recognition. After 30 to 40 year of vast research in this area of face recognition there is still not technique or a method that would provide a complete robust solution for all the different situations. This dissertation is dedicated towards this situation and presents a new method or technique for automatic human face recognition using MATLAB. With the summarization of biometric and face recognition research, its advantages, , limitation and development direction have been identified. Different type of feature extraction technique have been identified and on the basis of literature survey it is been concluded that appearance-based technique is mainly used because it uses small number of features and recognition rate is comparatively high. From the various feature extraction methods PCA with the combination of DCT performs better because it reduces the dimension of the image space which is needed to describe the data economically. After going through comparisons conducted in numerous papers it has seen that PCA in combination with DCT is slightly better than LDA. About the classifiers, it has been seen that various type of classifier on the basis of similarity and probability based. The artificial neural network classifier is simple and provides better and optimal result. It is not saying that other classifiers are not able to provide better result but any classification process, technique or procedure seeks a functional relationship between the group membership of the object and also the attributes of the object, accurate and optimal identification of this basically underlying function is doubtlessly very important and the neural network are universal functional approximator so we can say that neural networks can approximate any function with arbitrary accuracy and lots of literature survey papers have shown this output too. The proposed system uses Principal Component Analysis in combination with Discrete Cosine Transform method to remove unwanted data from face images and provide most relevant feature vectors.

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