Automated Attendance Management System Based On Face Recognition Algorithms

Shireesha Chintalapati, M.V. Raghunadh
Department of E and CE
NIT Warangal,INDIA 506004
Email: cshireesha102@gmail.com, raghunadhmv@gmail.com

***Abstract*—In this paper we propose an automated attendance management system. This system, which is based on face detection and recognition algorithms, automatically detects the student when he enters the class room and marks the attendance by recognizing him. The system architecture and algorithms used in each stage are described in this paper. Different real time scenarios are considered to evaluate the performance of various face recognition systems. This paper also proposes the techniques to be used in order to handle the threats like spoofing. When compared to traditional attendance marking this system saves the time and also helps to monitor the students.**

***Keywords*- Face Recognition, LBP, SVM**

I. INTRODUCTION

In this modern era of automation many scientific advancements and inventions have taken place to save labor, increase the accuracy and to ameliorate our lives. Automated Attendance System is the advancement that has taken place in the field of automation replacing traditional attendance marking activity. Automated Attendance Systems are generally bio-metric based, smart-card based and web based. These systems are widely used in different organizations. Traditional method of attendance marking is very time consuming and becomes complicated when the strength is more. Automation of Attendance System has edge over traditional method as it saves time and also can be used for security purposes. This also helps to prevent fake attendance.

An Attendance Management System which is developed using bio-metrics,in our case face, generally consists of Image Acquisition, Database development, Face detection, Pre-processing, Feature extraction, and Classification stages followed by Post-processing stage. The subsequent sections in this paper are literature survey, detailed description of various stages in the proposed model, results and conclusions and scope for improvement.

II. LITERATURE SURVEY

In [1] the authors have proposed a finger print based attendance system. A portable fingerprint device has been developed which can be passed among the students to place their finger on the sensor during the lecture time without the instructor's intervention. This system guarantees a fool-proof method for marking the attendance. The problem with this approach is that passing of the device during the lecture time may distract the attention of the students.

A number of works related to Radio Frequency Identification (RFID) based Attendance Systems exist in the literature. In [2] the authors have proposed RFID based system in which students carry a RFID tag type ID card and they need to place that on the card reader to record their attendance. RS232 is used to connect the system to the computer and save the recorded attendance from the database. This system may give rise to the problem of fraudulent access. An unauthorized person may make use of authorized ID card and enter into the organization.

Iris is the another bio-metric that can be used for Attendance Systems. In [3] the authors have proposed Daugman's algorithm based Iris recognition system.This system uses iris recognition management system that does capturing the image of iris recognition, extraction, storing and matching. But the difficulty occurs to lay the transmission lines in the places where the topography is bad. In [4] authors have proposed a system based on real time face recognition which is reliable, secure and fast which needs improvement in different lighting conditions.

III. PROPOSED MODEL

The system architecture is as shown in Figure 1. The proposed automated attendance management system is based on face recognition algorithm. When a person enters the class room his image is captured by the camera at the entrance. Face region is then extracted and pre-processed for further processing. As not more than two persons can enter the classroom at a time face detection algorithm has less work. Face Recognition proves to be advantageous than other systems as discussed in the Table I. When the student's face is recognized it is fed to post-processing. The System algorithm is discussed.

The stages in the proposed Automated Attendance Management System are as shown in the Figure 1. Technical details of implementation of each stage are discussed in the next sections.

A. Image Capture

The Camera is mounted at a distance from the entrance to capture the frontal images of the students. The captured

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Algorithm 1 Pseudo Code of Proposed System

1. Capture the Student's Image
2. Apply Viola-Jones algorithm (Face Detection)
3. Extract the ROI in Rectangular Bounding Box
4. Convert to gray scale,apply histogram equalization and Resize to 100x100
5.

if Updating Database **then**
    Store in Database
else
    Apply PCA/LDA/LBPH (For feature Extraction)
    Apply Distance Classifier/SVM/Bayesian (for Classification)
end if

6. Post-processing

TABLE I
Drawbacks of various Attendance Systems

Type of the System	**Drawback**
RFID-based	Fraudulent usage
Fingerprint-based	Time Consuming for students to wait and give their attendance
Iris-based	Invades the privacy of the user
Wireless-based	Poor performance if topography is bad

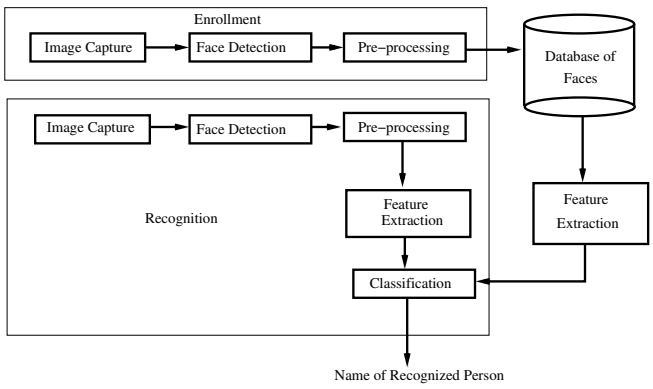


Fig. 1 System Architecture

Fig. 2 Extracted and Pre-processed faces

image is preferred to be of the size 640x480 to avoid resizing of the image in the back-end as we observed resizing may some times results in poor performance.

B. Face Detection

A proper and efficient face detection algorithm always enhances the performance of face recognition systems. Various algorithms are proposed for face detection such as Face geometry based methods, Feature Invariant methods, Machine learning based methods. Out of all these methods Viola and Jones proposed a framework which gives a high detection rate and is also fast.

Viola-Jones detection algorithm is efficient for real time application as it is fast and robust. [5] Hence we chose Viola-Jones face detection algorithm which makes use of Integral Image and AdaBoost learning algorithm as classifier. We observed that this algorithm gives better results in different lighting conditions and we combined multiple haar classifiers to achieve a better detection rates up to an angle of 30 degrees.

C. Pre-processing

The detected face is extracted and subjected to pre-processing. This pre-processing step involves with histogram equalization of the extracted face image and is resized to 100x100. Histogram Equalization is the most common Histogram Normalization technique. This improves the the contrast of the image as it streches the range of the intensities in an image by making it more clear.

D. Database Development

As we chose biometric based system enrollment of every individual is required. This database development phase consists of image capture of every individual and extracting the bio-metric feature, in our case it is face, and later it is enhanced using pre-processing techniques and stored in the database. In our project we have taken the images of individuals in different angles, different expressions and also in different lighting conditions. A database of 80 individuals (NITW-database) with 20 images of each has been collected for this project. Figure 2 shows few extracted and pre-processed faces stored in the database.

E. Feature Extraction and Classification

The performance of a Face Recognition system also depends upon the feature extraction and their classification to get the accurate results. Feature extraction is achieved using feature based techniques or holistic techniques. In some holistic techniques we can make use of dimensionality reduction before classification. We compared the results of different holistic approaches used for feature extraction and classification in real time scenario. Table II provides the comparison details.

Principal Component Analysis (PCA) was the first algorithm that represents the faces economically. In PCA the face images are represented using eigenfaces and their corresponding projections along each eigenface. Instead of using all the all the dimensions of an image only meaningful dimensions are considered to represent the image. Mathematically an image using PCA is represented as

$$\chi = WY + \mu$$

where χ is the face vector, Y is vector of eigenfaces, W is the feature vector, and μ is the average face vector. These projections (feature vectors) are then used as classification features in face recognition. Later FisherâĂŹs Linear Discriminant Analysis (LDA) was proposed in which the ratio of between-class scatter and within-class scatter maximizes. PCA does not consider the discriminative information in the data where as LDA stores the discriminative information in the data. LDA may recognize an image in well-illuminated condition but fails in bad-illuminated conditions. There are some cases in which PCA outperforms LDA and vice versa. [6] Local Binary Pattern Histogram (LBPH) is recently proposed algorithm for face feature extraction. In this method LBP image is segmented into local regions and histogram of each is extracted and are concatenated to form a face descriptor. [7]. Accuracy of a system implemented using PCA and LDA are affected by database size which is not the case in LBP. [8]

In general features extracted from PCA and LDA are subjected to distance classifiers. The distance between the features of probe image and features of trained images is calculated. If the distance is less than the threshold then the probe image is recognized.

$$e_r = min\|\omega - \omega_i\|$$

where e_r is euclidean distance ω is image vector and i is number of trained image. But we can make use some machine learning algorithms for better classification. PCA is used for feature extraction and Support Vector Machine (SVM) is used for the classification. SVM is recently proposed algorithm which is an effective pattern classification algorithm. For pattern recognition SVM finds the optimal separation of closest points in the training set. This separation can be done linearly or non-linearly. In real world scenario we require a multi-class classification. Support Vector Classification, a SVM type, is used for multi-class classification. Naive Baiyes classifier is a simple classifier which assumes independence of features of a class. In Bayes Classification Small amount of training data is enough for estimation. [9]

So Face Recognition involves in two stages, feature extraction and classification. The above mentioned feature extractors combined with classifiers are compared in various real world scenarios such as lighting conditions, Unintentional facial feature changes (occluded faces), Expressions. System Performance is also evaluated in terms of recognition rate,distance , false positive rate, time taken for training. False Positive Rates are calculated by considering 60 real time image frames in Table II. It has been observed that LBP based algorithm gives least false positive rate and good recognition rate as it correctly differentiates between the unknown and known faces. LDA can make correct discrimination between the images only if the discrimination is provided in the database (for example images at different lighting conditions). Distance also plays as a criteria in this system model as the image frames are captured when person enters the room and face region is resized. So the face region captured at about $4feet$ and $7feet$ gives better results for LBPH and other algorithms respectively. For a Training data of 150 images training time is calculated. LBP based algorithm requires minimum time for training where as SVM and Bayes classifiers take more time for training. In classifiers comparison SVM does better classification than the rest.

F. Post-processing

In the proposed system, after recognizing the faces of the students, the names are updated into an excel sheet. At the end of the class a provision to announce the names of all students who are present in the class is also included. This is implemented using text to speech conversion. The system is also equipped with the facility of sending notification mail to the absentees when that facility is enabled.

IV. THREATS TO THE SYSTEM

Major threat to the face recognition systems is spoofing. Hence anti-spoofing technique like eye blink detector is included in the system. In order to detect the eye blink the number count of eye detection and count of iris region detection are compared. In static image the number of times eye get detected is equal to the number of times the iris region is detected or iris region detection count would be zero(if person closes his eyes). This count is incremented for certain number of frames.

As shown in Figure 3 the eyes are extracted from the image using haar classifiers as in (i), then eye region is converted to gray scale image as in (ii) and the image is subjected to inverse suppression using binary threshold filter (as shown in (iii)). Then iris region gets a gray scale

TABLE II
Comparison of Holistic Face Recognition Algorithm

Performance Evaluation Conditions	**PCA + Distance Classifier**	**LDA + Distance Classifier**	**PCA+SVM**	**PCA+Bayes**	**LBPH +Distance Classifier**
False Positive Rate	55%	53%	51%	52%	25%
Distance of object for correct recognition	$7feet$	$7feet$	$7feet$	$7feet$	$4feet$
Training time	1081 millisecs	1234 millisecs	24570 millisecs	29798 millisecs	563 millisecs
Recognition Rate(Static Images)	93%	91%	95%	94%	95%
Recognition Rate(Real time video)	61%	58%	68%	65%	78%
Occluded Faces	2.5%	2%	2.8%	2%	2.3%

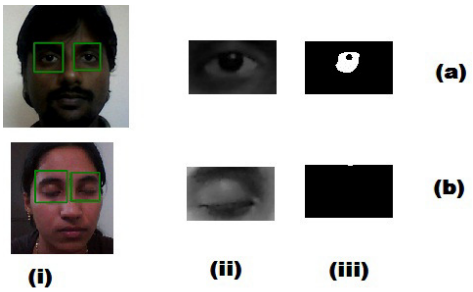


Fig. 3 Eyes and Iris Region Extraction

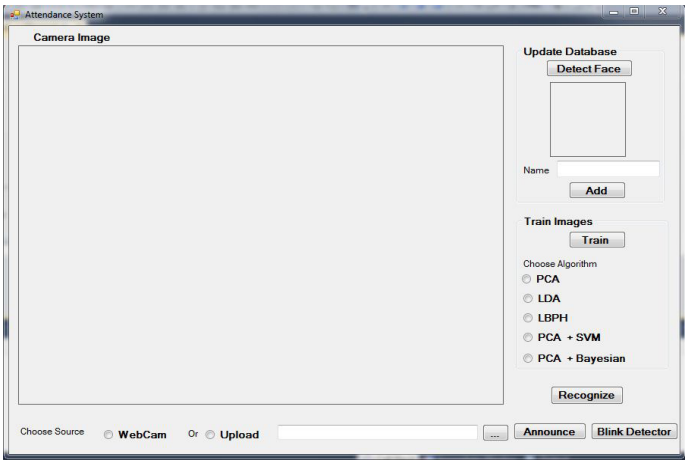


Fig. 4 User Interface of the System Proposed

value of 255 and the rest is of the value 0. If eyes are closed the inverted image is totally black. Based on this blink count can be calculated.

To continuously monitor the presence of students in the class live streaming is also incorporated in the system.

V. Graphical User Interface (GUI)

The GUI is developed using Winforms Application in Microsoft Visual C # and EmguCV wrapper. The front end developed is as shown in Figure 4.

The system provides the following functions

- Choose the source of input (Webcam/Recorded Video)
- To Update the Database
- Choose the algorithm for training and classification (PCA/LDA/LBPH/PCA+SVM/PCA+Bayesian)
- Announce the Attendees' Names
- Option for Blink Detection

Excel Sheet and Emails are generated when Recognition is completed. Figure 5 shows the extraction of face region and updating to the database after pre-processing. Figure 6 shows the recognition process. Post-processing step includes updating the excel sheet with students names who are present as shown in Figure 7

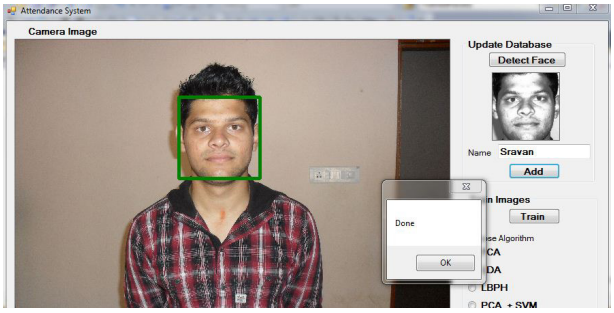


Fig. 5 Extraction and Updating Database

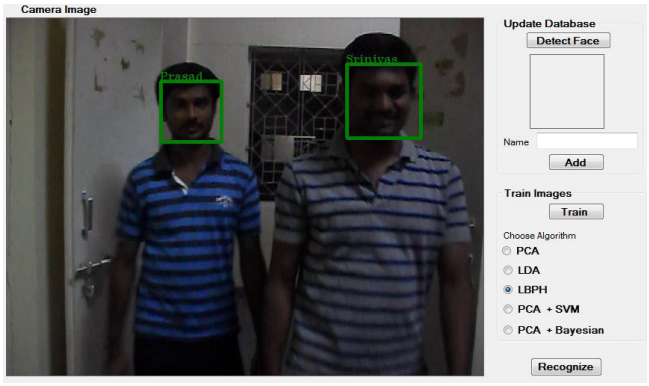
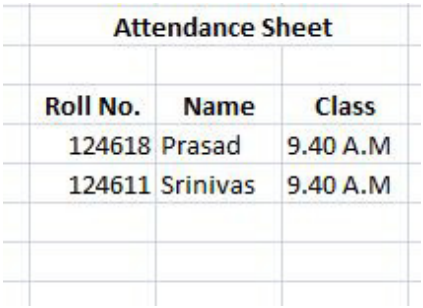


Fig. 6 Recognizing the faces



Attendance Sheet		
Roll No.	Name	Class
124618	Prasad	9.40 A.M
124611	Srinivas	9.40 A.M

Fig. 7 Excel sheet of attendance

VI. Conclusion and Future Work

Automated Attendance Systems based on face recognition techniques thus proved to be time saving and secured.This system can also be used to identify an unknown person. In real time scenarios LBPH outperforms other algorithms with better recognition rate and low false positive rate. SVM and Bayesian also prove to be better classifiers when compared to distance classifiers.

The future work is to improve the recognition rate of algorithms when there are unintentional changes in a person like tonsuring head, using scarf, beard. The system developed only recognizes face upto 30 degrees angle variations which has to be improved further. Gait recognition can be fused with face recognition systems in order to achieve better performance of the system.

VII. ACKNOWLEDGMENT

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