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Bio-Metric Authentication of a person using Face Segmentation Approach

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ABSTRCT

Face recognition is one of the most important applications of the Biometric-based authentication system. Face recognition plays an important role especially in commerce, banking, social and law enforcement areas. Identification of people in different environment requires three steps which are acquisition, normalization and recognition. Acquisition involves the detection and tracking of face in the dynamic scenes. Normalization is the segmentation, alignment and standardization of the face images and finally recognition is concerned with classifying a face as known or unknown. In this paper, we perform all the above steps by capturing the image using a camera. The image which is captured is segmented and stored into a database. It will be used in retrieval and matching. The features we consider are eyes, nose and mouth. The proposed algorithm has been tested on various images and its performance has been found to be good in most cases. Experimental results show that our method of detection and verification has very good accuracy. The result of the work of course depends on surrounding factors such as face orientation, expression, lighting and background.

Keywords: ***Face Division, Face Extraction, Face Component, Face Segmentation, Face Recognition,***

I. INTRODUCTION

Over the past few years, face recognition has become one of the most important biometrics authentication techniques. Face recognition is a biometric approach to verify or recognize the identity of a person based on his/her physiological characteristics. Biometrics are capable of measuring both behavioral and physiological characteristics. In physiological biometric, data is derived from direct measurement. In behavioral biometric, data is derived from an action. Both these biometrics are based on measurements. Face Recognition is an integral part of biometrics and is a successful application of image analysis and pattern recognition. The main aim of face recognition is to recognize a person from video or pictures stored in a database.

Biometric technology is motivated by traditional methods. Traditional methods can be categorized as possession-based methods and knowledge based methods. In possession based method, items such as keys, badges, or cards are utilized. This method requires low cost. However, these items can be shared, duplicated and easily lost. Using password or PIN has its own drawbacks in knowledge-based method. Some passwords are easily guessed. Besides, they can be forgotten or shared. Two main tasks used in face recognition are Verification and Identification. Verification means one to one (1:1) matching and Identification means one to many (1: N) matching. Face verification is commonly applied in access control applications. Identification system determines the identity of input image and compares query face image against all image templates stored in a database.

Face recognition technology is a combination of various technologies and their features and characteristics make face recognition a better performer depending on the application. Detection, Extraction and Recognition are the three phases of face recognition. An explanation of each phase of face recognition is given in the next sections.

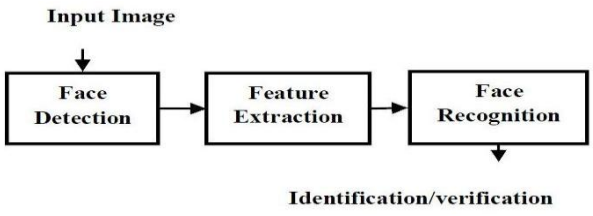


Fig 1: Phases of face recognition problem

II. RELATED WORK

Different approaches for face detection do exist. These approaches can be classified into three categories. Namely template-based, feature-based and appearance-based.

Template-matching approach is the simplest approach to detect a complete face using a single template. Even multiple templates may be used for each face to account for recognition from different viewpoints. Another important variation occurs by using a set of smaller facial feature templates that correspond to eyes, nose, and mouth, for a single viewpoint. The advantage of template-matching is its simplicity. But the problem with this approach is that it requires large amount of memory and is quite unproductive in matching [1]. In feature-based approaches, face is represented using the facial features such as position and width of eyes, nose, and mouth [2]. This approach has the advantage of consuming less memory space and has higher recognition and speed when compared to the template-based approach. In the appearance-based approaches, face images are projected onto a linear subspace of low dimensions. Such a subspace is first constructed by using principal component analysis that operates on a set of training images, with eigen faces acting as eigenvectors. In the later stages, the concept of eigen faces was extended to eigen features, such as eigen eyes, eigen mouth, etc. for the detection of facial features [3].

Face feature extraction is the second step and it deals with segregation of a face in a test image and to isolate it from the remaining scene and background. In one of the approaches, elliptical structure of human head has been utilized [4]. This method finds the outline of the head by using one of the edge detection schemes for example Canny's edge detector. An ellipse is then fit to mark the facial region in the given image. But the problem with this method is that it is applicable only to frontal face views.

Face recognition is the third step which is performed at the subordinate-level. In this, captured face is compared with the faces which are stored in database and then classified as known or unknown face. The classification process may be affected by several factors such as scale, pose, illumination, facial expression, and disguise.[5]

III. PROPOSED WORK

In this paper, we have proposed a new method, which includes two phases. They are face registration phase and face verification phase. During face registration, we capture dynamic scene of a person using a camera and by using Viola-Jones algorithm, we detect face from the scene. Face detection determines the location and size of human face in digital images. It detects facial features and ignores everything else such as buildings, trees and other bodies. Face detection can be regarded as a specific case of object-class detection. The major phase of Viola-Jones algorithm includes Harr-Features, Integral Image, Adaboost algorithm and Cascading.

Haar Features: This includes four basic feature types. As shown in fig 2 we have Edge Features, Line Features and Four-rectangle features.

Edge Line Four-Rectangle

Fig 2: Harr Features

Features are extracted from sub windows of a sample image. The base size for a sub window is 24 by 24 pixels. Each of the four feature types are scaled and shifted across all possible combinations.

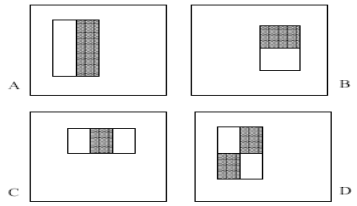


Fig 3: Possible combination of Harr Features

Following figure shows how Harr features can be used to match either part or whole face of a person.

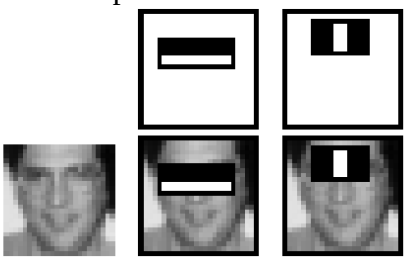


Fig 4: Haar Features on the Image of a person

Integral Image: Number of these rectangular Haar features has to be evaluated each time. This has prompted Viola Jones come up with a technique which will reduce the computation rather than summing up all pixel values under the black and

white regions every time .They have introduced the concept of integral image to find the sum of all pixels under a rectangle.

The integral image computes a value at each pixel (x,y) that is the sum of the pixel values above and to the left of (x,y) inclusive. This can quickly be computed in one pass through the image.

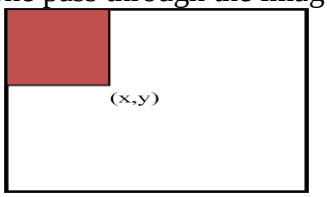


Fig 5: Integral Image

Adaboost: Adaboost is a machine learning algorithm which helps in finding only the best features among all the features. After these features are found, a weighted combination of all these features is used in evaluating and deciding whether any given window contains a face or not. Features are also called weak classifiers. Adaboost constructs a strong classifier as a linear combination of these weak classifiers.

$F(x)=a_1f_1(x)+ a_2f_2(x)+ a_3f_3(x)+a_4f_4(x)+..$

where F(x) represents strong classifier, fi(x) represents weak classifier.

Cascading: A c er is composed of stages e stages.

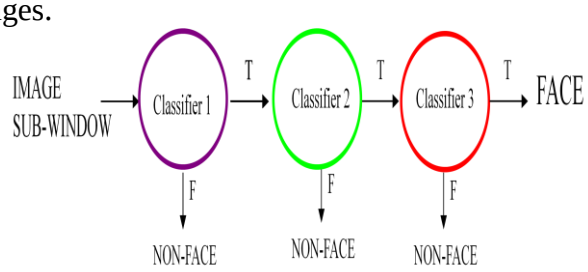


Fig 6: Cascading classifier for face

Once the face from the scene is detected, then the next part in the face registration includes fragmenting a face into eyes, nose and Mouth. The division of face image considers the image size. We can extract segments of the face by using Haar features and Cascading Process. These two help in matching each segmented part of the face such as eyes, nose and mouth. The following figure shows how a face image is divided into number of segments.

Fig 7 : Division of a face into Eye, Nose and Mouth

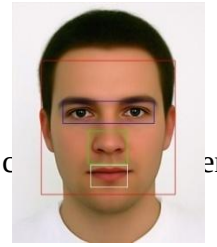
We need to extract the segments from the face. It can be done using following steps:

1. Consider a face Image X which is represented as a two dimensional matrix of size n*n.

2. Divide the Image X into 4 parts A, B, C and D as shown below.

A	B
C	D

3. Central part of A is considered as Right Eye. It can be obtained by considering part A as an image with (x,y) coordinate values. The centre is obtained by taking (x/2,y/2) values. Similarly central part of B is considered as Left eye. The intersection of A, B, C and D gives the Nose part. Below this lies part of the Mouth. This extraction is as shown below.



4. All the above steps for extracting the segments of the face can be done using Vision.CascadeObjectDetector in MAT Lab.

Once the face segments are extracted, then each part of the image such as Face, Eyes, Nose and Mouth will be registered individually and the information will be stored in a database.

Next phase of our work will include Face Verification. We capture face using a camera and detect face from the captured scene using Viola-Jones algorithm. We will then compare each segmented part of the face with the data stored in the data base. For this purpose, we will use Principal Component Analysis (PCA). PCA is the fundamental technique for image reconstruction. It computes the principal component scores from a part of the input image and reconstructs the whole input image based on the principal component scores.

Principal Component Analysis approach used for face recognition involves the following initialization operations:

1. Acquire a set of training images.

2. Calculate the eigen faces from the training set keeping only *M* images whose eigen values are the highest. These *M* images define the face space. As new faces are encountered the eigen faces can be updated.

3. Calculate the corresponding distribution in *M*-dimensional weight space for each known individual (training image), by projecting their face images onto the face space.

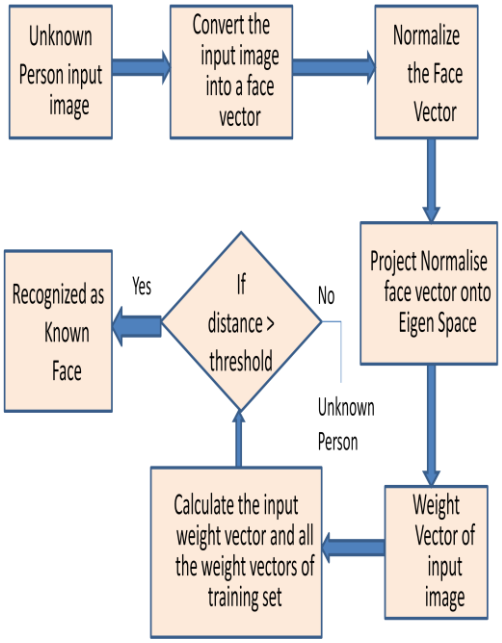


Fig 8: PCA algorithm for Face Recognition

Once the initialization is done, following steps are used to recognize new face images:

1. The captured image is going compare with all eigen faces of stored images.

2. Check whether the image sufficiently close to the face space.

3. If so, classify the weight pattern as either a known or as unknown.

IV. EXPERIMENTAL RESULT

We provide video as an input to our system in the real time. The first stage is the Registration phase in which users are registered by capturing their faces using camera. Soon after the capture of the face, it will be segmented into three parts namely eye, mouth and nose. A user can register n times and the data of these registered users are stored in a database. The following figure shows the result of registration phase.

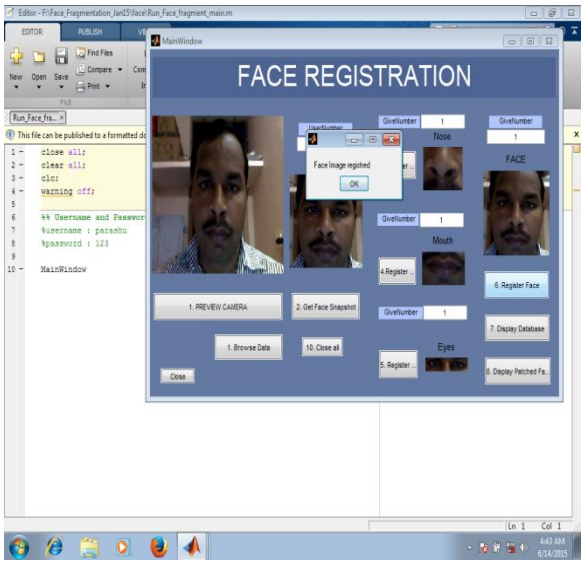


Fig 9: Face Registration phase of user

Next phase is verification phase in which the users are verified to determine whether they are authenticated users or not. We capture image of the person in the verification phase. From this image, we can detect face and extract the segmented part of the face such as eye, nose and mouth as discussed in previous section. The testing is done by combining the segmented part of the face and comparing with the existing data base. The result shows how much percentage of each segmented part matches the existing segment in the data base. Based on this user can be classified as known or unknown.

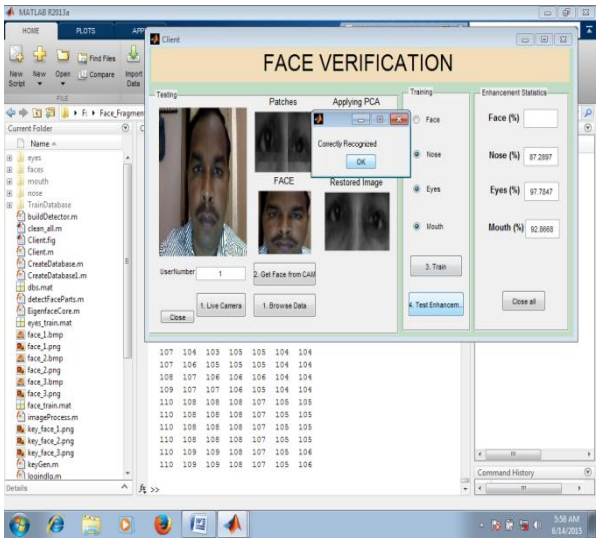


Fig 10: Face Verification phase of the person

After obtaining the result from our method, it is necessary to compare the result with the existing technique.

We examine the result by considering 5 input images as a part of experiment. We found that the

result obtained from proposed method has high accuracy compare to the existing technique. We plot the graph based on the result obtained from existing technique and proposed technique.

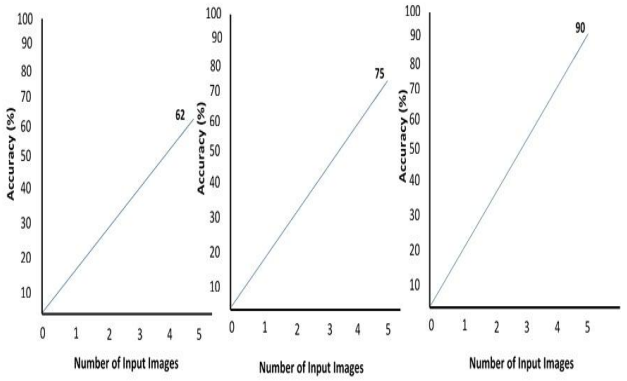


Fig 11: Graphs show the recognition accuracy for a face authentication using existing techniques (Graphs 1 & 2) and proposed technique (Graph 3).

From the graph it is clear that authentication of face from the existing technique such as

i) Reconstruction of face from machine identification yields as accuracy of 62% [1],

ii)Reconstruction of face from Human subject identification yields an accuracy of 75%[1] and where as

iii) iii) Biometric authentication of face from face

iv) segmentation approach (Proposed) yields an accuracy of 90%.

V. CONCLUSION

In this paper, we have considered segmented parts of a face for the purpose of user authentication. The proposed method is expected to help in correctly recognizing a person and will be useful in ATMs, Banks etc where high security is required. Even with a partial face, the proposed method is expected to work effectively in recognizing a user. Experimental results show that the accuracy in the proposed method in recognizing faces is more when compared to the existing methods. The results further confirm that using segmented parts of the face improves security in biometric authentication systems.

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