Human Face Detection and Recognition using Genetic Algorithm: A Review

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***Abstract*—Face detection is one of the challenging problems in the image processing. Human skin color is an effective feature used to detect faces, although different people have different skin color, several studies have shown that the basic difference based on their intensity rather than their chrominance. Textures of human faces have a special texture that can be used to separate them from different objects. This paper, introduce a face detection and recognition system to detect (finds) faces in images from galleries of known people. To detect the face before trying to recognize it saves a lot of work, as only a restricted region of the image is analyzed, opposite to many algorithms which work considering the whole image. This system is caped with three steps. The first step is to classify each pixel in the given image as a skin pixel or a non-skin pixel. The second step is to identify different skin regions in the skin detected image. The last step is to decide whether each of the skin regions identify is a face or not. Finally recognition is done by using Genetic Algorithm. As the genetic algorithm is computationally intensive, the searching space is reduced and the required timing is greatly reduced.**

***Keywords*—Artificial Neural Network, Genetic algorithm.**

I. INTRODUCTION

Face detection is the essential front end of any face recognition system, which locates the face regions from images. It also has numerous applications in areas like surveillance and security control systems, content-based image retrieval, video conferencing and intelligent human-computer interfaces [1]. Most of the current face recognition systems presume that faces are readily available for processing. However, in reality, we do not get images with just faces. We need a system, which will detect the face in image, so that this detected face can be given as input to face recognition systems. Given an image, the goal of a face detection algorithm is to identify the location and scale of all the faces in the image. The task of face detection is so trivial for the human brain, yet it still remains a challenging and difficult problem to enable a computer to do face detection. This is because the human face changes with respect to internal factors like facial expression, beard and mustache, glasses etc and it is also affected by external factors like scale, lightning conditions, contrast between face and background and orientation of the face.

Face recognition is the process of automatically determining whether two faces are the same person [2]. A number of factors make this a challenging problem for computers. Faces in images and video can be captured at various resolutions, quality, and lighting conditions. Different cameras have different imaging properties. Moreover, people's facial expressions as well as their pose with respect to the camera can vary widely, and facial characteristics can change dramatically as people age over time.

Digital images and video are becoming more and more important in the multimedia information era. The human face is one of the most important objects in an image or video. Detecting the location of human faces and then extracting the facial features in an image is an important ability with a wide range of applications, such as human face recognition, surveillance systems, human computer interfacing, video-conferencing etc.

II. LITERATURE REVIEW

There are various approaches proposed by various researchers for face recognition. We can broadly classify these approaches or techniques based on the face on which they can be applied.

A. Eigen face-based Recognition Approach:

The information theory approach of encoding and decoding face images extracts the relevant information in a face image, encode it as efficiently as possible and compare it with database of similarly encoded faces. The encoding is done using features which may be different or independent than the distinctly perceived features like eyes, ears, nose, lips, and hair [3]

Mathematically, principal component analysis approach will treat every image of the training set as a vector in a very high dimensional space. The eigenvectors of the covariance matrix of these vectors would incorporate the variation amongst the face images. Now each image in the training set would have its contribution to the eigenvectors (variations). This can be displayed as an '*eigenface*' representing its contribution in the variation between the images. These eigenfaces look like ghostly images and some of them are shown in figure 2.In each eigenface some sort of facial variation can be seen which deviates from the original image. The high dimensional space with all the eigenfaces is called the image space (feature space). Also, each image is actually a linear combination of the eigenfaces. The amount of overall variation that one eigenface counts for, is actually known by the eigenvalue associated with the corresponding eigenvector. If the eigenface with small eigenvalues are neglected, then an image can be a linear combination of reduced no of these eigenfaces. For example, if there are M images in the training set, we would get M eigenfaces. Out of

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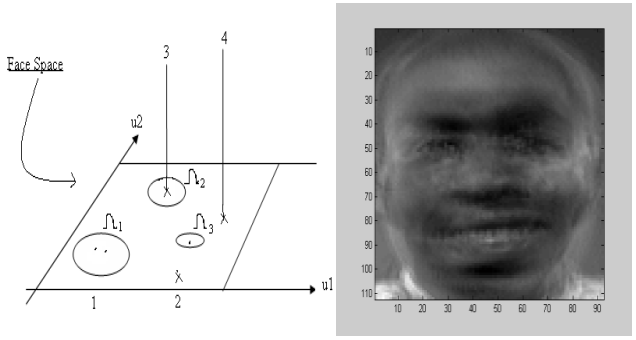
these, only M' eigenfaces are selected such that they are associated with the largest eigenvalues. These would span the M'-dimensional subspace 'face space' out of all the possible images (image space).
When the face image to be recognized (known or unknown), is projected on this face space (figure 1), we get the weights associated with the eigenfaces, that linearly approximate the face or can be used to reconstruct the face. Now these weights are compared with the weights of the known face images so that it can be recognized as a known face in used in the training set. In simpler words, the Euclidean distance between the image projection and known projections is calculated; the face image is then classified as one of the faces with minimum Euclidean distance.



(a) (b)

Figure 1

(a) The face space and the three projected images on it. Here u1 and u2 are the eigenfaces.
(b) The projected face from the training database.

B. 3D Face Recognition Approach:

Three-dimensional face recognition (3D face recognition) is a modality of facial recognition methods in which the three-dimensional geometry of the human face is used. It has been shown that 3D face recognition methods can achieve significantly higher accuracy than their 2D counterparts.3D face recognition has the potential to achieve better accuracy than its 2D counterpart by measuring geometry of rigid features on the face[4]. This avoids such pitfalls of 2D face recognition algorithms as change in lighting, different facial expressions, make-up and head orientation[4]

The main technological limitation of 3D face recognition methods is the acquisition of 3D image, which usually requires a range camera. Alternatively, multiple images from different angles from a common camera may be used to create the 3D model with significant post-processing. This is also a reason why 3D face recognition methods have emerged significantly later (in the late 1980s) than 2D methods.

C. Principal Component Analysis (PCA):

Principal Component Analysis (PCA) PCA also known as Karhunen-Loeve method is one of the popular methods for feature selection and dimension reduction. Recognition of human faces using PCA was first done by Turk and Pentland [5] and reconstruction of human faces was done by Kirby and Sirovich [6]. The recognition method, known as eigenface method defines a feature space which reduces the dimensionality of the original data space. This reduced data space is used for recognition. But poor discriminating power within the class and large computation are the well known common problems in PCA method. This limitation is overcome by Linear Discriminant Analysis (LDA). LDA is the most dominant algorithms for feature selection in appearance based methods [6]. But many LDA based face recognition system first used PCA to reduce dimensions and then LDA is used to maximize the discriminating power of feature selection. The reason is that LDA has the small sample size problem in which dataset selected should have larger samples per class for good discriminating features extraction. Thus implementing LDA directly resulted in poor extraction of discriminating features. In this [7] Gabor filter is used to filter frontal face images and PCA is used to reduce the dimension of filtered feature vectors and then LDA is used for feature extraction. The performances of appearance based statistical methods such as PCA, LDA and ICA are tested and compared for the recognition of colored faces images in [8]. PCA is better than LDA and ICA under different illumination variations but LDA is better than ICA. LDA is more sensitive than PCA and ICA on partial occlusions, but PCA is less sensitive to partial occlusions compared to LDA and ICA. PCA is used as a dimension reduction technique in [9] and for modeling expression deformations in [10].A recursive algorithm for calculating the discriminant features of PCA-LDA procedure is introduced in [11]. This method concentrates on challenging issue of computing discriminating vectors from an incrementally arriving high dimensional data stream without computing the corresponding covariance matrix.
The key procedure in PCA is based on Karhumen Loeve transformation. If the image elements are considered to be random variables, the image may be seen as a sample of a stochastic process [12]. The PCA basis vectors are defined as the eigenvectors of the scatter matrix *ST,*

$$ST = \Sigma Ni=1 (xi - \mu) (xi - \mu)T$$

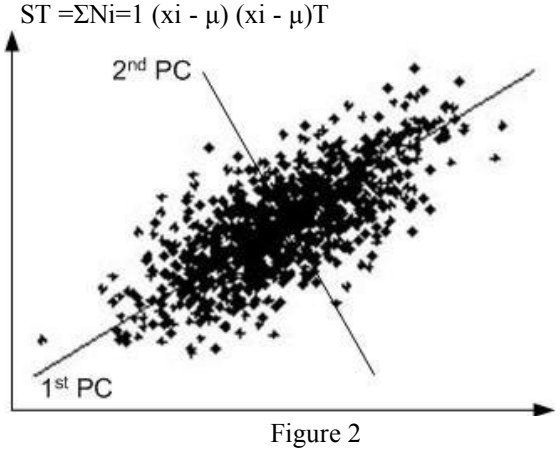


Figure 2

D.Support Vector Machine (SVM):

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Support Vector Machines (SVM) are one of the most useful techniques in classification problems. One clear example is face recognition. However, SVM cannot be applied when the feature vectors defining samples have missing entries. A classification algorithm that has successfully been used in this framework is the all-known Support Vector Machines (SVM) [13], which can be applied to the original appearance space or a subspace of it obtained after applying a feature extraction method [14] [15] [16]. The advantage of SVM classifier over
traditional neural network is that SVMs can achieve better generalization performance.

E. Active Appearance Model (AAM):

An Active Appearance Model (AAM) is an integrated statistical model which combines a model of shape variation with a model of the appearance variations in a shape normalized frame. An AAM contains a statistical model if the shape and gray level appearance of the object of interest which can generalize to almost any valid example. Matching to an image involves finding 27 model parameters which minimize the difference between the image and a synthesized model example projected into the image. The AAM is constructed based on a training set of labeled images, where landmark points are marked on each example face at key positions to outline the main features [17,18].

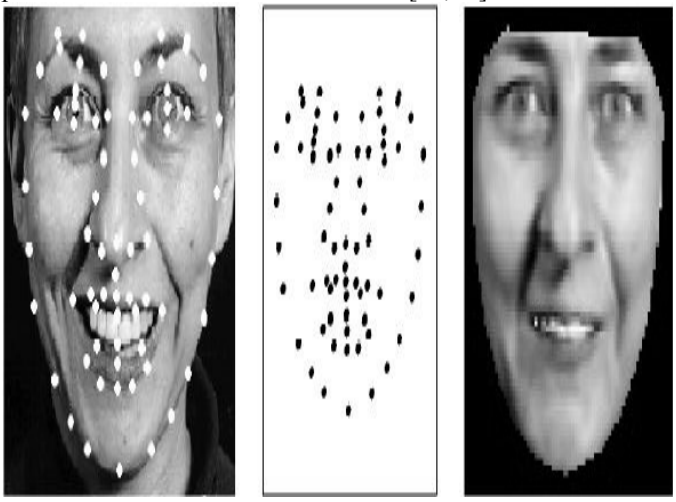

Figure 3: The training image is split into shape and shape normalized texture.

III. PROPOSED WORK AND OBJECTIVES:

The entire propose work has divided into two modules

1) *Face Detection*
2) *Face Recognition*

1) Face Detection

- First we consider a color image as an input for a system. Here we are concentrating on color image because; we require a color skin region of a human face.
- After receiving a color image there is a need to detect a skin region by following color patterns.
- If the skin region of a human face is detected and accepted properly, then first we will load the features images which are available in database and then secondly, locate various features in skin area.
- At last, we present the output in the form of "Face regions with features".
- If skin region is not present in the image, then we discard this image and no further processing is done.

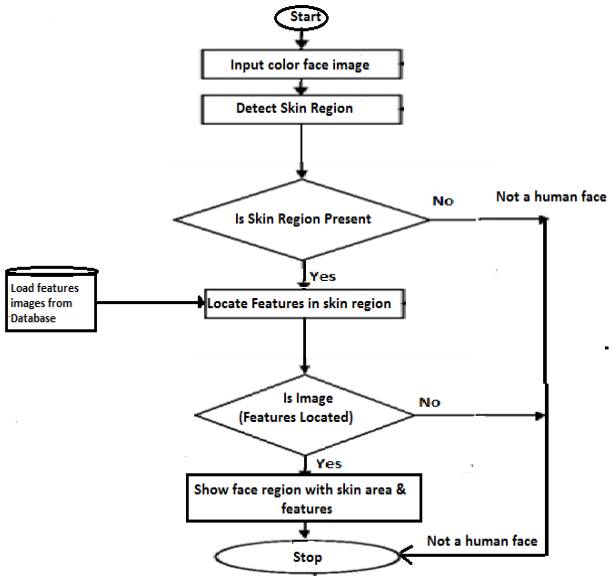

Figure 4:Proposed Method for Face Detection

2) Face Recognition

- Load detected image as input to the face recognition system.
- Train artificial neural network using Genetic algorithm.
- Load trained file.
- Test Input image using Artificial Neural Network .

Analyze and fetch result with recognize face.

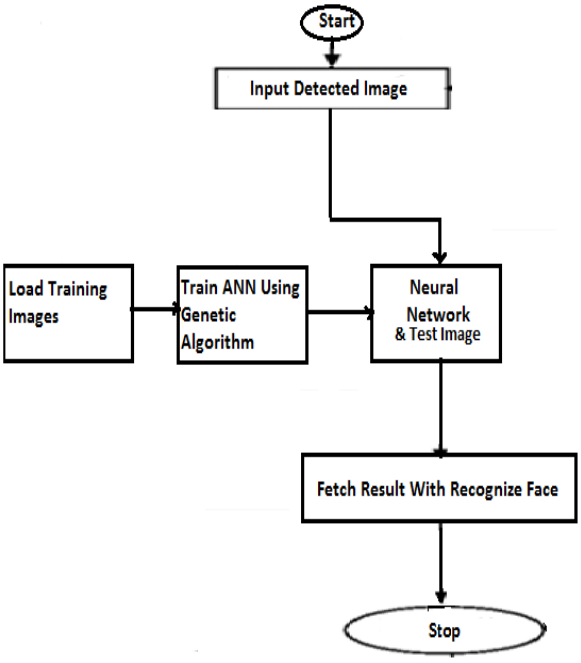

Figure 5: Proposed Method for Face recognition

IV. CONCLUSION

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We have used a specific method for generating features vector of the whole face in an image, by first detecting face regions using the color of skin which presents a robust overlooked in different background, accessory and clothing. It is a fast algorithm for extracting human faces in color images and easy to implement. GA is then applied to perform the recognition task. This solution was implemented using Matlab environment. Results indicate that the proposed method achieves good results.

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