AUTOMATIC USER AUTHENTICATION SYSTEM FOR OCCLUDED FACES

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ABSTRACT

Developments in sensor technologies have increased interest in face recognition. The face has become an emerging biometric modality, which is preferred especially in high security applications. Occlusion in an image is nothing but covering an object. Occlusion has been seen in many areas of image processing. It is seen in recognition of iris where the eyelashes occlude the iris; identification via ear can also be occluded by ear rings. Even in real time application face image is occluded via accessories such as sunglasses, beard, and hat. Dealing with these facial occlusions is a great difficult, which should be handled to enable applicability to fully automatic security systems. In this paper, we propose a system which is fully automated and robust to the occlusions. Here we mainly consider two problems: One is handling occlusion for surface registration, and the other one is user authentication with missing data. We are using an adaptively selected-model-based registration scheme. For this registration ICP is used. After registering faces into the database facial occlusions are detected and removed. For authenticating the person PCA is used. An experimental result shows that the ICP together with the PCA classification offer an occlusion robust face recognition system.

Index Term:* *Face Recognition System, Registration, Biometrics, Curvature Analysis.

I. INTRODUCTION

In biometric systems, human beings are identified by their exclusive features, such as physiological and behavioral features. The human face is preferred because of more advantage that is contactless acquisition. This is used in range of applications such as security systems. Basically recognizing persons from their faces is a big task. The main things which decreases the performance of a face recognizer because in the presence of illumination differences, facial expression variations, and the presence of occlusions. In this proposed system, challenges caused by all the things can be handled bitterly when compared with the existing system. Greater occlusion differences are still more complex for recognizing the face. In this project, we proposed a system which is robust under realistic occlusions. In our approach, occlusion handling is considered before the registration phase and after removing then the occluded removed face is stored in the database for further proceedings. And using the non occluded facial parts face authentication is done. With this system we will get higher recognition rate when compared with the already existing systems. And even if the face is rotated to some angle also it recognizes the person where as the existing system if the face is rotated by 30% they are not able to recognize or authenticate a person.

II. RELATED WORK

Sensor technologies have increased interest in face recognition. In [1] they proposed, by using 3-D face, it is possible to obtain competitive results when compared with other modalities such as iris and high-resolution 2-D facial images. In [2],[3], A thorough survey of previously proposed 3-D face recognition systems can be found in and detailed fundamental analysis of concepts are given in 3D face recognition in ambient intelligence environment scenario .we focus on the recent face recognition approaches dealing with realistic occlusion variations. In [4], they proposed an iterative approach for the parameter estimation of 3-D morphable model fitting procedure. In [6] they proposed that the visibility map is used to exclude occluded regions from further computations. Similar to the morphable model formulation, proposed to encode all the geometric quantities and the structural information residing in a facial surface as an Attributed Relational Graph. Identification is achieved by partial matching of these graphs. In [7], Lin and Tang proposed a method which encapsulates the occlusion detection and recovery problems through a generative process. A Bayesian formulation is proposed, where the quality assessment model is constructed by learning a priori information from a set of images.

In [5] they consider occlusions caused only by eyeglasses and propose a method to compensate for the missing data. Initially, the glasses region is extracted using color and edge information. The offline-generated eigen faces from a set of non occluded images are then used together with the extracted glasses region for missing data compensationIn [8] they proposed to divide face into local regions. Each region is modelled individually by a mixture of Gaussian distributions, and fusions achieved by probabilistic evaluation of regional matches. In [9] they propose a part-based local representation approach based on Independent Component Analysis (ICA). ICA representations are constructed for local regions corresponding to salient parts such as eye, nose, and lip areas. Conservation of discriminative features is achieved by reordering of basis images.

In [10] they proposed face recognition system for expression and occlusion invariance a Part-based method is proposed, where facial regions are aligned independently to average regional models. The regional division scheme is also employed in the classification stage, where the regional classification results are fused with different fusion techniques. The experimental results indicate performance improvement by the part-based system, both for expression and occlusion variations.

In [11] they proposed a nose-based registration scheme for better handling of occluded faces. Curvature information is utilized for automatic detection of the nose area, and an average nose model is used for fine alignment via Iterative Closest Point (ICP) algorithm. On the registered surfaces, occlusions are detected by analyzing the difference from the average face model, and the occlusion-removed surfaces are completed by a modified version of the Gappy PCA method. The restored faces are classified using different local masks, and multiple classifiers are fused for final identity estimation.

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III. EXISTING SYSTEM

The existing studies using facial data, only a few consider facial occlusion detection, removal, restoration and missing data handling. One of the system detect occlusions by analyzing the difference between an original face and its approximation by the Eigen face approach. The regions detected as occlusions are removed and the locations of the missing parts are employed in the restoration process, which is handled by Gappy PCA. Another existing system refined the occlusion detection method by including the difference of the input image from the mean face. A Bayesian formulation is proposed, where the quality assessment model is constructed by learning *a priori* information from a set of images. Another approach for occlusion handling considers the facial surface as a combination of partitions. When local patches are considered separately, the areas where occlusions occur can be compensated for, in the classifier fusion phase. The facial surface is divided into local regions. Each region is modeled individually by a mixture of Gaussian distributions, and fusion is achieved by probabilistic evaluation of regional matches. In one existing system they propose a part-based local representation approach based on Independent component analysis(ICA). ICA representations are constructed for local regions corresponding to salient parts such as eye, nose, and lip areas. Conservation of discriminative features is achieved by reordering of basis images. In another existing system, a face image is represented by applying multi scale and multi orientation Gabor filters and obtaining the Local Binary Pattern (LBP) map. Recognition is achieved by matching regional histograms. Recently, there has been increasing interest in the area of sparse representation techniques. For robust face recognition against occlusions and corruptions, Wright *et al.* proposed an identification technique, where the occlusion robustness is obtained by sparsely representing corrupted pixels. Additionally, identification performance for occluded facial images is improved by block partitioning. The disadvantages of this existing are the restoration does not offer improvement for faces occluded by more than 30%, Not suitable for fully automatic face recognition system and Occlusions are detected roughly by thresholding the difference from a mean face, and Gappy PCA is utilized to discriminate between face and non face images.

IV. PROPOSED WORK

We proposed a system which is fully automated to recognize the faces. We are introducing a technique called adaptive model based registration scheme. Where the faces are registered and occlusions are removed. Whenever input is given it tries to compare that particular input with the trained data base images and gives the output as whether the person is authenticated or not. In this model it contains mainly two modules one is preprocessing module and the other one is processing module.

The pre-processing module flows goes with the initialization of the camera then taking a snapshot. For face detection viola jones algorithm is used in pre-processing module. Registration of faces will be done through ICP algorithm and finally the database contains the trained Images.

The processing module flows goes with the Initialization of the camera and gets snapshot. For Face detection Viola Jones algorithm is used and the facial Occlusion removal is done through masked projection techniques. Comparison of input image with trained image is carried out by PCA algorithm. For registration module we are using ICP algorithm and for recognition module PCA algorithm is used.

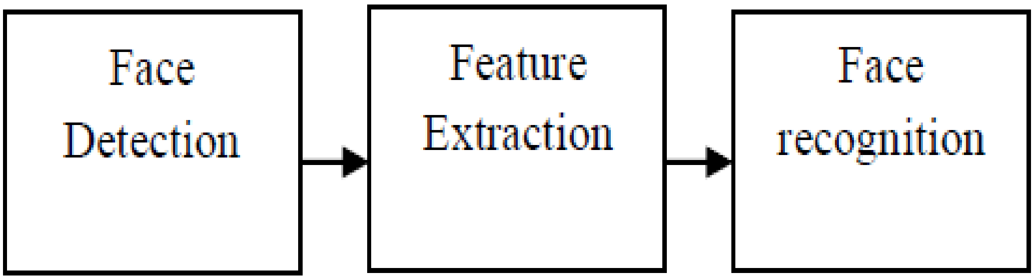

Figure 1. Three Step Process for Face Authentication

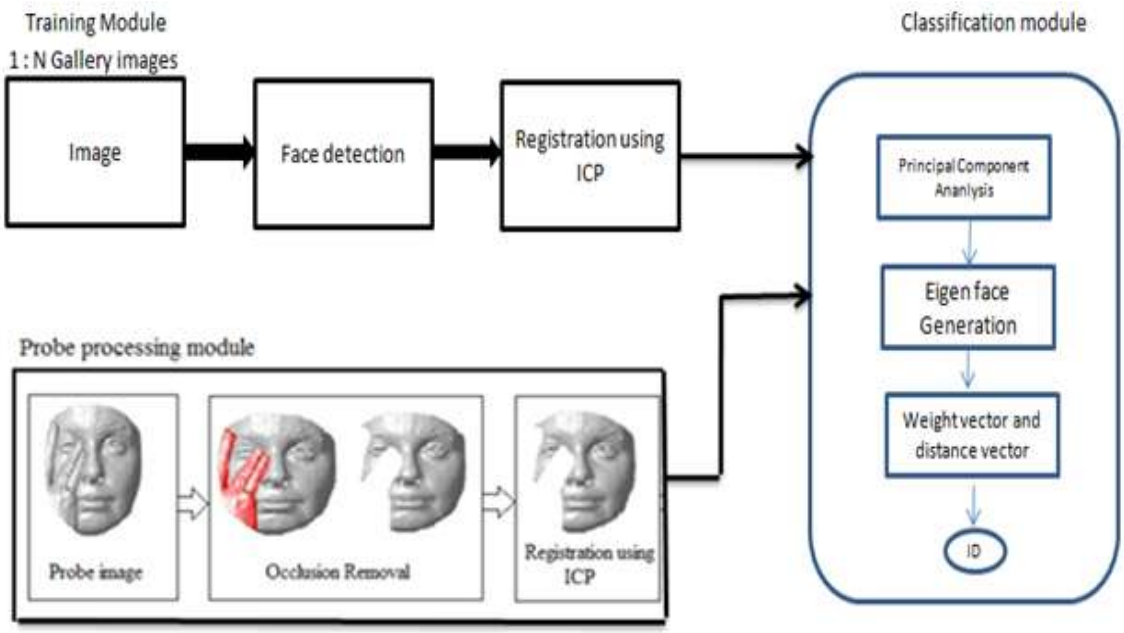

Fig 2: Illustrative Diagram of the Proposed Face Recognition Appraocah

The input to the recognition system is a video and the output is authentication of a person. of the subject. Here we are defining recognition system as a 3stage process as in Fig.1.The system which we used in the project is shown in Fig.2.

4.1 Face Detection

Face detection determines the locations of the face and size of the face in a given input image. Face detects features of the face in a given image and ignores everything in a given image. For this face detection we are using Viola Jones Detection technique. The technique mainly depends on the Haar-cascades represented in Fig.3. These features are the rectangular features and are evaluated easily and quickly. But the value which we will get is more and complex for finding the face in image. The special representation called integral image calculates the values of pixel (x,y) such that the value is simply the sum of above and left of the value. Adaboost helps to classify the face and non-face pixels. In order to know whether there is any face in a given image or not for that it uses the cascading technique. At the end of these 4 stages the output is detected face.

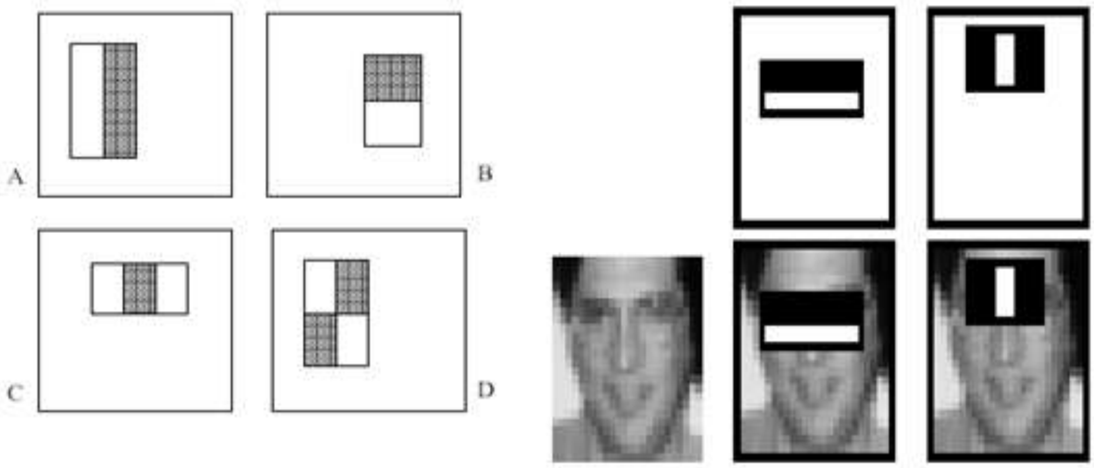

Fig 3: Haar Feature Types

4.2 Face Registration

Once face detected, candidate face images are normalized in pose and orientation in order to perform a final classification into faces or non-faces. Since face is a surface we are considering a nose using surface curvature information. Initially it calculates the curvature maps for the given surface. That is the shape index, once it is calculated then this shape index finds the nose in given image. The shape index (SI(i) is a smooth transition between the concave (0<si(i)<0.5) an the convex shapes (0.5<SI(i)<1). Since nose is a convex shape so it considers the values from 0.5 to 1 as a thresholding. Based on this thresholding it finds whether the feature is a nose or not. In this way it calculates and finds the nose and removes all the concave part from the face. After detecting nose first it finds the nearby features with respective to the nose and finds the distance between them. Using Euclidean distance formula distances are calculated to each and every nearby feature. Then these distance values are going to be stored in the database for further recognition. These data is used for recognition of an input image or a video. By using Euclidean distance the facial features are computed and stored in the form of distance values.

4.3 Face Recognition

Principal Component Analysis (PCA) is the fundamental technique for image recognition. Mainly this PCA contains two things one is generation of Eigen faces and then recognizing the unknown person.

4.3.1 Calculating the Eigen Faces

Let the training set of images be Γ1, Γ2….ΓM. Where each training set contains M images. M could be 100 of size. And each image in the training set is of size N×N dimension. Once we have training set. Convert each of the face images in training set it to a vector form. Means we convert each and every image into a column vector. This column vector consists of N2 1 dimensions. Now once converted all the images in a training set into face vector the next step in training the recognizer will be the normalize the face vector. Normalization means we are going to remove all the common features that these faces shared together that should be removed from each face that each face vector space can be left with unique features. For normalizing the face vector first we need to find the common features that are given by the average face vector and are denoted by "Ψ".

The average face is nothing but the average features of whole training set. Then subtract the mean (average) face vector from each face vector to get the normalized face vectors "Ψ. In this step it is left with the face vectors having unique features. In order to find the average of the training database images the following formula is used.

The average face of this set is then defined by

$$\Psi = \frac{1}{M}\sum_{i=1}^{m} \tau_i$$

Next step is to calculate the Eigen vectors; we need to calculate the covariance matrix C. The covariance between points i and j, denoted, can be approximated by

AAT

Where $A = \Phi 1 \Phi 2 \ldots\ldots \Phi M$ by using principle component analysis analysis on the set of large vectors. For calculating this if A contains the N2×M dimensions then the AT becomes M×N2 dimensions, by linear algebra C become N2×N2. Here N2 is the dimension of a image that is present in the training database.

$\mu i = AVi$

From this we see that AVi are the eigenvectors of C . If we let$V= v1v2\ldots\ldots\ldots vm$ be the matrix formed from the eigenvectors of $AATU= u1u2\ldots\ldots\ldots up$ be the matrix formed from the eigenvectors ofAT, then U=AV. Although M eigenvectors ("eigen faces") are necessary to encode each image of the training set without loss of information, *M'* <*M* are sufficient enough for recognition. Therefore, from the *M* eigenvectors of *V*, we pick the *M'* eigen vectors that account for the most variation, i.e. the *M'* eigenvectors having the highest Eigen values. Next step is select K best eigen faces, such that K<M and can represent the whole training set. Selected K Eigen faces must be in the original dimensionality of the face vector space. Next step is representing each face image a linear combination of all K Eigen vectors. Means each face from training set can be represented a weighted sum of the k Eigen faces + the mean face.

4.3.2 Recognizing the Unknown Face

After calculating all the Eigen faces and Eigen vectors those values are stored in the database. Whenever a probe image is given first it converts the face into vector form and then finds the covariance then by calculating the distance from the input image to the images which is already present in the database using threshold value it displays whether the person is authenticated or not.

V. EXPERIMENTAL RESULTS

The registered database contains the faces. When ever the input image is given the recognition system tries to compare that particular face with the database images and shows that the person is authenticated or not. The following snapshots are some experimental results with the face recognition system.

5.1 Real Time Video is given as Input

When a person standing in front of a camera, it tracks the real time video as input and tries to detect the face. In the above figure it detects the face and it highlights the face using rectangular box.

Figure 5.1 : Snapshot Of An Real Time Input Video

5.2 Recognition of Face in the Presence of Occlusion

Figure 5.2: Occlusion of Mouth Area by Hand

5.3 Multi Face Recognition

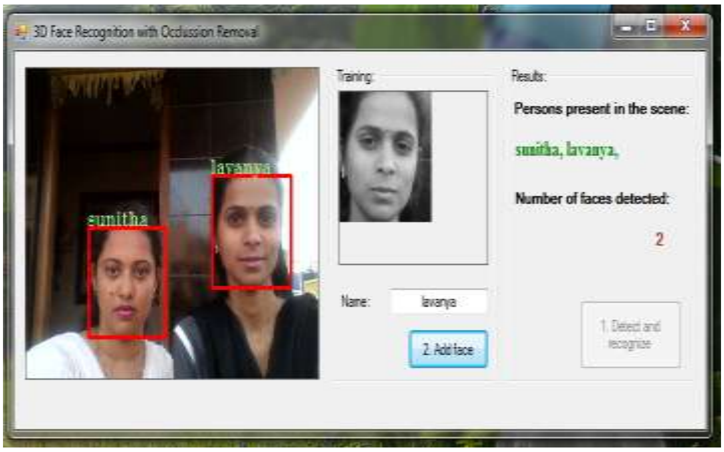

Fig 5.3 : Recognition Of Multiple Faces

The above two figures shows successful recognition of face. In figure 5.2 even when some features of the face are occluded externally by hand. The system considers the non occluded part of the face and tries to recognize that person with the database images. The system notices the correct name and displays in the output screen even when multiple faces is given as input.

VI. CONCLUSION

In this paper we present a system which is automatic recognize the face. The proposed detects the face of a person even if that person is occluded externally or naturally. This proposed system is robust to all occlusions. Here we are giving input as a video. The system will detect the face even though the face occluded externally. The system considers the non occluded parts in the face and tries to match the input face with the database images using PCA. For registration of the faces we are using the ICP algorithm that is more effective than the others. For face detection viola jones algorithm is used.

The Experimental results shows that the used algorithm will recognize partial occluded faces with more recognition rate when compared with the existing methods. Even this proposed system gives good performance under substantial occlusions, expressions, and even for less pose variations.

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