Attendance System based on Face Recognition using Eigen face and PCA Algorithms

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Abstract-- The attendance maintaining system is difficult process if it is done manually. The smart and automated attendance system for managing the attendance can be implemented using the various ways of biometrics. Face recognition is one of them. By using this system, the issue of fake attendance and proxies can be solved. In the previous face recognition based attendance system, there were some disadvantages like intensity of light problem and head pose problem. Therefore to overcome these issues, various techniques like illumination invariant, Viola and Jones algorithm, Principle component analysis are used. The major steps in this system are detecting the faces and recognizing them. After these, the comparison of detected faces can be done by crosschecking with the database of student's faces. This smart system will be an effective way to maintain the attendance and records of students.

Keywords: Biometrics, Face recognition, smart attendance.

I. INTRODUCTION

Face Recognition technique is one of the most efficient biometric technique for identification of people. [1] We can utilize it in the field of education for managing the attendance of students. There are a lots of colleges and schools in which thousands of students are taking the education. In every classroom there are about ninety to hundred students are studying. Also in every few days, a new school or college is opened. To maintain the attendance and records of these so many numbers of students is a very difficult task.

In a classroom with large number of students, it is a very tedious and time consuming task to take the attendance manually. Therefore we can implement an effective system which will mark the attendance of students automatically by recognizing their faces.

In [1], the process of this face recognition system is divided into various steps, but the important steps are detection of face and recognition of face. Firstly, to mark the attendance of students, the image of students' faces will be required. This image can be snapped from the camera device, which will be placed in the classroom at a suitable location from where the whole classroom can be covered. This image will act as input to the system. For the effective face detection, the image needs to be enhanced by using some image processing techniques like grayscale conversion of image and histogram equalization [2]. To identify the students sitting on the last rows neatly, the histogram equalization of image needs to be done.

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After enhancing the image quality, [2] the image will be passed to perform face detection. In the face detection step, we need to use the various algorithms like Ada-Boost algorithm, neural networks, support vector machines, etc. the efficiency of Ada-Boost algorithm is most effective of all these. Therefore we will use this algorithm for detecting faces of students by using the [3] [4] haar feature classifiers and cascade concepts of Ada-Boost algorithm.

To recognize the faces is the next task to be done after detecting faces of students from image. For face recognition, there are various techniques available like Eigen face, PCA and LDA hybrid algorithm, etc. we are going to utilize Eigen face technique along with principle component analysis. In the Eigen face, when faces are detected, they are cropped from image. Each student's face is cropped and the various features are extracted from them like distance between eyes, nose, outline of face, etc. using these faces as eigen features, the student are recognized and by comparing them with the face database and their attendance is marked.
A database of faces needs to be created for the purpose of comparison. By enrolling the students to that database, we can maintain the information of the students like roll number, student's name, and his or her photo for the identification.

Related Work:
By doing the literature survey on the papers on face recognition, [1] we come to know that, there are various techniques and algorithms which are used for face recognition. In the recent ten years, a lot of algorithms are developed for face recognition. [2] Most of these algorithms like Neural Networks, work only for the single image of a system. But we cannot apply this single image system in classroom attendance system as we need to recognize the multiple faces. [3] The AdaBoost Algorithm is the most efficient algorithm for multiple face recognition. [6] In 1970's a system was created with 21 subjective markers like hair color and lip thickness. This system was created by Goldstein, Harmon and Lesk.

II. REVIEW OF LITERATURE SURVEY

In the literature survey done for the face recognition, we realized that it is two-step process face detection and face recognition. In the face detection, when image is captured, the image area is classified into regions like "face" and "non face".

In [5], the different approaches for face detection are holistic approach, feature based approach, and appearance based. In Holistic approach, the entire face region is considered as input to face detection system. In feature based approach, the features of

face such as nose and eyes are segmented and then taken as input in face detection system.

For face recognition, we need to use different algorithms, like PCA and Eigen face techniques which use the concept of region of interest [2]. machines techniques are used.

In [9] the Illumination Invariant algorithm is used for improving the light intensity problem of surroundings. The Eigen face technique is very sensitive to the head orientation; therefore the camera and scanner support should be implemented for more flexibility.

Table. 1 Comparison of various algorithms for face recognition

Method	No. of Images	Success Rate	Reference no.
Principal Component Analysis (PCA)	400	79.65%	5
Principal Component Analysis + Relevant Component Analysis	400	92.34%	5
Independent Component Analysis	40	Gauss function 81.35%	8
Support Vector Machines	-	85-92.1%	10
Neural Networks	-	93.7%	11
Eigenfaces Method	70	92-100%	12
Eigenfaces with PCA method	-	92.30%	13

III. PROPOSED METHODOLOGY

A. ARCHITECTURE

The architecture of this face recognition based attendance system is shown in the above mentioned diagram. The working of this smart attendance system is very simple and easy to understand. To bring this system into work, we will need some hardware devices for our project. Firstly, we will need a high definition camera which has to be fixed in the classroom at a suitable location from where the whole class can be covered in the camera.

When the camera takes the picture of all students, that picture is enhanced for further processing. In the enhancement, the picture is first transformed in grayscale image, and then it will be equalized using histogram technique.

After enhancement, the picture will be given for detecting the faces of students which will be done by face detection algorithm.
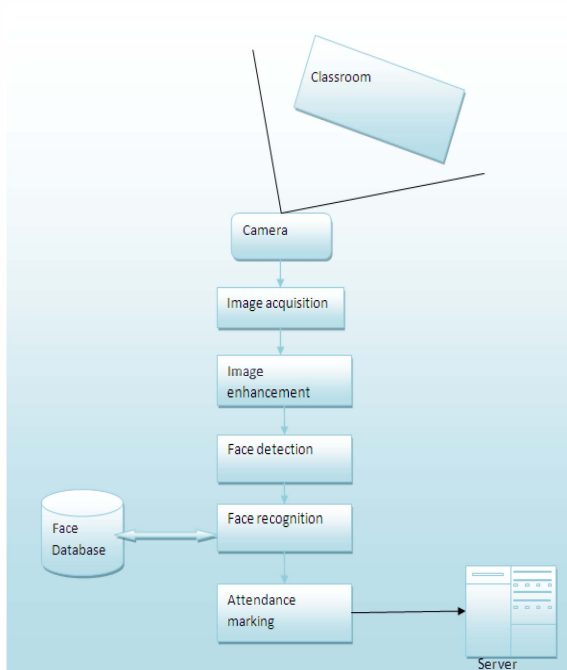
Fig. 1   Architecture of face recognition based attendance system.

Then after detection of faces, each student's face will be cropped from that image, and all those cropped faces will be compared with the database of faces. In that database, all students' information will be already maintained with their image. By comparing the faces one by one, the attendance of students will be marked on server.

B. METHODOLOGY

For implementing the automated face recognition system, we need to follow some particular methodologies. The certain steps need to be performed for this process. Those steps are as follows:

Steps for Face Recognition based Attendance System**:**
- Enrollment
- Image Acquisition.
- Converting the image into gray scale image.
- Histogram Normalization.
- Removing Noise.
- Classification of Skin.

- Face Detection.
- Face Recognition.
- Attendance marking

Above are the steps which need to be followed for successful attendance marking.

Enrollment:
The student or person will be enrolled to the database using their general information and unique biometric features. This information will be saved in the form of templates. The enrollment includes:
- Taking image by camera
- Enhancement of that image
- Feature extraction
- Maintain Database

The image of person will be captured from the camera and then it will be enhanced using histogram equalization and noise filtering. Then after this process, the features are extracted from the image. The unique features will be stored in the face database and a particular id will be assigned to that person.

Image Acquisition:
A high definition camera device will be installed in front of the classroom. The camera device will capture the image of whole classroom. This captured image is given as an input to the system.

Grayscale conversion of image:
The image which is captured from the camera device sometimes may have the brightness in it which needs to be removed for the appropriate result. Therefore the Captured image is converted to grayscale image for the enhancement

Histogram Normalization:
Histogram Normalization is a technique used for contrast enhancement. After this the image will be equalized for removing the contrast so that the students sitting on the back rows can be clearly seen and it will be easy to recognize them. Then it generates the histogram of the equalized image.

Noise Removal:
When the input image is captured by camera, it may contain the noise which has to be filtered from image. The median filtering is one of efficient techniques for removing the noise.

Skin Classification:

In the skin classification technique, all the pixels are made black except the pixels which are closely related to the skin. Those pixels become white. The accuracy of face detection algorithm is improved after skin classification.

Face Detection:

After the enhancement of image, the image comes to face detection module. This module will detect the faces of students from image. The Viola and Jones Algorithm is used for the purpose of face detection. It is also known as the Ada-Boost algorithm for face detection which is created by Viola P. and M. J. Jones.

Face Recognition:

Face recognition is the next step after face detection. The face recognition can be achieved by cropping the faces from the image and comparing them with the enrolled images in the face database. For the face recognition, the concept of selection of region of interest is used, and the faces are verified one by one using the EigenFace method.

Attendance:

After the verification of faces and successful recognition is done, the attendance will be marked on the server.
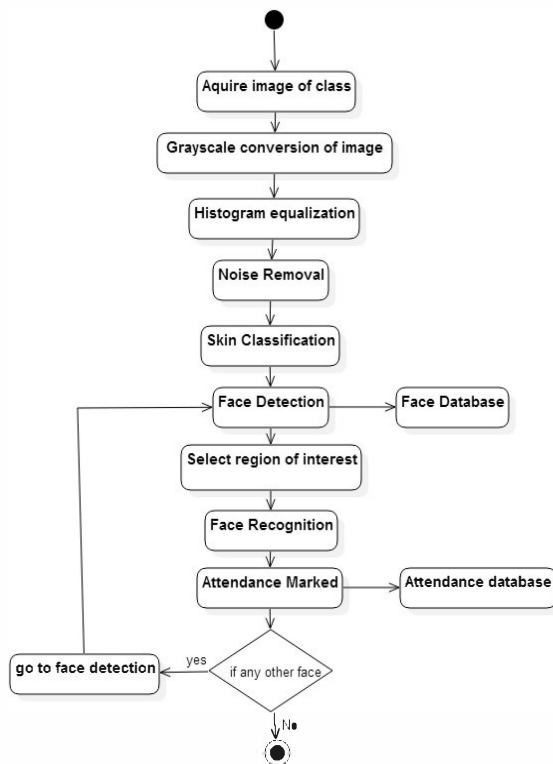

Fig.2 Activity diagram of Face Recognition

C. ALGORITHM

The algorithm shows the step by step working of a system. For this system, we will need to use the following algorithm.

ALGORITHM: FACE_RECOGNITON_FOR_ ATTENDANCE_SYSTEM.

INPUT: Classroom image captured by the camera.

OUTPUT: Attendance marking.

PROBLEM DESCRIPTION: Identification of student

Step 1: Start

Step 2: Enroll the students' information in the face database

Step 3: Install a camera device in classroom.

Step 4: Input the image taken by camera.

Step 5: Enhancement of image.

    i.   Convert to grayscale image.
    ii.   Generate histogram of grayscale image.
    iii.   Equalize the image.
    iv.   Generate histogram of equalized image.
    v.   Remove noise from image
    vi.   Skin classification of image.

Step 6: Face Detection.

    i.   Crop the faces of students form image
    ii.   Select the region of interest.

Step 7: Face Recognition

    i.   Compare the cropped images with face database images
    ii.   Mark the attendance on attendance server.
          a.   If any other face, Then Go to ii) of step 6

Step 8:   End.

IV. MATHEMATICAL MODEL

A mathematical model is a description of a system using mathematical concepts and language.

The mathematical modeling for our system is as follows:-

S= {Σ, F, δ, C}
S = Face Recognition.
Σ = set of input symbols = {Image, Face Database}
F = set of output symbol = {Match Found, Not Found, Attendance Marked}

δ = 1. Start
    2. Read training set of N * N images.
    3. Select training set of N * M
         Where, M: number of sample images

4. Find average face, subtract from the faces in the training set, create matrix A

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

Where,

Ψ = Average Image

Γ^i = Image Vector

$\Phi_i = \Gamma^i - \Psi$

Where, i= 1,2,3,….M.

A= [Φ1, Φ2, Φ3,…..,ΦM]

5. Calculate covariance matrix: AA'

$$C = A \; A^T$$

6. Calculate eigenvectors of the c covariance matrix.

7. Calculate eigenfaces = No. of training images - no. of classes (total number of people) of eigenvectors.

8. Multiply set of eigenvectors byA matrix to create a reduced eigenface.

9. Calculate eigenface of image.

10. Calculate Euclidian distance between the image and the eigenfaces.

$$\epsilon_k = ¿ \vee \Omega - \Omega k \vee ¿^2$$

11. Image will be recognized if Euclidian distance is minimum.

12. Output: Recognized image then compared to input face database and marked the attendance.

C = {only on input image, eigenfaces generates grayscale images}

CONCLUSION

The smart and automated attendance system can be proven as an efficient system for classroom attendance. By using this system the chances of fake attendance and proxies can be reduced. There are a lots of Biometrics Systems which can be used for managing attendance, but the face recognition has the best performance. So we need to implement a reliable and efficient attendance system for classroom attendance which can work for multiple face recognition at one time. We found the solution for light intensity problem and head pose problem for which we can use the Illumination Invariant algorithm. Also to implement this system, no any specialized hardware is required. A camera device and a standalone PC, database servers are sufficient for constructing the smart attendance system.

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