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Intruder Detection in Smart Cities using Mh-PCA
(Face recognition System)

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***Abstract*: With this development era, Indian population is moving towards the cities, technology and growth make the people curious, which led to the commitment for the development and construction of 100 Smart Cities to meet the demands of its rapidly growing and urbanizing population. And in smart cities it is very necessary to have the biometric system for security purpose. There are many biometric technologies like fingerprints, iris and voice verification, but face recognition is one of the most popular authentication methods in biometric verification. The working range of face recognition is larger than other biometric information processing. This will help in the access control in smart city for security purpose and makes the city crime free or fraud free. A face recognition system is studied, implemented and tested in this paper. First, the image of the individual is captured using an integrated webcam. The captured image is then transferred to the database developed in MATLAB. In this stage, the captured image is compared to the training image in the database to determine the individual status, but in the paper these images were kept already as test images. Principal Component Analysis (PCA) algorithm is selected for the face recognition due to its fast response of recognition process and less sensitive to noise. The system is tested with a database of 16 people. As we increased training images up to 26 we found better results and we compute PCA with Manhattan distance, until now we used Euclidian distance in PCA, which was not giving best result. But after using Manhattan distance we are able to get best result. The tested system has acceptable performance to recognize faces within intended limits. If the system does not recognizes the individual as criminal, he can get access to the facility otherwise the police is informed of his location.**

Keywords—PCA, Manhattan, Euclidean

1. INTRODUCTION

In smart cities, it is very necessary to have a reliable security system that can secure our assets. The conventional security system requires a person to use a key, identification (ID) card or password to access an area such as colony, home and office. However, the existing security system has several weaknesses where it can be easily forged and stolen. So, the problems lead to an increased in interest in biometric technology to provide a higher degree of security to replace the conventional security system. There are many biometric technologies like fingerprints, iris and voice verification, but face recognition is one of the most popular authentication methods in biometric verification.

Face recognition systems are usually applied and preferred for people and security cameras in metropolitan life. These systems can be used for crime prevention, video surveillance, person verification, and similar security activities. Besides from that, the facial imaging has easy client acceptance and makes face recognition universal. The input of the system is a face image captured by camera. Once the face image is captured, it is then transferred into MATLAB programming for the face recognition process. Next, the input face image will be compared to the training image in the training database. The recognition process is done by using Principal Component Analysis (PCA). The project will evaluate face recognition on a pre-recorded database of thefts and criminals through their police records. The database will be recorded in a controlled artificial environment with a camera setup. Validated faces are classified, output results are; this face belongs to criminal or not, according to their pre-recorded database. If output result of system gives correct results, then entry in colonies, malls, buildings, metro will be possible otherwise inform to the police

2.LITERATURE SURVEY

PCA(Principal Component Analysis):

The PCA is one of the most popular representation methods for face image and used for face recognition algorithms. It reduces the dimensionality of the image as well as retains some of the variations. This is also called by Karhunen- Loève method. It is one of the popular methods for feature selection and dimension reduction. PCA is a procedure in which reduction of variable is possible. It is useful when some redundancy is found in obtained data and this consequences reduction of variables into small number of variables which are called principal components. PCA normally the use of Eigen faces. For using PCA the system finds the Eigen values, Eigen vector and Euclidian distance. PCA applies on both database image and input image. After comparing with database it declares whether face is matches or not. Principal Component Analysis commonly uses the eigen faces in which the test and training images must be the same dimensions as well as normalized to line up the eyes and mouth of the subjects whining the images [1]. By this image compression basics reduce the dimension of data and provides structure of facial pattern to be most effective low dimensional. This reduction drops the useless information and decomposes the face structure into orthogonal (uncorrelated) components known as eigen faces. Each face image is represented as weighted sum feature vector of eigen faces which are stored in 1-D array. A test image is compared against the training images by measuring the distance between their respective feature vectors then matching result will be disclosed. From this

algorithm, can reduce the data needed to identify the individual to 1/1000th of the presented data.

To perform PCA several steps are undertaken:

1) Pre-processing: Before face detection and classification pre-processing is essential. Input image of RGB format is converted into Gray image. The acquired image is resized to a specific size and resolution. The image is resized to 640x480 pixels.

2) Mean Image: Mean image calculation is very important for PCA work properly.

3) Covariance Matrix: Calculation of covariance matrix.

4) Eigen value and Eigen vector: from covariance matrix, we can calculate the Eigen value and Eigen vector

5) Euclidian Distance: The Euclidian distance measure between two values. We can calculate by distance between Eigen values of input image and database image.

After the calculation of Euclidean distance we tend to compare from database and declare the match weather the person present in data base or not. PCA has ability for interpretation. For example a 100x100 pixel area containing a face can be very accurately represented by just 40 Eigen values. Each eigen value define the magnitude of each eigen face in each image. Moreover, all interpretation (i.e. recognition) operations can now be done using just the 40 eigen values to represent a face instead of the computing the 10000 values contained in a 100x100 image. [1] The goal of PCA is to cut back the dimensionality of the info whereas retentive the data (with no redundancy)as many as doable within the original dataset .PCA permits to perform a linear transformation that maps information from a high dimensional space to a lower dimensional sub-space. Etemad combines the PCA and Linear Discriminant Analysis (LDA) for various aspects of human faces within the spatial and within the wavelet domain. PCA is correct to dimension reduction and if variety of training samples is large, then LDA is correct to pattern classification PCA identifies the variability between the face pictures. [2]

3. METHODOLOGY

3.1 Image Acquisition

In the image acquisition process, the input face image is captured via camera. Once the input image is captured, the skin segmentation performed. The purpose of image acquisition is to seek and extract a region which contains only the face. These captured images are sent to face detection algorithm. It detect face of a person after that, person is recognized by applying recognition theorems on it.

3.2 Preprocessing of image

The acquired image is resized to a specific size and resolution. The image is resized to 640x480 pixels. Compressing the original features through dimension reduction without destroying the important information from the image.

3.3 Database

A database were created from frontal photos of people for this thesis, that was accustomed check the algorithms and a larger database that was collected for the important analysis [3]. This database consisted of 26 individuals of each gender male and female.

3.4 Face Detection Part

Skin segmentation algorithm: For face recognition system, locating and extracting face image performs by face detection operations. Our paper reveal that skin segmentation is the first step for face detection, reduces operational time for searching face in whole image.

3.5 Face Recognition Part

PCA algorithm:

Determine PCA subspace from training data.

$$X^i = [x_1^i, \dots, x_N^i]$$

*i*th image vector containing *N* pixels is in the form e is the vector of eigenvalues of the covariance

Store all p images in the image matrix

$$X = [X^1, \dots, X^p\ ]$$

Compute covariance matrix

$$\Omega = XX^T$$

Compute eigen values and eigen vectors

$$\Omega V = \Lambda V,$$

Where Λ is the vector of eigenvalues of the covariance matrix.

Order eigenvectors

$$V = [V_1, V_2, \dots, V_p]$$

Order the eigenvectors in V according to their corresponding eigenvalues in descending order. Keep only the eigenvectors associated with non-zero eigenvalues. This matrix of eigenvectors forms the eigen space V, where each column of V is the eigenvector. Visualized eigen- vectors of the covariance matrix are called eigen faces. Now we can calculate by distance between Eigen values of input image and database image. PCA is based is the distance measures, between two points. The problem of finding the distance between two or more point of a set is defined as the Euclidean distance. That's why we use Euclidean distance in PCA.

In MATLAB:

Euclidean distance between 'A' and 'B' is

Euclidean Distance = sqrt (sum ((A-B).^2))

It is easy to code and have fast calculation.

4. IMPLEMENTATION

The developed system has been tested for many live acquired images and results are satisfactory for such a pioneering work in the thesis. Improvements are required for better performance. System description and possible improvements are discussed in this chapter. So, we will try to find best distance measure other than Euclidean which was in existing PCA.

Manhattan Distance: The Manhattan Distance is the distance between two points measured along axes at right angles. For example if X= (a, b) and Y=(c, d), the Manhattan distance between X and Y is

$$|\mathbf{a - c}| + |\mathbf{b - d}|$$

Cosine distance: The cosine of two vectors can be derived by using the Euclidean dot product formula:

$$a.b = \|a\|\|b\|cos\theta$$

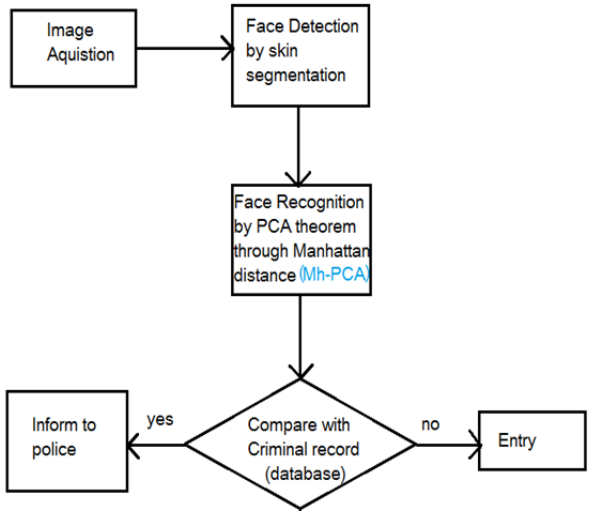
We have a database of 7 sample images of 16 peoples. The reason is that acquisition of face image may differ each time the image taken. For example, shaved and no-shaved faces are included for my samples. Now, we take 3 images of each individual in training images and conclude operations using Euclidean, Manhattan, Cosine to find which distance gives best result. Then we takes 5 images of each individual in training images and then 7 images. And finds its accuracy rate.

Table 4.1 Percentage of three distance

No. of training Images	Euclidean Distance	Manhattan Distance	Cosine Distance
3	85%	100%	75%
5	93.75%	100%	75%
7	93.75%	100%	81.25%

From the table 4.1 shows Manhattan gives best result up to 100%, that's why we choose Manhattan distance for large database, and compare with Euclidean distance which used in existing PCA.

4.1 Proposed Methodology: I proposed the method in which the distance is computed by Manhattan distance instead of Euclidean distance in PCA and gives the name Mh-PCA**.** The steps of algorithm of Mh-PCA is shown in figure 4.1.

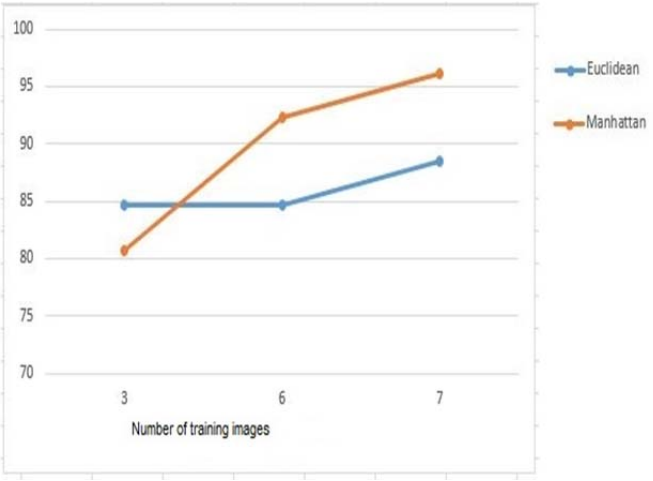


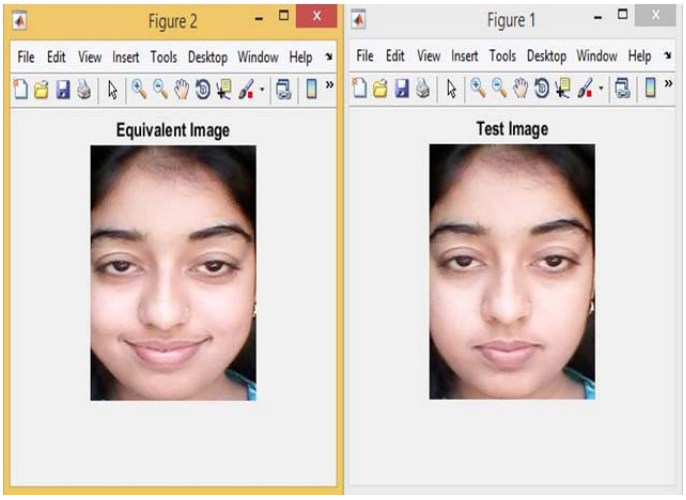
5. Results And Discussion

Now we take large database of 26 peoples, it means in test images we have 26 images and we compare it with different number of training images, first of all we take 3 images of each individual in training images and compute results of both distances Euclidean and Manhattan then 6 images then 7 images takes as training images. The analysis shows that the system gives a higher accuracy rate with Manhattan distance in PCA rather than Euclidean distance. That's why I give the name of this algorithm is Mh-PCA. Besides, the accuracy rate of the system is directly proportional to the number of training image .Therefore, in order to get maximum accuracy rate of the system, all parameters should be set in controlled conditions. The system gives the highest accuracy rate with all parameters is in controlled condition which is **96.15%** in Table5.1.

Table 5.1 Percentages of both distances

No. of training images	Euclidean distance	Manhattan distance
3	84.61%	80.76%
6	84.61%	92.30%
7	88.46%	**96.15%**





Conclusions And Future Enhancements

PCA is used for face recognition and we use different distance (Manhattan) to compute it rather than Euclidean distance and it gives best results in recognition system. Proposed system can be affected by pose, system working range. As a conclusion, Mh-PCA is a reliable algorithm to be used in face recognition security. The objective in developing a face recognition security system for access control using PCA algorithm is achieved. Some improvements can be applied in face recognition part like head pose may be different, and perform on very big database according to smart city with small number of training images.

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