International Journal of Advanced Engineering and Innovative Technology (IJAEIT)
ISSN No 2348-7208 Special Issue on "Emerging Technology for Innovative India"

MISSING CHILD IDENTIFICATION USING FACE RECOGNITION SYSTEM

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Abstract: **The human face plays an important role in our social interaction, conveying people's identity. Face recognition is a task that humans perform routinely and effortlessly in their daily lives. Face recognition, as one of the primary biometric technologies, became more and more important owing to rapid advances in technologies such as digital cameras, the Internet and mobile devices, and increased demands on security. A facial recognition system is a computer application capable of identifying or verifying a person from a digital image or a video frame from a video source. Face Recognition System is a computer based digital technology and is an active area of research. This paper addresses the building of face recognition system by using Principal Component Analysis (PCA) method. The PCA has been extensively employed for face recognition algorithms. It not only reduces the dimensionality of the image, but also retains some of the variations in the image data. The system functions by projecting face image onto a feature space that spans the significant variations among known face images. The significant features are known as "Eigen faces", because they are the eigenvectors (Principal Component) of the set of faces they do not necessarily correspond to the features such as eyes, ears, and noses. The projection operation characterize an individual face by a weighted sum of the Eigen faces features and so to recognize a particular face it is necessary only to compare these weights to those individuals.**

Keywords: Face recognition, Principal Component Analysis, Eigen faces, Eigenvectors.

I. INTRODUCTION

Biometric-based techniques have emerged as the most promising option for recognizing individuals in recent years since, instead of authenticating people and granting them access to physical and virtual domains based on passwords, PINs, smart cards, plastic cards, tokens, keys and so forth, these methods examine an individual's physiological and/or behavioral characteristics in order to determine and/or ascertain his identity. Passwords and PINs are hard to remember and can be stolen or guessed; cards, tokens, keys and the like can be misplaced, forgotten, purloined or duplicated; magnetic cards can become corrupted and unreadable. However, an individual's biological traits cannot be misplaced, forgotten, stolen or forged.

Biometric-based technologies include identification based on physiological characteristics (such as face, fingerprints, finger geometry, hand geometry, hand veins, palm, iris, retina, ear and voice) and behavioral traits (such as gait, signature and keystroke dynamics). Face recognition appears to offer several advantages over other biometric methods, a few of which are outlined here:

Almost all these technologies require some voluntary action by the user, i.e., the user needs to place his hand on a hand-rest for fingerprinting or hand geometry detection and has to stand in a fixed position in front of a camera for iris or retina identification. However, face recognition can be done passively without any explicit action or participation on the part of the user since face images can be acquired from a distance by a camera. This is particularly beneficial for security and surveillance purposes. Furthermore, data acquisition in general is fraught with problems for other biometrics: techniques that rely on hands and fingers can be rendered useless if the epidermis tissue is damaged in some way (i.e., bruised or cracked). Iris and retina identification require expensive equipment and are much too sensitive to any body motion. Voice recognition is susceptible to background noises in public places and auditory fluctuations on a phone line or tape recording.

Signatures can be modified or forged. However, facial images can be easily obtained with a couple of inexpensive fixed cameras. Good face recognition algorithms and appropriate preprocessing of the images can compensate for noise and slight variations in orientation, scale and illumination. Finally, technologies that require multiple individuals to use the same equipment to capture their biological characteristics potentially expose the user to the transmission of germs and impurities from other users. However, face recognition is totally non-intrusive and does not carry any such health risks.

II. FACE RECOGNITION SYSTEM

Face recognition system consist of three major steps, acquisition of face data, extracting face feature and recognition of face[5]. Fig. 1 shows typical structure of face recognition system. The subject under consideration is given to the system for the recognition. Later on feature is extracted from the image and finally it is given for the recognition purpose.

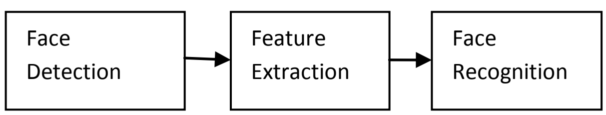


Fig 1.Face recognition system

These steps are elaborated as follow[5]:

A. Acquisition of Face Data

First step in the face recognition system is Acquisition and Processing of Face Data. In this step face images is collected from different sources. The sources may be camera or readily available face image database on the website. Illumination condition, background, lighting conditions, camera distance, the size and orientation of the head causes serious effect on the performance of face recognition systems.

B. Extracting Face Feature

Feature extraction process is defined as the process of extracting relevant information from a face image. In feature extraction, a mathematical representation of original image called a biometric template or biometric reference is generated, which is stored in the database and will form the basis (vector) of any recognition task. Later these extracted features used in recognition.

C. Recognition of Face

Once the features are extracted and selected, the next step is to classify the image. Appearance-based face recognition algorithms use a wide variety of classification methods Such as PCA, LDA. In classification the similarity between faces from the same individual and different individuals after all the face images in database are represented with relevant features. Sometimes feature extraction & recognition process done simultaneously.

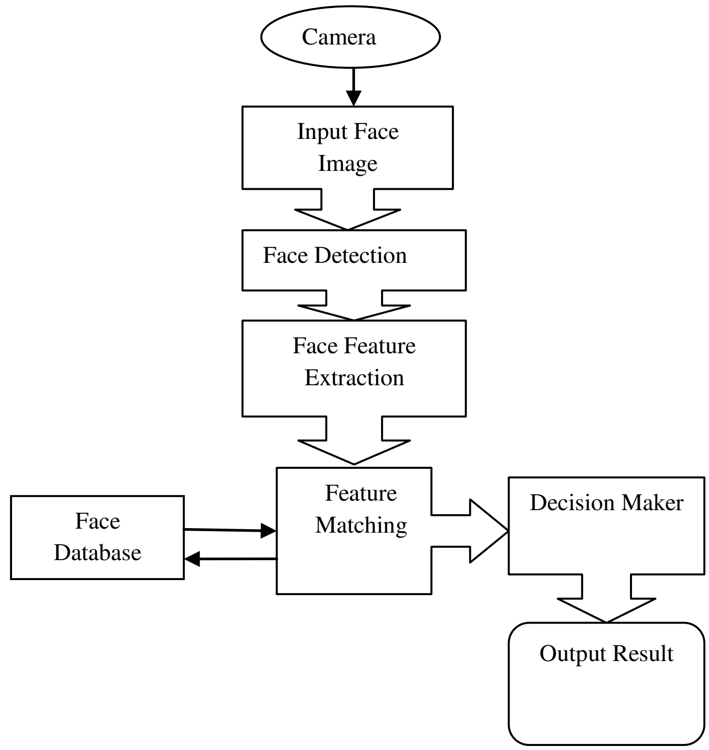


Fig 2.Work Flow Model

III. PRINCIPLE COMPONENT ANALYSIS (PCA)

PCA is a useful statistical technique that has found application in fields such as face recognition and image compression. It is a way of identifying patterns in data, and expressing the data in such a way as to high light their similarities and differences. Since patterns in data can be hard to find in data of high dimension, where the luxury of graphical representation is not available, PCA is a powerful tool for analyzing data.In PCA, faces are represented as a linear combination of weighted eigenvectors called as Eigen faces; these eigenvectors are obtained from covariance matrix of a training image set called as basis function[5]. The number of Eigen faces that obtained would be equal to the number of images in the training set. Eigen faces takes advantage of the similarity between the pixels among images in a dataset by means of their covariance matrix[5]. These eigenvectors defined a new face space where the images are represented. PCA is a commonly used method of object recognition as its results, when used properly can be fairly accurate and resilient to noise. To perform PCA several steps are undertaken:

- Stage 1: Subtract the Mean of the data from each variable.
- Stage 2: Calculate and form a covariance Matrix
- Stage 3: Calculate Eigenvectors and Eigenvalues from the covariance Matrix
- Stage 4: Construct a Feature Vector
- Stage 5: Transposition

Mean Subtraction

For PCA to work properly, you have to subtract the mean from each of the data dimensions. The mean subtracted is the average across each dimension. So, all the x values have $\bar{x}$ (the mean of the x values of all the data points) subtracted, and all the y values have $\bar{y}$ subtracted from them. This produces a data set whose mean is zero.

Covariance Matrix

Covariance is always measured between2 dimensions to perform statistical analysis to see if there is any relationship between the dimensions.The basic Covariance equations for two dimensional data is:

$$cov(x,y) = \frac{\sum_{i-1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)}$$

which is similar to the formula for variance. In this equation x represents the pixel value and $\bar{x}$is the mean of all x values, and n the total number of values. The covariance matrix that is formed of the image data represents how much the dimensions vary from the mean with respect to each other. The definition of a covariance matrix is:

$$C^{n\times n} = (c_{i,j}, c_{i,j} = cov(Dim_i, Dim_j))$$

Where $C^{n\times n}$ is a matrix with n rows and n columns, and Dim_x is the xth dimension.

Eigenvectors and Eigen values

Eigen values are a product of multiplying matrices. Eigen values are found by multiples of the covariance matrix by a vector in 2 dimensional space (i.e. a Eigenvector). This makes the covariance matrix the equivalent of a transformation matrix. Eigenvectors can be scaled so ½ or x2 of the vector will still produce the same type of results. This process of taking the eigenvectors of the covariance matrix makes it possible to extract lines that characterise the data.

To construct feature vector

Once Eigenvectors are found from the covariance matrix, the next step is to order them by Eigenvalue, highest to lowest. This gives you the components in order of significance. Also, we can decide to ignore the components of lesser significance. To be precise, if you originally have n dimensions in your data, and so you calculate p eigenvectors and eigenvalues, and then you choose only the first p eigenvectors, then the final data set has only p dimensions. Here the data can be compressed and the weaker vectors are removed. To construct a *feature* vector, we have to arrange the selected eigenvectors in columns to form a matrix.

Transposition

The final stage in PCA is to take the transpose of the feature vector matrix and multiply it on the left of the transposed adjusted data set. We compare two faces by projecting the images into facespace and measuring the Euclidean distance between them. When it is passed an image to recognize it performs PCA and compares the generated Eigen values and Eigenvectors.

IV. ANDRIOD APPLICATION FOR FACE RECOGNITION

We believe that this algorithm will be helpful in identifying the child who has been missing as finding similarities in the two images and identifying the principal components of both the images will give us a better analysis of the image itself.

The android app is capable of capturing images and forwarding it to known workstation where the algorithm is simulated to check whether input image matches with database image. A notification can be sent to the user about the result. Moreover, location of the user can be obtained to record the activity of the missing child.

The algorithm can be further modified to increase the accuracy of the system. In the years to come, the technology to predict the child's face also can be added so as to find the child even after the kid is missing for years.

The workflow of the idea is shown:

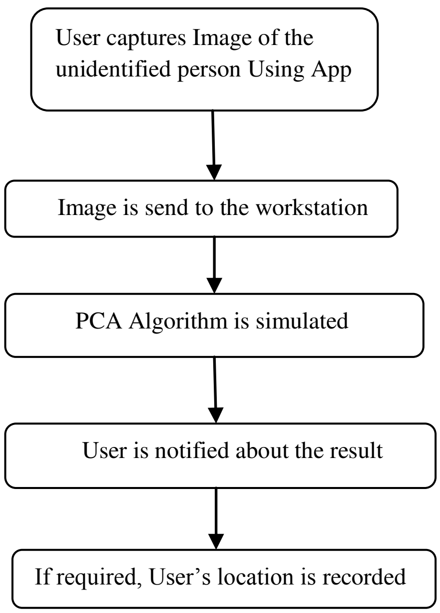


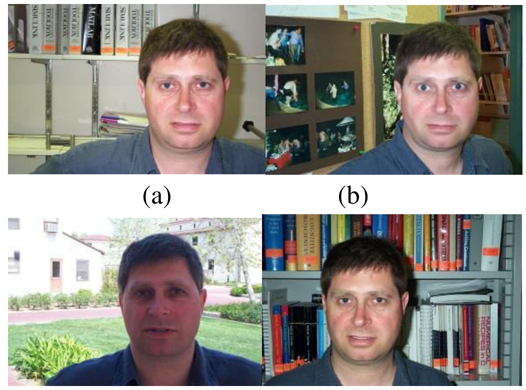
Fig.3 Workflow model

V. RESULTS AND DISCUSSION

The algorithm for PCA based face recognition system is developed in the Matlab 7.12.0.635(R2011a) environment. The database used is Frontal face dataset collected by Markus Weber at California Institute of Technology. The database includes 450 face images having resolution 896 x 592 pixels in Jpeg format. It includes images of 27 or so unique people under with different lighting. The process of face recognition involves providing an individual image as a test image or input image to the system, the system then runs the algorithm and checks whether the image matches to any individual's image present in the database. The recognition accuracy of the system is computed as the ratio of the faces recognized correctly from the test set over the total number of faces in the test set.

$$Accuracy = \frac{Faces\ correctly\ recognized}{No.of\ faces\ in\ the\ database}$$

The calculated Accuracy of the PCA algorithm was approximately 91%.



(a) (b)

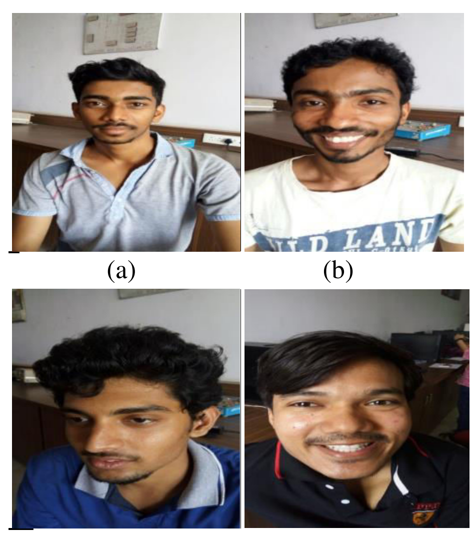
(c) (d)

Fig.3 Standard Database images

Considering 4 different facial images of the same person in the standard database and providing them as an input, the resulting Euclidian distances are shown in the table. The images were correctly recognized.

Table I

Test Image	Euclidian Distance	Result
(a)	2.132e+017	Recognized
(b)	1.23e+52	Recognized
(c)	1.59e+23	Recognized
(d)	1.56e+002	Recognized



(a) (b)

(c) (d)

Fig.4 Database images

Now working on facial images of different candidates under different illuminations conditions and poses and providing them as an input, the resulting Euclidian distances are shown in the table. The images were correctly recognized.

Table II

Test Image	Euclidian Distance	Result
(a)	3.3366e+017	Recognized
(b)	7.308e+017	Recognized
(c)	5.927e+017	Recognized
(d)	9.395e+017	Recognized

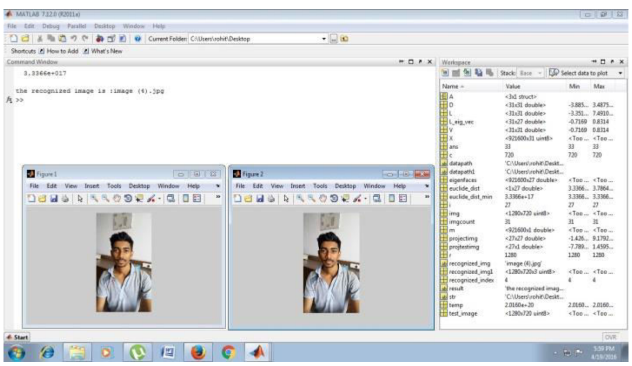


Fig.5 Command Window and Result

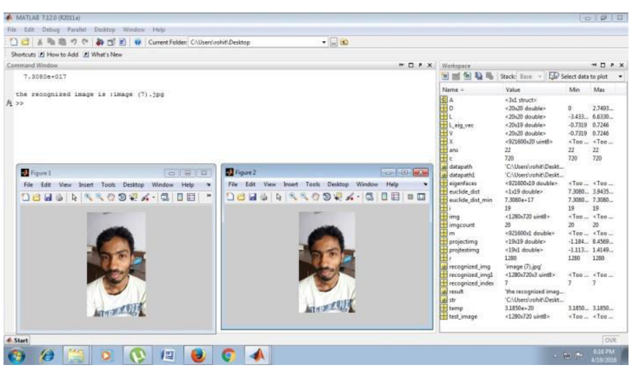


Fig.6 Command Window and Result

VI. APPLICATION

In the future, we believe that face recognition will gain enough importance to be used by the society and nation as a whole. A child is missing if he runs away; he is sick, lost or even abducted. Missing kids can be later on used for trafficking purposes or even worse - murdered. Living in a society where the weakest sector of society - which happens to be also the youngest sector is mishandled or ignored would be a crime in itself. Not everyone knows about the laws and so searching for him becomes an individual task, few who go to the concerned authorities rarely get the appropriate answers. The need for finding this missing child can be found in the vastness of engineering. By face recognition methods, we can connect a person who has lost a child to the person who has seen the child.

CONCLUSION

The paper presents a simple approach for face recognition which minimizes computation time while achieves high detection accuracy. The test results show that the algorithm works very well for most of the challenges including background variations, illumination problem, pose variations and number of faces in the database. In future work related to prediction based good quality face recognition system can be done.

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