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Bank Locker Security System Using Face Recognition

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Abstract: **This paper presents an advanced Bank locker security system based on Face Recognition. The locker holders will be able to access their locker after the system recognizes their face and exercises locker door control to allow entry. Detection is performed on the basis of skin color model. This will help reduce computational complexity. Viola Jones Algorithm is used for the same. An additional password protection is provided to enhance locker security. In case of a wrong password entry, the true locker holder will be notified with an alert call from the bank to the saved contact number in the system. The system is designed to capture a person's real-time image, compare it with the stored images in the database and on detecting a match, will grant them access after password entry has been verified. Face recognition is performed using the Principal Component Analysis and a specific face can be recognized by comparing the principal components of the current face to those of the known individuals in a facial database built in advance. Illuminance variations are manipulated using the Discrete Cosine Transform Algorithm (DCT).**

Keywords: **Face detection, Skin color, Face Recognition, Principal Component Analysis (PCA), DCT**

I. INTRODUCTION

Face detection and recognition technology [7, 10] has been widely discussed with respect to computer vision and pattern recognition. Numerous techniques have been developed due to the growing number of real world applications. Biometrics consists of methods for uniquely recognizing humans based upon one or more intrinsic physical or behavioral traits. Face detection is a method to find whether or not there are any faces in a given image (usually in gray scale) and, if present, return the image location and face content. Face detection is a type of object class detection in which the locations and sizes of all objects in an image that belong to a given class are found. While earlier work dealt mainly with frontal faces, several systems have been developed that are able to detect faces fairly accurately with in-plane or out-of-plane rotations in real time.

Face detection is not straightforward because it has lots of variations of image appearance, such as pose variation (front, non-front), occlusion, image orientation, illuminating condition and facial expression.

Among the proposed face detection algorithms, those based on skin color information is an important category. This paper proposes a system for color face detection using Viola Jones algorithm based on skin color information.

For face recognition, the eigenface approach was presented by Turk and Pentland introduced in [5]. This approach is based on PCA, which was later refined by Belhumeur et al. [14] and Frey et al. [15].

A. Literature Survey

There have been various approaches proposed for face detection, which could be generally classified into four categories. (i)Template matching methods,(ii) Feature-based methods, (iii)Knowledge-based methods [7], and (iv) Machine learning methods. Template matching method means the final decision comes from the similarity between input image and template. Feature-based methods use low-level features such as gray [4], color [5,6], edge, shape [5,6], and texture to locate facial features, and further, find out the face location. Knowledge-based methods [7] detect an isosceles triangle (for frontal view) or a right triangle (for side view). Machine learning methods use a lot of training samples to make the machine to be capable of judging face or non-face.

The rest of this paper is organized as follows. Section II describes the overview of the proposed method. The proposed Face detection algorithm is presented in the Section III and IV. Finally, the experimental results and conclusion are drawn in Section V and Section VI.

II. OVERVIEW

A webcam will be placed on the bank locker door, in which the input image of the accessing person will be recorded and the face will be detected using face detection

algorithm and recognized by using face recognition algorithm (PCA). If the person is not the user, then an 'ACCESS DENIED' warning will be displayed on the LCD screen attached to the locker. In case of a perfect match being detected, the user will be asked to enter the previously set password via the dial pad. A correct entry will receive an 'ACCESS GRANTED' message and an unlocked locker door. If he/she enters a wrong password, they will be provided two more chances for password entry, and in the event of failure to enter the correct password, the authorized person will be immediately intimated with a warning message to his/her mobile through GSM [7].

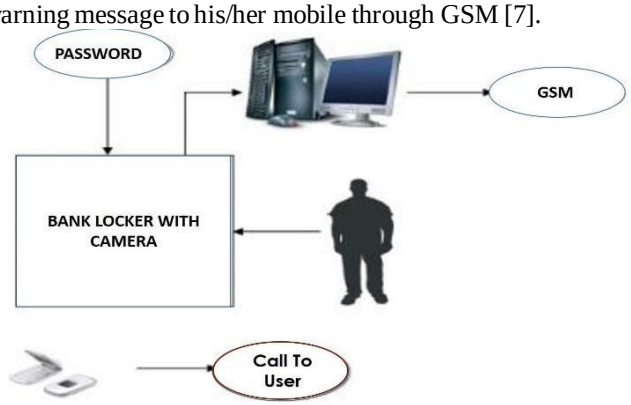

Figure.1 Bank Locker security system

III. FACE DETECTION USING SKIN COLOR INFORMATION

Color is a powerful fundamental factor of human faces. Skin colors are clustered in a small region of the chromatic color space. Processing color is faster than processing other facial features. Hence, skin color detection is first done on the input color image to reduce the computational complexity. Accuracy of the skin color detection is crucial for the face detection system. Hence choosing a suitable color space for skin color detection is very important.

A. Color Spaces

In order to improve the performance of skin color clustering, usually the YCbCr space is used to build a skin color model, as the chrominance components are almost independent of luminance component in the space.

In the color detection process, each pixel is classified as either skin or non-skin based on its color components. Skin pixels and non-skin pixels are gathered respectively from a large amount of skin color samples and non-skin color samples that make up of the skin region's backgrounds in two subspaces.

B. Face Detection By Viola Jones

The totally corrective algorithm was applied to the face detection problem using the framework introduced by Viola and Jones[2]. Viola-Jones algorithm is designed to detect faces by default, but it can be trained to detect any other object such as vehicles, buildings, skin disease patterns(melanoma) etc. In Matlab Simulation it is implemented by simply using the CascadeVisionObject(). The function is implemented along with the creation of a boundary box which is trained to pick out facial properties-in this case, face color and edges. The boundary box when superimposed over the captured image separates out the face area from the surroundings based on the training parameters.

To train a classifier, Viola and Jones select from a large number of very efficiently computable features. Every weak classifier performs a simple threshold function on one of the features. Having such a large set of weak classifiers, AdaBoost learning is used to choose a small number of weak classifiers and to combine them into a single classifier, based on previously chosen features and exponential loss, thus deciding whether an image is a face or a non-face. Training errors converge to zero quickly in this method.

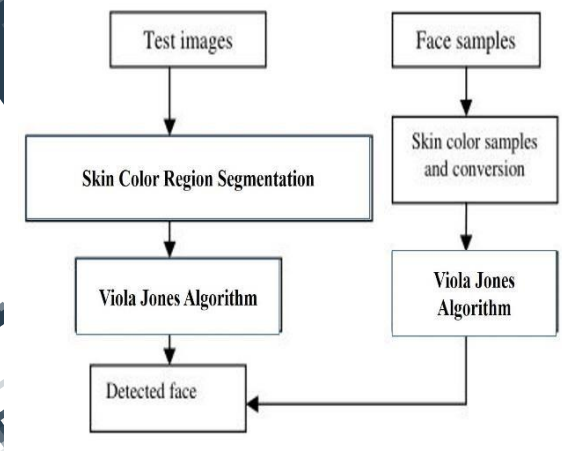

Figure2. Block Diagram of Face Detection

C. Discrete Cosine Transform Algorithm

Facial features may appear different under varying ambience conditions and this could undermine the recognition output.

A discrete cosine transform is modified to improve the performance by truncating the appropriate number of low frequency coefficients and scaling the high frequency coefficients, which will enhance the detail of the image so that it improves the performance of the face recognition system. It is employed to compensate for illumination variations in the logarithm domain.

An input image is given to logarithm transform to expand the values of dark pixels [6]. This logarithmic image is given to discrete cosine transform (DCT) method. DCT converts image from spatial domain to frequency domain; it gives the

frequency components of the image. Here, low frequency coefficients are removed and high frequency coefficients are scaled, which will remove the illumination effects and highlight the details of the image respectively. After pre-processing method, the image will be given to the feature extraction method where the PCA method is used

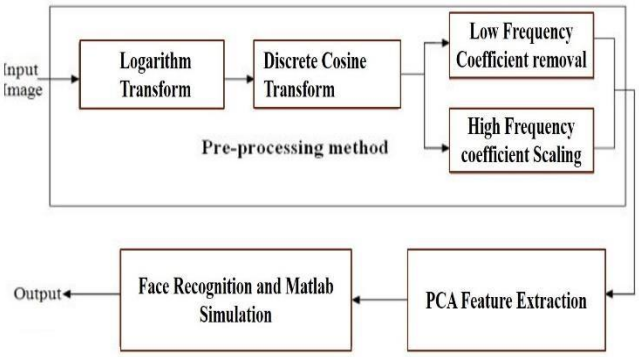

Figure 3. Block diagram of DCT application

DCT coverts image from spatial domain to frequency domain. It is performed on the whole face image to get all frequency components of the face image. The output image of logarithm transform is given to DCT, which performs low frequency coefficient removal and high frequency coefficient scaling. While removing low frequency coefficients, we scale some high frequency coefficients of DCT to make details of the face image clearer. Under poor illuminations, the high- frequency features become more vital for the recognition process.

IV. FACE RECOGNITION BASED ON PCA

The PCA algorithm is based on K-L translation which is a useful orthogonal transformation [1,7]. After K-L translation, an image can be dimensionally reduced to a point of a feature subspace. With this feature subspace, any face image can be projected to it, and we can get a set of coordinate coefficients. This set of coefficients can be used as a basis for face recognition. Such a feature subspace is also known as eigenface space, hence the method is also known as the eigenface method. By using PCA algorithm, a specific face can be recognized by comparing the principal components of the current face to those of the known individuals in a facial database built in advance

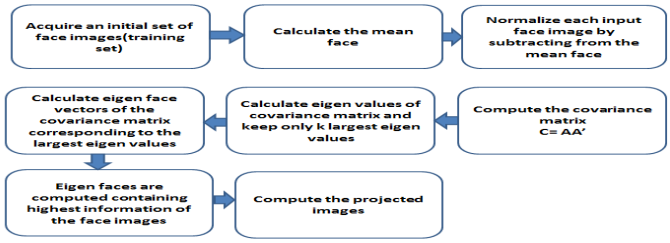

Figure 4. Features Extraction using PCA

The steps involved in PCA are:

A. Prepare the data: A 2-D facial image can be represented as 1-D vector by concatenating each row (or column) into a long thin vector. Let us suppose we have M vectors of size N (= rows x columns of image) representing a set of sampled images. Then the training set becomes: Γ1, Γ2, Γ3..... ΓM

B. Subtract the mean: The average matrix Ψ has to be calculated, then subtracted from the original faces (Γi) and the result stored in the variable Φi

$\Psi=1M\Sigma\Gamma nMn=1$ and $\phi i=\Gamma i-\psi$

C. Calculate the co-variance matrix: In the next step the covariance matrix A is calculated according to:

$A=\phi T\phi$

D. Calculate the eigenvectors and eigenvalues of the covariance matrix: In this step, the eigenvectors (eigenvectors) Xi and the corresponding eigenvalues λi should be calculated.

E. Calculate eigenfaces:

$[\phi]Xi=fi$

where Xi are eigenvectors and fi are Eigen faces.

F. Classifying the faces: The new image is transformed into its eigenface components. The resulting weights form the weight vector: $\Omega k=\Omega kT(\Gamma k-\psi)$

where, k = 1, 2, 3, 4… and $\Omega kT=[\Omega 1\Omega 2\ldots..\Omega M]$

The Euclidean distance between two weight vectors d $(\Omega i,\Omega j)$ provides a measure of similarity between the corresponding images i & j. Euclidean Distance is defined as follows:

$d(x, y) = \|x-y\|2 = \Sigma(xi-yi)2ki=1$

where x, y are the eigenfeature vectors of length n.

V. EXPERIMENTAL RESULTS AND ANALYSIS

The simulation of this project was implemented using the MATLab software. It covers the protection aspects of a single account (single user or joint account). Initially a facial database is constructed which is made to store around 10 images of each locker owner. More training images may be stored if required.

Figure 5. Database Creation

Using a webcam, the accessing person's real-time image is captured and Viola Jones algorithm detects out the face area from the surroundings, separated out by a defining, boundary box.

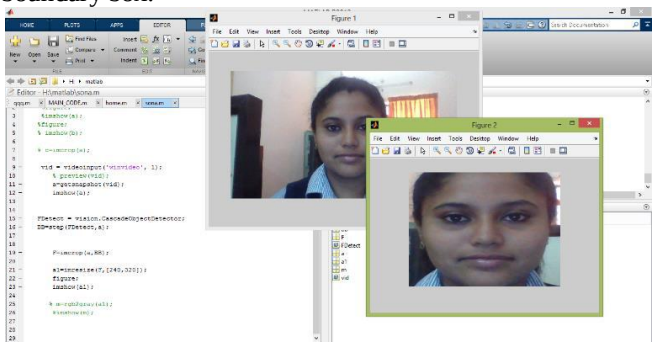

Figure 6. Viola Jones face Detection

Next, the cropped out image is converted to gray-scale in order to limit the pixel values within the range 0-255. This will help reduce the computational complexity. DCT normalization is applied before PCA algorithm recognizes the face, to remove ambience variation effects. PCA compares the principal components of the current face with that of those stored in the database [1], and if a match is detected, password entry is requested by the program.

Figure

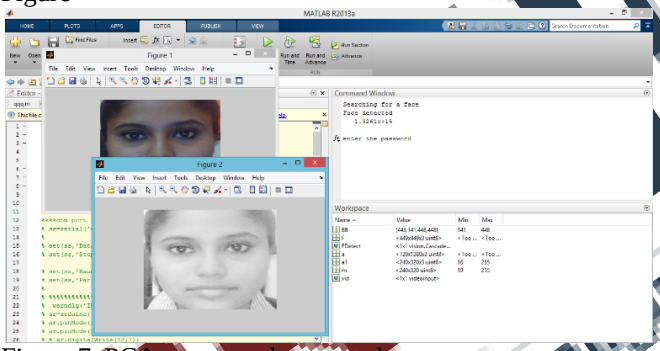

Figure 7. PCA output and password request

The user is given a total of three attempts to get the password correct. If the entered password is correct then the program will display an 'access granted' message via a dialogue box. In the event of a wrong password entry, an 'access denied' dialogue is displayed and an alert call is made by the bank to the authorized owner's personal mobile number which is set in the program beforehand. AT Commands are used for the serial interfacing of a GSM module with the MATLab simulation.

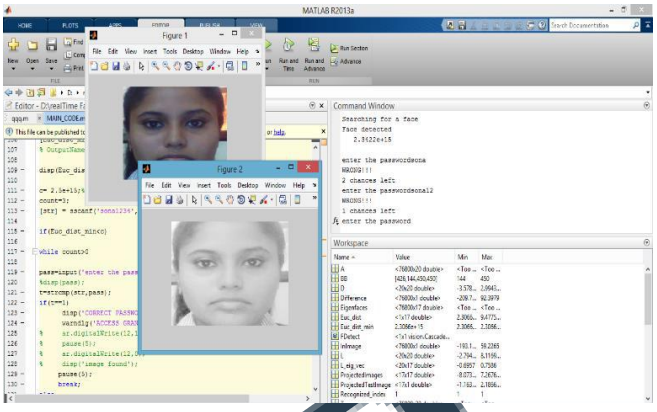

Figure 8. Password attempts

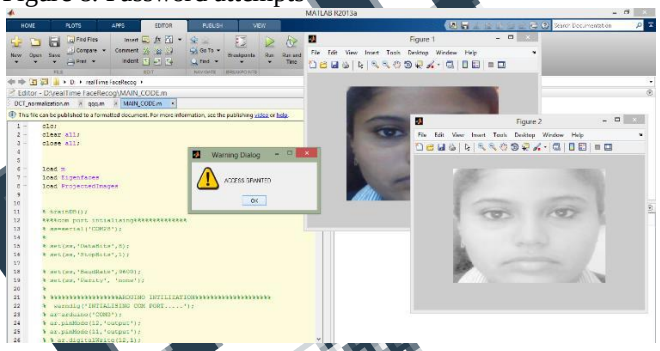

Figure 9. Access Grant

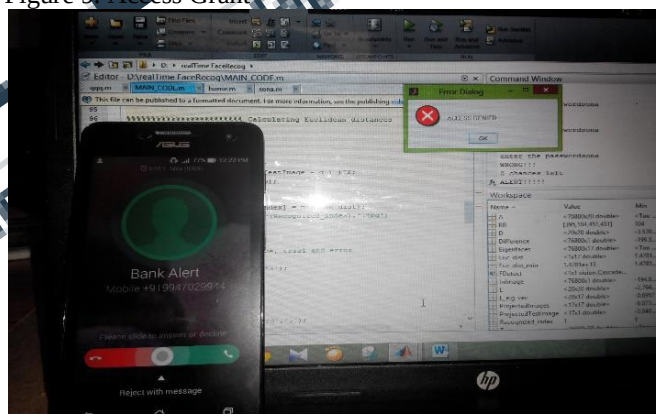

Figure 10. Activating Alert Call

In case a mismatch is detected by the PCA during the recognition stage, the program will directly display an 'access denied' dialogue box.

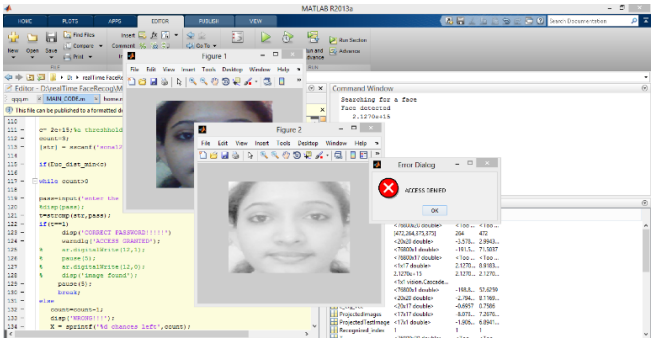

Figure 11. Access Denial

CONCLUSION

This paper presents a bank locker security system which employs a face recognition mechanism. DCT algorithm was incorporated in order to increase the efficiency of the face recognition process. Password protection is set as the second stage to enhance locker security. Furthermore a call service has been added to warn the locker owner about unauthorized access attempts. The above experimental analysis was carried out on different persons and in various different illumination settings. The future scope would be to extend a modified version of the above program to also include Car lock security, Home security and Visitor log systems, Attendance Monitoring etc.

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