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# Independent Component Analysis Algorithm Using Image Processing Based Human Face Detection and Tracking -Automatic Attendance System

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**ABSTRACT:** The daily attendance management is a big task in any organization. The image processing based attendance marking system takes the daily attendance of people in industries and educational institutions automatically. The work presented in this paper proposes a method to automatically take the attendance of students in a university. The system makes use of face recognition technology for identifying the students who are present in each class. It is an efficient way to record and manage the attendance activity in a university. The system stores the details of each student as well as their facial features in the database and it compares the new patterns with the previously stored patterns as per the requirement. The system is technologically very simple, easily installable and maintainable. In this paper, one application of the automatic face recognition, such as attendance marking is discussed in detail. Also, the software and hardware details of the system are discussed. The same system with some modifications, can be used in a wide range of applications such as to prove the identity of a person to log in to a computer; to draw cash from an ATM; to identify the presence of known criminals in airports, railway stations, LOC areas in country border etc; to enter a protected site and so on.

**KEYWORDS:** Face detection, face recognition, Eigen face method, image processing, attendance marking system

## I. INTRODUCTION

The conventional personal identification techniques like passwords, keys, barcodes and smartcards have a major drawback: they don't check who is entering or holding the information. They only check whether the correct information is presented to the system. Such systems can be easily deceived because any person who has the ID card or anyone who knows the password can easily claim the identity of that person. Also there are some other drawbacks for such systems: the person has to remember the password or he has to carry the ID card. In barcode system, line of sight reading is required. Biometrics based personal identification systems eliminates most of these drawbacks. Biometrics is the automated recognition of individuals based on their behavioral and biological characteristics. Fingerprint, hand geometry, face, iris scan, retinal scan, signature, gait, voice are some of the well known biometric characteristics. In biometric based attendance systems, subject is being identified using any of biometric techniques Biometric systems are more reliable because biometric characteristics cannot be easily stolen, duplicated or lost and also the user does not have to memorize the password or he does not have to carry some ID cards. But each of these biometric systems has certain disadvantages also. The finger prints and hand geometry based systems fail to identify the individuals if the finger or hand is injured or dirty. Retinal and iris scan are very much susceptible to diseases that change the characteristics of the eye. For obtaining the retina scan, laser light must be directed through the cornea of the eye. Iris based systems need a specialized camera which is very expensive and also the photo should be taken very close to the subject. Voice based systems might not work properly if the voice of the person changes due to flu or throat infection. Any noise in the background also affects the performance of the system. So, compared to the above mentioned biometric systems, face recognition based systems have many advantages due to the following reasons:

• Easy to deploy, can use existing image capturing devices (webcam, security camera etc)

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• Contact free process
• It does not require user cooperation unlike fingerprint. People can be identified without their knowledge.
• It is easier to obtain a photo rather than a finger print or iris scan.

Face recognition systems have numerous applications in access control systems, network security, crowd surveillance systems, and attendance systems and so on. In this paper, the design and implementation of a face recognition system is discussed in detail. And the system performance is evaluated for an application like automatic attendance marking of students in a university. The system identifies the students with the help of image processing technologies. So students who are absent and intruders are checked out automatically. In the proposed system, cameras installed in each class room will capture the photo of the students. Each student will be identified using face recognition technology and the attendance report will be generated automatically. The system can locate a subject's face and then recognize the person by comparing characteristics of the face to those of known individuals. For face recognition, Eigen face approach (proposed by M Turk and A Pent land is used. The entire paper is organized as described below. Section II presents an overview of image processing technique. Also the algorithms used for implementing face detection and face recognition are discussed. Section III describes the implementation details of image processing based attendance marking system.

## II. IMAGE PROCESSING

Image processing implies a set of computational techniques for analyzing, enhancing, compressing and reconstructing images. Image processing has extensive applications in many areas, including astronomy, computer vision, robotics, remote sensing by satellites, medical image processing and biometrics. An overview of face recognition system and the algorithms used for implementing the image processing based attendance marking system are described in the coming sections.

*A. Overview of face recognition system*

The system is made up of a camera which take the photos of individuals and a computer unit which performs face detection (locating faces from the image removing the background information) and face recognition (identifying the persons). First, face images are acquired using webcam to create the database. Face recognition system will detect the location of face in the image and will extract the features from the detected faces. As a result of feature extraction process, templates are generated which is a reduced set of data that represents the unique features of enrolled user's face.

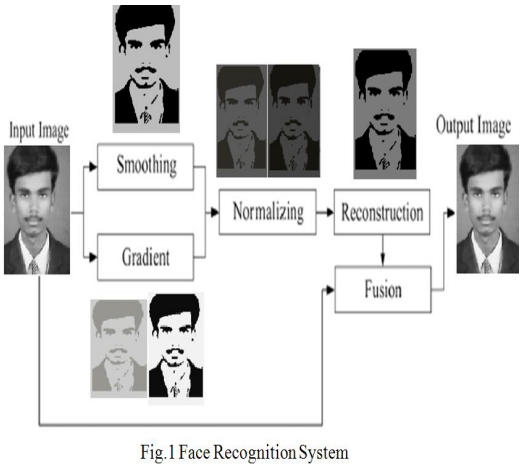


Fig.1 Face Recognition System

These templates are stored in database. For an unknown face image, template is generated as described above and is compared with those stored in the database, which outputs the identity of that face if a match occurs. An overview of face recognition system is shown in fig. 1.

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*B. Face detection system*

Face detection is the first and the most important step towards face recognition. Given images with different complex backgrounds, a face detection algorithm will identify and locate the faces in the image accurately. In the proposed system, for face detection Independent component analysis algorithm with Eigen features are used. It is a method for computing fast approximations to support vector decision functions in the field of object detection.

*C. Face recognition system*

A simple approach to extract the information contained in an image of a face is to somehow capture the variation

$$U_l^T U_k = \delta_{lk} = \begin{cases} 1, \text{ if } l=k \\ 0, \text{ otherwise} \end{cases}$$

$\Gamma_1, \Gamma_2, \ldots, \Gamma_M,$

in a collection of face images, independent of any judgments of features, and use this information to encode and compare individual face images. The system functions by projecting face images onto a feature space that spans the significant variations among known face images. The significant features are known as eigenfaces because they are the Eigen vectors (principal components) of the set of faces; they do not necessarily correspond to features such as eyes, ears and noses. The projection operation characterizes an individual face by a weighted sum of the Eigen face features, and so to recognize a particular face it is necessary only to compare these weights to those of known individuals. Let the training set of M number of face images be,

$$\Psi = \frac{1}{M} \sum_{n=1}^{M}$$

Each face differs from the average by the vector

$$\Phi_i = \Gamma_i - \Psi$$

This set of very large vectors is then subject to principal component analysis which seeks a set of M orthonormal vectors, Um, which best describes the distribution of the data. The Kth vector ,Uk, is chosen such that

$$\lambda_k = \frac{1}{M} \sum_{n=1}^{M} (U_k^T \Phi_n)^2$$

is a maximum subject to Ul. The vectors U(k) and scalars lamda (k) are the eigenvectors and Eigen values respectively of the covariance matrix

$$C = \frac{1}{M} \sum_{n=1}^{M} \Phi_n \Phi_n^T = AA^T$$

Where the matrix A= [1 2….. M].The covariance matrix C is N2 * N2 and calculating N^2 Eigen vectors and Eigen values is an intractable task for typical image sizes. So a computationally feasible method is needed. Consider the Eigen vectors vi of A^TA such that A^TA vi=µivi Pre multiplying both sides by A, we have AA^TA vi=µi Avi where Avi are the Eigen vectors and µi are the Eigen values of C=AA^T

Following these analysis, we construct the M × M matrix L=ATA, where $L_{mn}$= m and find the M eigen vectors, vi ,of L. These vectors determine linear combinations of the M training set face images to form the eigenfaces Ul= v^lk _k, l=1,…,M With this analysis, the calculations are greatly reduced from the order of the number of pixels in the images (N2) to the order of the number of images in the training set (M). In practice, the training set of face images will be relatively small (M<< N2). From analysis it is found that M' (M'<M) significant eigen vectors of the L matrix with the largest associated eigen values are sufficient for reliable representation of the faces in the face space characterized by the eigen faces.For k=1,…,M'. The weights form a projection vector,T =[w1 w2...wM] describing the contribution of each eigen face in representing the input face image, treating the eigen faces as a basis set for face images. For the input face image also, calculate the projection vector as described above and compare it with projection vector corresponding to each face stored in the database. The idea is to find the face that minimizes the difference. If the difference is minimum for a particular person's face in the database then, it can be concluded that the input face is of that person.

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## III. IMAGE PROCESSING BASED ATTENDANCE MARKING SYSTEM

After giving the alarm, students should come in attention. Web camera captures the face of students. Using an ICA algorithm, the captured faces will processed further. If the face is coincide with the respective database, the attendance allocated for the student. Crossing some time delay the absentees list will transmitted to a controller room over GSM

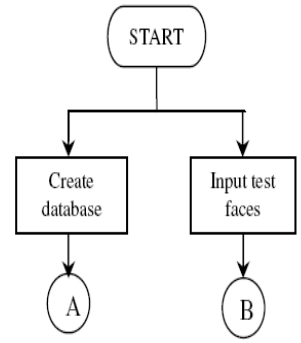


Fig. 2. Flow chart for image processing based attendance marking system application GUI

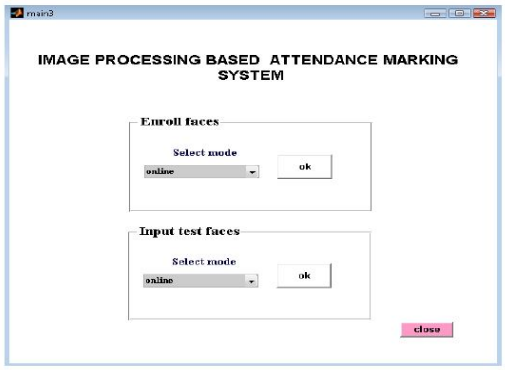


Fig. 3. Front-end view of the GUI for the image processing based attendance marking system application

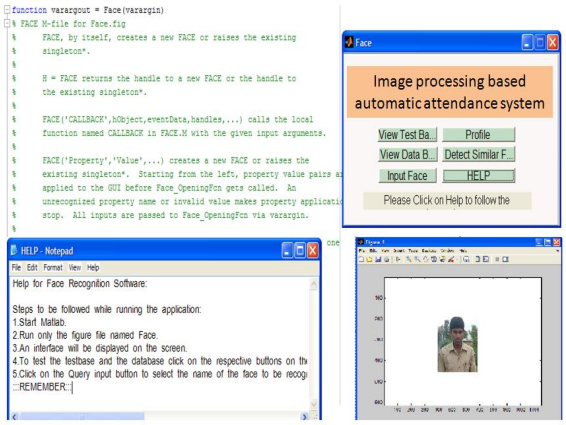


Fig. 4. GUI for enrolling faces in image processing based attendance marking system application

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To mark the attendance, photos of the students who are present in the class are taken using webcam. Based on the photos taken, the system will recognize each student and their attendance will get marked in an excel sheet automatically which can be saved for later use. The software and hardware details of the system are given in the following sections.

*A. Attendance marking system application*

The image processing based attendance marking application is developed in MATLAB7.6.0 (R2008a). It does the following tasks

1) Enroll faces (add images to the database)
2) Detect and extract faces from the images added.
3) Create eigenfaces for all the extracted faces and store them in the database.
4) Update database (If needed)
5) Test input images
6) Mark the attendance for the recognized students in an excel sheet automatically.

The flow chart for the entire application is shown in fig. 2. It mainly consists of two subsystems; create database and test faces. application GUI.The front end view of the GUI created is shown in fig. 3. In the GUI, first the mode for creating the database is to be chosen first. If the photos are taken directly from the camera 'online' option is chosen or if the photos are stored in the system then, 'offline' option is chosen. After selecting the mode to enroll faces in the main window of the GUI, a new window will appear as shown in fig.4. Database creation is given in Fig.6.
done in this window. The flowchart for database creation is shown in fig. 5. After adding all the images to database, eigen faces are calculated.

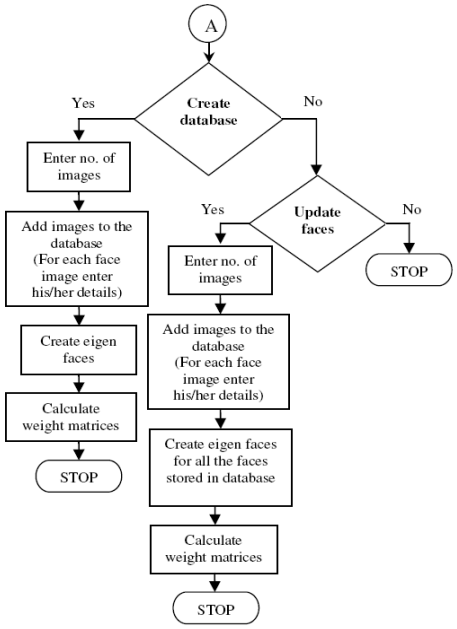


Fig. 5. Flow chart for creating database

Finally 'close' button is pressed to navigate to the main window. In the main window, the mode for inputting the test photos ('offline' or 'online') is chosen. Then a new window for testing the unknown faces will appear as shown in Fig. 6. The multi model face recognition is shown in fig. 7.

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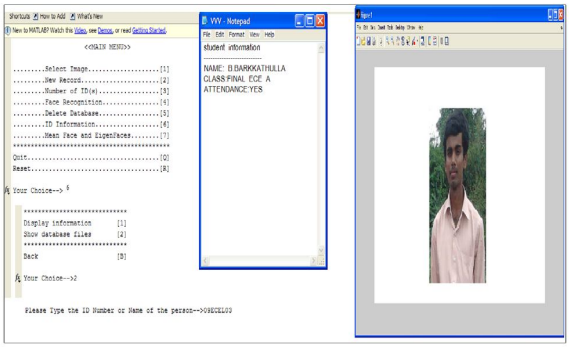

Fig.6. GUI for testing input faces in image processing based attendance marking system application

If the mode chosen is 'offline', the 'select test face' option is used, to browse for the test photo. If 'online' selection is made then, the hardware connected to the system will take the photos. Also, the photos will be displayed in the window.

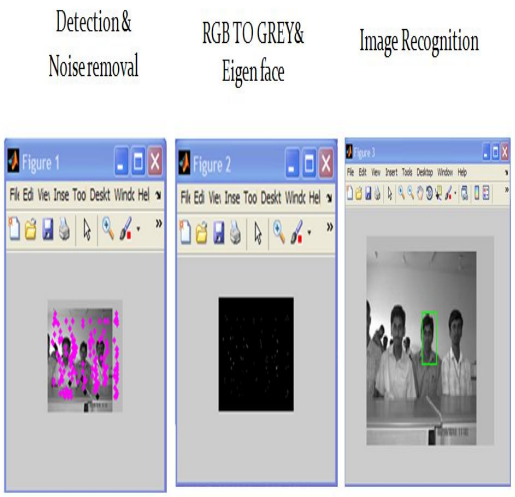


Fig.7 Multi model face detection

Finally, the attendance will get automatically marked in an excel sheet as '1' for the students who are present.

*B. The image processing based attendance marking system hardware*

The hardware implementation of image processing based attendance marking system was done by making use of a PIC 16F877 micro controller and a Passive Infra Red (PIR) sensor which will detect the presence of a person. The block diagram for the hardware is shown in fig.

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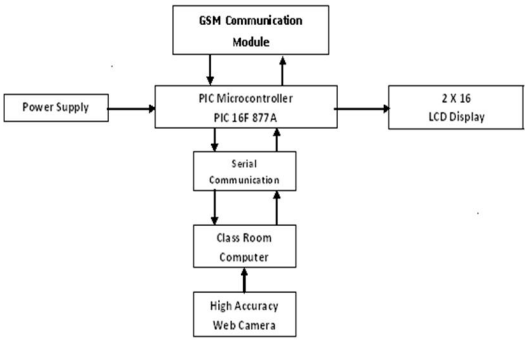


Fig.8.1 Class Room Section

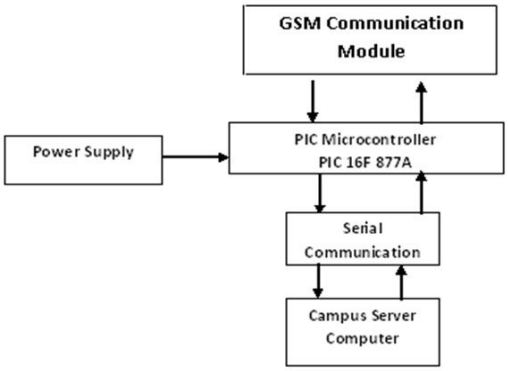


Fig.8.2 Controller Block

As soon as the PIR sensor senses the arrival of a person, one pin of the microcontroller goes high which in turn turns on a buzzer and a LED and also transmits a bit '1' serially to the image processing based attendance marking application on PC. If the sensor output is low, bit '0' will be transmitted.

Whenever the application detects bit '1', it will turn on the webcam automatically. Then the camera will take the photo and that photo will get processed in the application. Finally the application will generate attendance report.

**IV.RESULTS AND DISCUSSION**

The application developed in MATLAB for image processing based attendance marking was tested both manually and automatically. First database creation was done using the photos of students in the university. Experiments were carried out using 22 photos. Among them, the face recognition algorithm was able to recognize 15 students correctly. Hence the percentage error obtained was 31.81. The eigen faces calculated are displayed as shown in fig. 9 and the attendance report generated for the students in the college is shown in Fig. 10.

Fig. 9. Eigen faces

| | | ATTENDANCE SHEET | | | | | | | | | | | | | | DATE:20/02/2012 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | YEAR/CLASS: | | | | 4 ECE A | | | | | | | | | | |
| | | SUBJECT: | | | | MICROWAVE ENGINEERING | | | | | | | | | | |
| | | COLLEGE: | | | | Dr.N.G.P.IT | | | | | | | | | | |
| Roll No. | Name | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | Akellesh V | 1 | | | | | | | | | | | | | | |
| 2 | Balasubramaniyam N | 1 | | | | | | | | | | | | | | |
| 3 | Barkkathulla B | 1 | | | | | | | | | | | | | | |
| 4 | Hariharan K | | | | | | | | | | | | | | | |
| 5 | Kavimuhil B | 1 | | | | | | | | | | | | | | |
| 6 | Kaviyarasu V | 1 | | | | | | | | | | | | | | |
| 7 | Krishna Boopathy J | 1 | | | | | | | | | | | | | | |
| 8 | Kirthika B | 1 | | | | | | | | | | | | | | |
| 9 | Manivannan R | 1 | | | | | | | | | | | | | | |
| 10 | Minhaaz A M | 1 | | | | | | | | | | | | | | |
| 11 | Narmatha K | 1 | | | | | | | | | | | | | | |
| 12 | Naavarasan P | | | | | | | | | | | | | | | |
| 13 | Naveen S | | | | | | | | | | | | | | | |
| 14 | Nisha D | 1 | | | | | | | | | | | | | | |
| 15 | Nivethika R | 1 | | | | | | | | | | | | | | |
| 16 | Banupriya S | 1 | | | | | | | | | | | | | | |
| 17 | Akhila zakharia | | | | | | | | | | | | | | | |
| 18 | Amal George | 1 | | | | | | | | | | | | | | |
| 19 | Anand A | 1 | | | | | | | | | | | | | | |
| 20 | Karthik R | 1 | | | | | | | | | | | | | | |

Fig.10 Attendance in excel sheet

Usually in the eigen face method, faces are cropped manually to remove the background. But in this proposed system, the objective is to recognize the individuals from a photo automatically.

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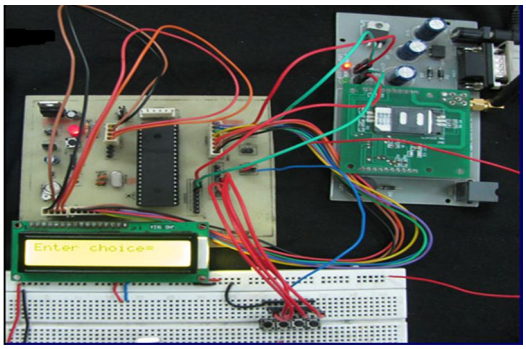


Fig.11 GSM Interfacing

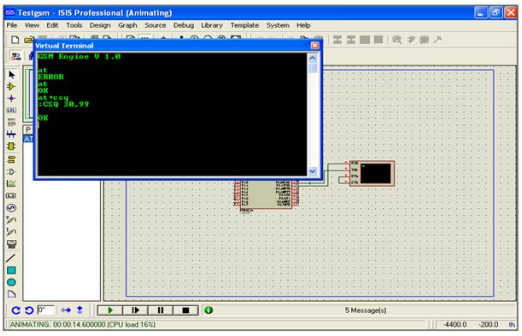


Fig12 Message Transmission Through GSM

So it was first needed to detect and extract the faces from the photo by using some face detection algorithm and then these extracted faces were to be used for the recognition. As the size of the face extracted by the face detection algorithm was small, there was a high percentage error as above mentioned was experienced in recognizing individuals. Also, there are some more limitations for the eigen face approach. First, the algorithm is sensitive to head scale. Second, it is applicable only to front views. Third, it demonstrates good performance only under controlled background, and may fail in natural scenes. When lighting is highly variable, eigenface often does no better than random guessing would Other factors that may stretch image variability in directions that tend to blur identity in PCA space include changes in expression, camera angle, head pose, image quality.

## V.CONCLUSION

In order to overcome the existing attendance system such as RFID & finger print technology, a new system has been designed & implemented entitled as 'image processing based automatic attendance system'. The system removes some of the drawbacks of traditional attendance system (where the attendance is taken by the teachers manually) like the chances of proxy attendance, wastage of class hours etc. The system can also track the time of entry of each student and it will be written in to the attendance sheet along with their attendance. The above mentioned is one of the applications of the face recognition system which is being developed. The system can be used in a range of applications like PC login security, robotics, vehicle security systems, terrorists screening, passport authentication etc. The result of the system is very efficient in such a way, reducing the time taken to update & track the attendance in a secured manner. In future this system module can be linked with the organization website/common server database as a module through which each & every candidate can update their attendance automatically by their own. The updates can be viewed by the organization chairman/secretary/the candidate via online at anytime without having dependency on others data & without wasting the individuals time.

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