Face Recognition: A Holistic Approach Review

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***Abstract*—Face recognition has become more significant and relevant in recent years owing to its potential applications. Face recognition has far reaching benefits to corporations, the government and the greater society. Face recognition is basically identifying individuals by their faces. There are many face recognition approaches which are generally classified as feature based and holistic approaches. Presently there are a very small number of studies which compare both these approaches. There is a tremendous increase in face recognition research nowadays; primarily because of the various negative events taking place around the globe. With the increase in the number of proposed algorithms and techniques the survey and evaluation of these algorithms and techniques becomes more vital to provide a boost to the research activities. The primary aim of this paper is to provide a critical summary of the existing literature on human face recognition over the past decade with special reference to holistic approaches to face detection.**

Keywords—Face Recognition System (FRS), Face Recognition, Face Detection, PCA (Principal Component Analysis), Eigenface, Artificial Neural Networks (ANN), Fuzzy Theory

I. INTRODUCTION

Though we as human beings have been using our FACES to identify people, recent development in Computer Science now provide same identification automatically. Early FRSs (Face Recognition Systems) used simple geometric models but as of today Face Recognition has matured into a science in itself. Implementation of engineering principles in this area has put FRSs into spot light. Face recognition can be used for both verification and identification (open-set and closed-set). FRS has been extensively studied over the past twenty-five years with respect to various domains viz. 2D, 3D and video resulting in huge advancements in FRS Research. But, performance of FRS is degraded under different postures, light conditions, facial expressions, unnatural obstruction and age. [11]

Face recognition offers a lot of opportunities to be explored for research. Hence this study aims to address the shortcomings that deteriorate the performance of face recognition system and explore new optimized techniques. The new system is being proposed to remove limitations such as posture, light conditions and expression variations, etc. [12]

Face recognition is basically pattern recognition for facial cases, which can be described to classify the known face and unknown face. Since the faces are highly dynamic and pose more issues and challenges to solve, researchers in the domain of pattern recognition, computer vision and artificial intelligence have proposed many solutions to reduce such difficulties so as to improve the robustness and recognition accuracy. The objective of this paper is to provide a survey of face recognition papers that appeared in the literature in the past concerning holistic approaches to face detection and recognition.

Basically face recognition approaches can either be classified as holistic based or feature based. The features used in holistic and feature-based approaches are fundamentally different.

In holistic based approaches recognition is done based on global features from faces, whereas in feature based faces are recognized using local features from faces. Holistic approach features represent optimal variances of pixel data in facial images used to uniquely identify a person. Whereas features of feature-based approaches represent face features like the eyes, nose and mouth to uniquely identify a person. [9]

II. FACE RECOGNITION SYSTEMS

Face Recognition System (FRS) process can be subdivided into two main parts. The first part is image processing and the second part is recognition techniques. The image processing part consists of face image acquisition through scanning, image enhancement, image clipping, filtering, edge detection and feature extraction [12]. The second part consists of the artificial intelligence which is composed by genetic algorithms and there are many approaches for face recognition [10].

Feature-based approaches first process the input image to identify and extract (and measure) distinctive facial features such as the eyes, mouth, nose, etc., as well as other fiducial marks, and then compute the geometric relationships among those facial points, thus reducing the input facial image to a vector of geometric features. Standard statistical pattern recognition techniques are then employed to match faces using these measurements [12].

However, if the facial features are manually extracted, it is reasonable to assume that the recognition performance would have been much lower if an automated, and hence less precise, feature extraction method had been adopted. In general, current algorithms for automatic feature extraction do not provide a high degree of accuracy and require considerable computational capacity [11].

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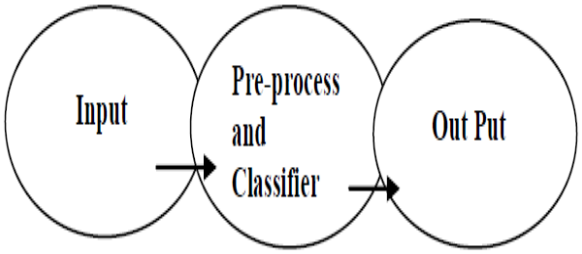

Fig1.Generic representation of a face recognition system

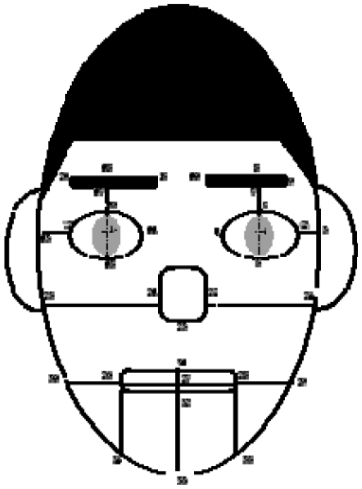

Fig 2. 35 Manually identified facial features

III. HOLISTIC APPROACHES TO FACE DETECTION

Holistic approaches to face recognition takes into consideration global information from the given set of faces to perform face recognition and verification. The global information is primarily represented by a very small number of features which are directly derived from the pixels of facial images. These features are responsible to distinctly identify and represent the variations among the different facial images and hence uniquely identify the individual or the subject.

A. The Eigenface Approach

The Eigenfaces methods so called Eigenvector or Principal Component Analysis (PCA) methods are the general methods of face recognition. Faces can be easily reconstructed by considering only a small amount of information obtained using Eigenfaces. [1] Eigenfaces are nothing but principal components mathematically that bifurcate the face into feature vectors in the form of covariance matrix. Then these vectors are used to calculate the variation among multiple faces. The faces are characterized by linear combination of highest Eigenvalues. The M Eigenfaces represent M dimensional face space. Here the researcher showed 96, 85 and 64% right categorization under varying lighting condition respectively, orientation and size by exploiting 2500 images of 16 each. The low face recognition rate is due to the silhouti background just at the back of the face. [2]

The correlation of entire face does not show reasonable results. The illumination normalization is very much necessary for Eigenfaces. [1] Eigenfeatures like eye, nose, mouth, cheeks, etc can be used instead of Eigenfaces. This approach is less sensitive as compared to the Eigenface method. In this case the system attains 95% recognition rate on 7562 FERED images of 3000 per person. In short, Eigenface approach is most reliable, fast and efficient that endows invariance information also in the presence of varying lighting and scaling conditions. [3]

In recent developments, a face recognition technique which is based on Multi linear principal component analysis and locality preserving projection to improve the performance of face recognition system which uses MPCA for facial image preprocessing and LPP for extraction of facial features. Experimental results reveal good facial recognition accuracy. [4]

Eigenface algorithm using principal component analysis (PCA) for reduce dimension to find vectors have best value to distribute face image in input face space. This vector define subspace named face space, training set projected into face space to find set of weight that describe contribution of each vector in face space.

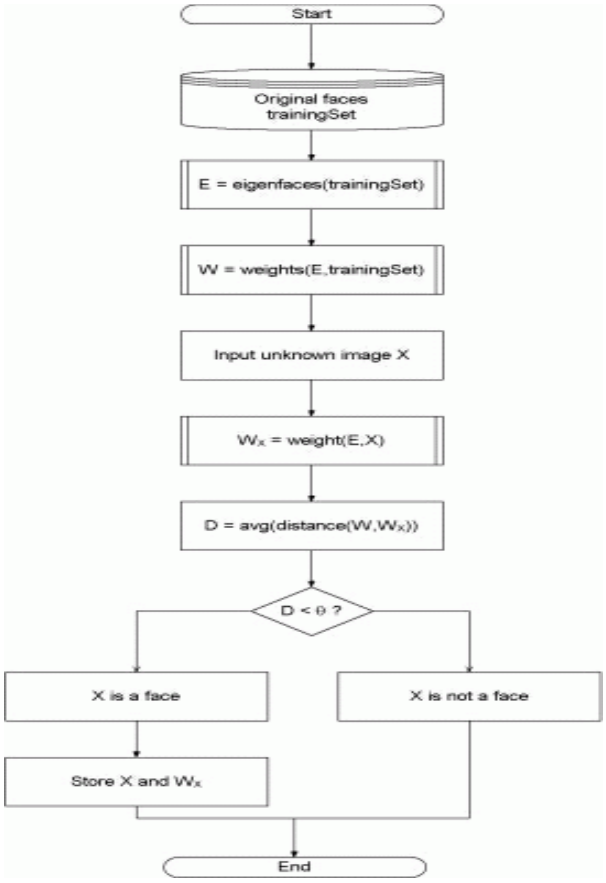

Fig 3. High-level functioning principle of the eigenface-based facial recognition algorithm [5]

B. The Neural Networks Approach

For face detection process training a neural network is a very difficult task as the problem arises in characterizing prototypical non-facial images. In the case of face recognition the sets are to be made are of different faces where as the two sets in face detection are facial images and non-facial images. It is easy to get a representative sample of images which contain faces, but it is much harder to get a representative sample of those which do not. The number of subjects in the second set can grow very quickly. This problem can be avoided using a big set of non facial images in the training process. [6]

This approach has been used with tremendous success as far as frontal face detection is concerned. A face detection system based on neural networks is presented in [7]. The retinally connected neural network examines small windows of a facial image and decides whether each window has a face. The system uses multiple networks to improve performance. [7] In the new neural network model proposed, the Constrained Generative Model, performed an accurate estimation of the face set, using a small set of counter-examples. It uses of three layers of weights allows to evaluate the distance between an input image and the set of face image. [8]

An Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. It is composed of a large number of highly interconnected processing elements (neurones) working in unison to solve specific problems. ANNs, like people, learn by example. An ANN is configured for a specific application, such as pattern recognition or data classification, through a learning process. Learning in biological systems involves adjustments to the synaptic connections that exist between the neurones. This is true of ANNs as well.

C. The Fuzzy Pattern Matching Approach

This approach uses fuzzy theory to representing diverse, non-exact, uncertain, and inaccurate knowledge or information. And information carried in individual fuzzy set is combined to make a decision. A new method to detect faces in color images based on the fuzzy theory is proposed where two fuzzy models are used to describe the skin color and hair color respectively. [9] Where a uniform color space is used to describe the color information to increase the accuracy and stableness. Here two different models have been used to take out the skin colored portions and the hair colored portions. Then a comparison is made between them with some pre-built templates with the help of fuzzy theory based methods for pattern matching that identifies human faces. [9]

Processes of composition and de-fuzzification form the basis of fuzzy reasoning. Fuzzy reasoning is performed to recognize face in the context of a fuzzy system model that consists of control, solution, and working data variables; fuzzy sets; hedges; fuzzy; and a control mechanism.

D. Other Approaches

Beside the above-mentioned approach to face recognition, some researchers also used other methods to perform the studies on face recognition, i.e., the rules of the shape and albedo of a face under all possible illumination conditions, Bayesian decision, etc. In order to develop a universal face recognition system which can handle all face recognition factors, the integrated approach could be a choice. A method that integrates the above different methods and applies different techniques would be the answer to all the drawbacks.

IV. CONCLUSION

Because holistic approaches to face detection embody global information of faces, the disadvantage of this approach is the variances captured may not be relevant features of the face. Face recognition is indeed a difficult problem as faces can vary a great deal in their orientation, facial expression and lighting conditions. The goal was to provide a survey of recent holistic approaches to face detection that complement previous surveys. We summarized holistic approaches like eigenface-based method, spatial matching detector method, neural networks method and fuzzy theory based method. The holistic approaches have the main advantage of distinctly capturing the most prominent features within the given facial images, so as to uniquely identify individuals amongst the given set; also automatically finding features. However, disadvantages are that face recognition performance could be drastically be affected by lighting, orientation and scale; or, features found from faces may not form part of the face but may be some other feature has been captured. For (example), features from the background of a facial image.

So in order to develop a universal face recognition system which can handle all face recognition factors, the integrated approach could be a choice.

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