Face recognition algorithms based Automated Attendance Management System

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Abstract: We are living in a world where everything is automated and linked online. The internet of things, image processing, and machine learning are evolving day by day. Many systems have been completely changed due to this evolve to achieve more accurate results. The attendance system is a typical example of this transition, starting from the traditional signature on a paper sheet to face recognition. Human face recognition is an important field for verification purpose especially in the case of student's attendance. This paper is aimed at implementing a digitized system for attendance recording. Current attendance marking methods are monotonous & time consuming. Manually recorded attendance can be easily manipulated. Hence the paper is proposed to LBP and SVM methods for tackle all these issues.

Keywords: *Face Recognition, LBP, SVM, Attendances;*

I. INTRODUCTION

A face 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. One of the ways to do this is by comparing selected facial features from the image and a face database.

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 [1]. 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 [2].

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.

A face 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. One of the ways to do this is by comparing selected facial features from the image and a face database [3]. Some face recognition algorithms identify facial features by extracting landmarks, or features, from an image of the subject's face. For example, an algorithm may analyze the relative position, size, and/or shape of the eyes, nose, cheekbones, and jaw. These features are then used to search for other images with matching features. Other algorithms normalize a gallery of face images and then compress the face data, only saving the data in the image that is useful for face recognition. A probe image is then compared with the face data [4]. One of the earliest successful systems is based on template matching techniques applied to a set of salient facial features, providing a sort of compressed face representation.

Recognition algorithms can be divided into two main approaches, geometric, which looks at distinguishing features, or photometric, which is a statistical approach that distills an image into values and compares the values with templates to eliminate variances [5]. Popular recognition algorithms include principal component analysis using eigenface, linear discriminant analysis, elastic bunch graph matching using the Fisher face algorithm, the hidden Markov model, the

multilinear subspace learning using tensor representation, and the neuronal motivated dynamic link matching.

II. 3-DIMENSIONAL RECOGNITION

Newly emerging trend, claimed to achieve improved accuracy, is three-dimensional face recognition. This technique uses 3D sensors to capture information about the shape of a face. This information is then used to identify distinctive features on the surface of a face, such as the contour of the eye sockets, nose, and chin.

One advantage of 3D face recognition is that it is not affected by changes in lighting like other techniques. It can also identify a face from a range of viewing angles, including a profile view. Three-dimensional data points from a face vastly improve the precision of face recognition. 3D research is enhanced by the development of sophisticated sensors that do a better job of capturing 3D face imagery [6]. The sensors work by projecting structured light onto the face. Up to a dozen or more of these image sensors can be placed on the same CMOS chip—each sensor captures a different part of the spectrum.

Even a perfect 3D matching technique could be sensitive to expressions. For that goal a group at the Technion applied tools from metric geometry to treat expressions as isometries. A company called Vision Access created a firm solution for 3D face recognition [7]. The company was later acquired by the biometric access company Bios crypt Inc. which developed a version known as 3D Fast Pass.

A new method is to introduce a way to capture a 3D picture by using three tracking cameras that point at different angles; one camera will be pointing at the front of the subject, second one to the side, and third one at an angle. All these cameras will work together so it can track a subject's face in real time and be able to face detect and recognize.

III. LITERATURE SURVEY

The author B. K. Mohamed and C. Raghu (2012) [8], title as "Fingerprint attendance system for classroom needs," in India proposed as Face recognition is an essential field in many applications, one which is Attendance Management System. Now days taking the attendance of the student in the classroom had become a tedious job for teachers like calling out their names waiting for response and also maintaining this attendance till the month to generate attendance report. Thus face detection and recognition module detects faces from the image captured by the camera, and the image of the face is stored.

The author T. Lim, S. Sim, and M. Mansor, (2009) [9] as "Rfid based attendance system," in Industrial Electronics & Applications, 2009.Radio-frequency identification (RFID) is a technology that uses radio waves to transfer data from an electronic tag, called RFID tag or label, attached to an object, through a reader for the purpose of identifying and tracking the object. RFID technology which is a matured technology that has been widely deployed by various organizations as part of their automation systems. In this study, an RFID based system has been built in order to produce a time-attendance management system.

Towler et al., (2017) [10] the author presence Face recognition is thought to rely on representations that encode holistic properties. Paradoxically, professional forensic examiners who identify unfamiliar faces by comparing facial images are trained to adopt a feature-by-feature comparison strategy. Here we tested the effectiveness of this strategy by asking participants to rate facial feature similarity prior to making same/different identity decisions to pairs of face images. Experiment 1 provided preliminary evidence that rating feature similarity improves unfamiliar face matching accuracy in novice participants. In Experiment 2, we found benefits of this procedure over and above rating similarity of personality traits and image quality parameters, suggesting that benefits are not solely attributable to general increases in attention.

A Face recognition system is an application of computer vision and image processing which is capable of performing two major tasks of identifying and verifying a person from an image or a video database. The objective of this paper is to automate the attendance system by integrating the face recognition technology using Eigen Face database and PCA algorithm with Matlab GUI. In Conventional attendance system there are several issues like fake attendance, lot of time consumption, manipulation of attendance, information cannot be secure. There are many limitations in implementing face recognition technologies like Image Quality, Image Size, Face angle, varying intensity of light. In order to overcome these issues various techniques like Illumination Invariant, Histogram equalization, PCA are used. By using this system attendance is updated automatically after comparing the detected face with original Eigen database in Ex eel sheet integrated with Matlab GUI.

The author Patel et al., (2014) [12] presents in this paper basic problem of student attendance management is defined which is traditionally taken manually by faculty. One alternative to make student attendance system automatic is provided by Computer Vision. In this paper we review the various computerized system which is being developed by using different techniques. Based on this review a new approach for student attendance recording and management is proposed to be used for various colleges or academic institutes.

The author presents (2014) [13] Convolutional Neural Networks has been playing a significant role in many applications including surveillance, object detection, object tracking, etc. Extensive research is recorded for face recognition using CNNs, which is a key aspect of surveillance applications. In most recent times, the Face Recognition technique is widely used in university automation systems, Smart Entry management systems, etc. In this paper, a novel CNN architecture for face recognition system is proposed including the process of collecting face data of students. Experimentally it is shown that the proposed CNN architecture provides 99% accuracy. Further, the proposed CNN framework is used to develop a "Smart Attendance Management System (SAMS)", which is a web-based application, to provide attendance of students using face recognition, in realtime. The proposed application is easy to deploy and maintain.

S. Chintalapati and M. V. Raghunadh et a., (2013) [14] 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.

IV. 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

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

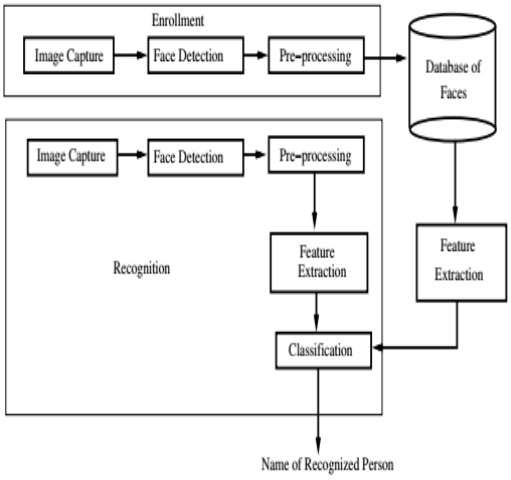

Fig. 1 System Architecture

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 sometimes 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. 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 rate up to an angle of 30 degrees.

C. Pre-processing

The detected face is extracted and subjected to preprocessing. 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 contrast of the image as it stretches the range of the intensities in an image by making it clearer.

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 eigen faces and their corresponding projections along each eigen face. Instead of using the entire 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 eigenface, 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. 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. Accuracy of a system implemented using PCA and LDA are affected by database size which is not the case in LBP.

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.

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 criterion 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.

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 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.

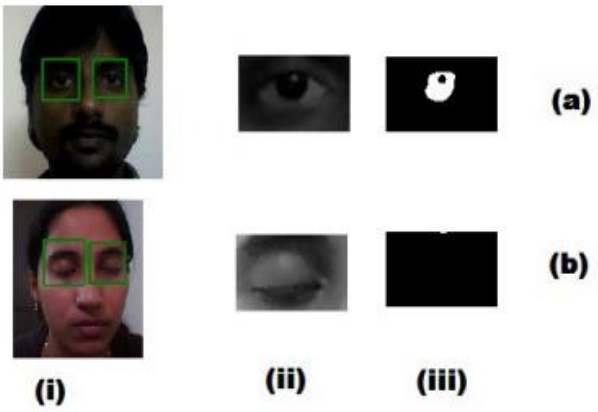

Fig. 3 Eyes and Iris Region Extraction

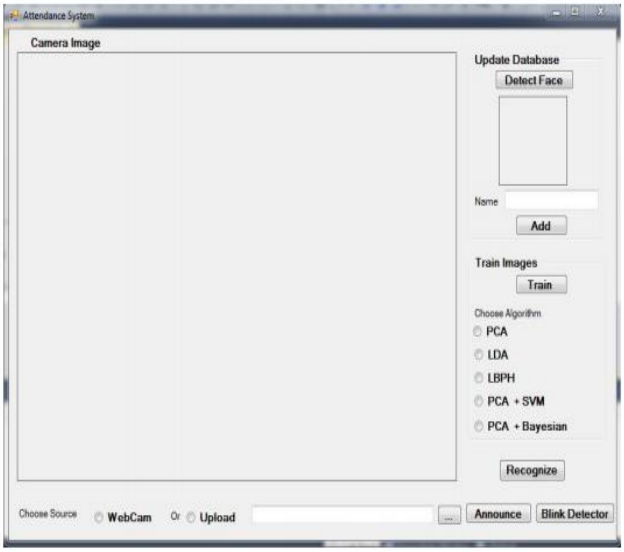

Fig. 4 User Interface of the System Proposed

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

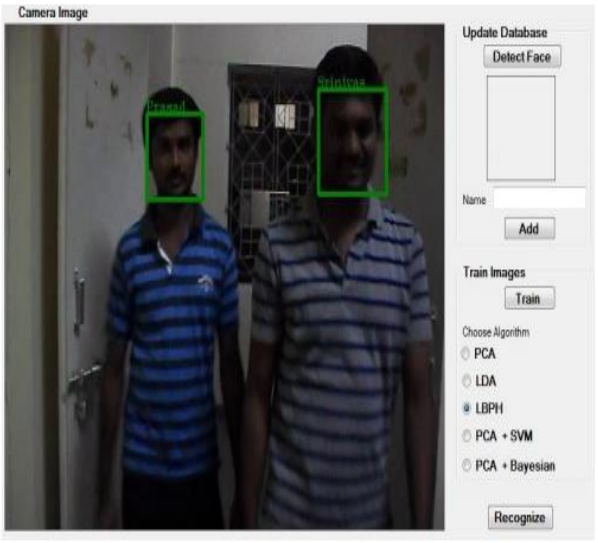

Fig. 6 Recognizing the faces

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, and beard. The system developed only recognizes face up to 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.

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