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***Abstract*—Student class attendance record plays an important role in the universities to keep track of students and to maximize their academic performance. Keeping this in mind, an efficient attendance management system is proposed in this paper. This system makes use of Dimensionality reduction technique using PCA based Face recognition algorithm incorporating Euclidean Distance as the Distance Classifier. Faces of the students are segmented using Viola-Jones algorithm. Based on the recognized faces, Attendance is updated into an Excel database. The algorithm has been tested using two different student databases. Training database is created using 50 subjects including male and female with different facial variations (15 instances per subject). Statistical data shows that an accuracy of the algorithm is greater than 99% with normal lighting conditions.**

***Index Terms*— Biometrics, Eigen Face, Principal Component Analysis, Reduction rate, Viola-Jones algorithm**

I. Introduction

SECURITY and Authentication play vital role in a society. Face Recognition is one of the well-known techniques for security and authentication [1]. In a university, student attendance record is important to control student discipline. There are many ways of attendance recording mechanisms which are being used in practice such as manual system, Radio Frequency Identification (RFID) based method and biometric technologies such as iris recognition, fingerprint recognition, face recognition and so on. Each of these technologies has advantages and disadvantages. Face recognition-based attendance management system is also one of the most advanced method of biometric technology. Success rate of this technology is high. Because of the advantages of biometric technology, many institutions started using this method for attendance marking of students [2,7]. Extensive study has been done in the literature on human faces compared to other objects. Reason behind this study is due to the remarkable face recognition capability of the human visual system and also due to number of important applications of face recognition technology [3,4,5]. Principal Component Analysis (PCA) is a dimensionality reduction technique which has been used prominently in industries and universities for person face identification.

PCA has been developed to make the computation simpler. Dimensional reduction of linear projection that maximizes the scatter of all projected samples is chosen by PCA to represent a high-dimensional training set into a lower dimensional subspace [6]. Work presented by Paul Viola and Michael Jones with a title "Fast and robust method for face recognition" was found to be 15 times faster than any method during the time of release and said to give 95% accuracy at about 17fps [8,9].

Organization of this paper: In Section II, related work on face recognition-based attendance management systems is been discussed. Section III presents the proposed lecture attendance management system. Section IV validates the proposed work by using statistical parameters such as Reduction Rate (RR) and Recognition Accuracy (RA). Results are verified by considering different data sets. Section V concludes the work.

II. Related Work

Shubhobrata et al. [10] proposed a study on automatic attendance management system based on face recognition developed using ubiquitous components. Zainab Hussain Arif et al. [11] presented a detailed critical review on technology, application domain & main findings used by different researchers in the field of automated attendance management system. Shreyak et al. [12] proposed a study on student attendance management system based on face recognition. This work uses Eigen face values, Principal Component Analysis (PCA) and Convolutional Neural Network (CNN) for its implementation. Kumar Neela Ashish et al. [13] presented a smart attendance marking system based on face recognition. In this study, Viola-Jones algorithm is used for face detection & PCA is used for feature selection.

It is clear from the literature review that, most of the attendance management systems are based on face recognition method and demand large memory when there are more number of face values. Hence, proposed study focusses on reducing the number of eigen vectors without affecting Recognition Accuracy.

III. Lecture Attendance Management System

The purpose of this system is to update the student attendance register automatically using face recognition technique [14]. This system is implemented in two phases as mentioned in

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Section 1 of the paper. In the first phase, student registration and two face datasets are created. In phase 2, a test face is detected & recognized and attendance register is updated.

A. Student Registration and Generation of Training Face Database

Student Registration: Student registration is a step carried out for the first time when a new student enrols for a course. During student registration, Student Name and University Seat Number are recorded in the attendance register as shown in Fig. 1.

• Image Capture: After successful registration, each student will be given proper instructions so as to obtain face images with different facial expressions. A total of 15 images is captured using a web camera.

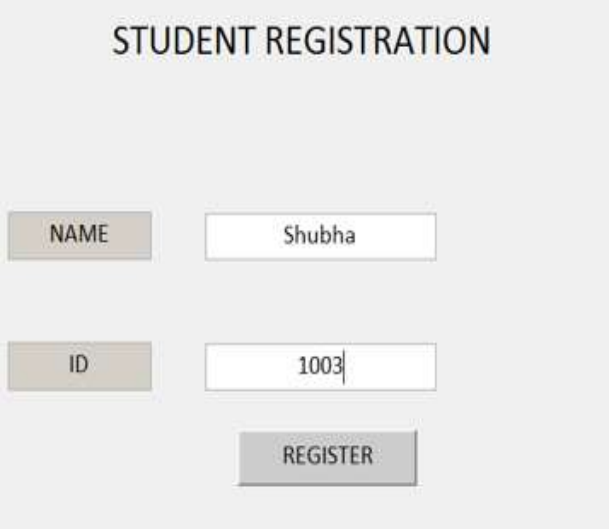

Fig. 1. Screenshot showing Student Registration.

Face Detection: Detection of face part from a given image is a crucial and essential preprocessing task in face recognition. From preliminary tests, it was concluded that this step increases efficiency by a large margin. Viola Jones algorithm is a well-known face detector technique. Viola Jones algorithm makes use of Cascade classifier for face detection. Face part of all the 15 images of a student are obtained by using Viola-Jones algorithm.

• Viola- Jones Algorithm: It uses Haar-like features that is scalar product between an image and Haar-like templates [9].

• Face Database: After face detection, images in the training dataset are resized to a lower dimension of 160 x 120 and stored as gray level images. Sample face images from dataset 2 are shown in Fig.2 and Sample Eigen faces for the same are as shown in Fig. 3.

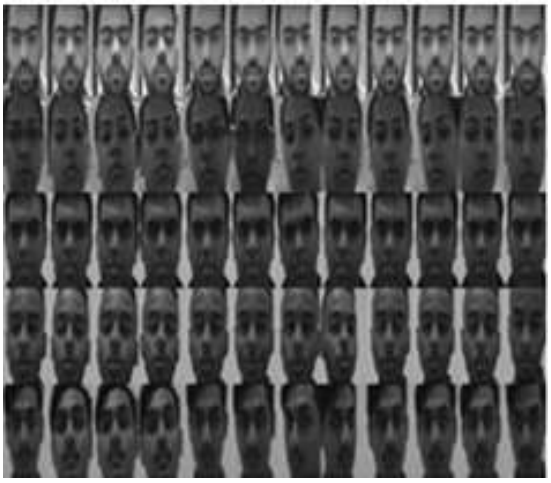

Fig. 2. Sample face images [Written informed consent was obtained from the students for the publication of images included in the manuscript]

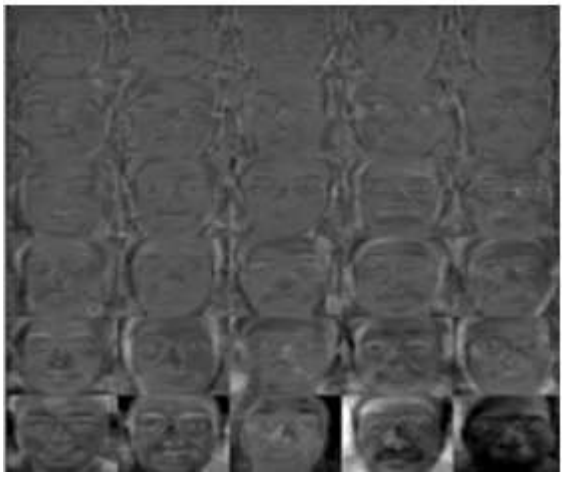

Fig. 3. Eigen faces of sample face images in dataset1vely.

B. Face Recognition and Attendance Update

• Test Face Detection: Once an image is captured, the test face is extracted using Viola-Jones algorithm, resized to 160 x 120 resolution and stored as gray level image [10].

• Face Recognition using PCA: PCA based face recognition is well discussed in most of the literatures [15,16,17,18]. Principal Component Analysis (PCA) is one of the widely used feature extraction methods which generates feature vectors that are a linear combination of initial features [19,20]. Advantage of PCA also lies in the Reduction Rate which is discussed in K.Keerthi Vasan et al. (2016)

• Attendance Update: Once the face recognition is complete, attendance register is updated as per the result. Sample of attendance register used for face-recognition based attendance system is as shown in Fig. 4.

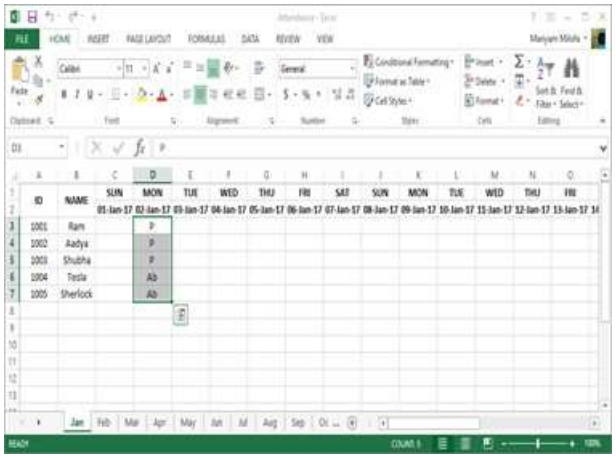

Fig. 4. Sample Attendance Register showing student attendance data.

IV. RESULTS & DISCUSSION

The experiments were carried out on databases captured during the registration phase.

A. Test 1using Student Database 1

A Total 750 facial images of students were used for creating student database 1. Facial images were captured with 15 different facial variations for 50 students. It has been ensured that lighting conditions are kept normal and constant throughout the test. All the face images are cropped to a dimension of 160 x 120 and converted into gray scale. In this case, the original dimension of Eigen vector is 749. By applying PCA, the number of Eigen vectors used for recognition can be reduced, resulting in much faster computation. For determining the recognition accuracy of PCA with Euclidean Distance (ED) as the distance classifier, a test was carried out. Results showed over 99% Recognition Accuracy (RA) when more than 60% of the feature vectors were being used for distance classification. The test also showed that ideal value for K (feature vector of principal components) as highlighted in Table 1 was 200 which gave an accuracy of 98.2%. Thus, it can be seen that even when half the number of Eigen vectors is used for computation, the accuracy does not vary as much.

B. Reduction Rate (RR) for PCA

Table 1. Recognition Accuracy with PCA + ED when Student database 1 is used

No. of Principal Components (K)	Reduction Rate (RR) K/D	Recognition Accuracy RA (%)
500	0.67	99.2
400	0.53	99.15
300	0.4	99
200	0.27	98.2
100	0.13	93
70	0.09	87
60	0.08	81
50	0.067	70
30	0.04	55
20	0.027	38

RR is a measure compression ratio in the case of PCA. If M is the dimensional space and K is the dimensional subspace, then RR can be calculated using equation (1).

$$RR = \frac{K_{ideal}}{M} \qquad (1)$$

Table 1 also shows the RR rate of the algorithm which is 0.267 at K ideal.

C. Test 2 using Student Database 1

This test checks the robustness of the algorithm against occlusion. When test images are captured in a classroom environment with N number of students, the chances of getting occluded images is high. Hence this test becomes a vital part of the proposed work. The Student Database 1 created as per the previous section has been used for this test. Table 2 shows the Reduction Rate (RR) and Recognition Accuracy (RA) for different values of K. It has been observed from the figure that RA is highly influenced by occlusion. In the figure, it is seen that there is a drastic decrease in RA when less than 50% of the Eigen vectors only are used (Highlighted in the figure).

Table 2. PCA-ED for D= 749 with Occlusion using student database 1

No. of Principal Components (K)	Reduction Rate (RR) K/D	Recognition Accuracy RA (%)
500	0.67	82.1
400	0.53	80
300	0.4	75
200	0.27	68
100	0.13	60

Student database 2 is created by taking 10 instances of 6 students with different lighting conditions. Thus, a total of 60 images are used in this database. This test is performed to show that size of the training dataset hugely influences the accuracy of the algorithm. In addition to that, varying lighting conditions are used to make the complete attendance system viable in a practical scenario. All the facial images are cropped to a dimension of 160 x 120 and saved as grayscale. Fig 4 shows the RR and corresponding RA when test images are captured with varying lighting conditions. From this test, it is noted that the PCA algorithm is sensitive to illumination variation, particularly when the training dataset is small. It has also been observed that as the size of the training dataset increases with more subjects and instances per subjects, RA increases. This test gave 55% accuracy when 50 % of principal components were being used.

From Fig 5, it can be seen that the accuracy greatly depends on occlusion.

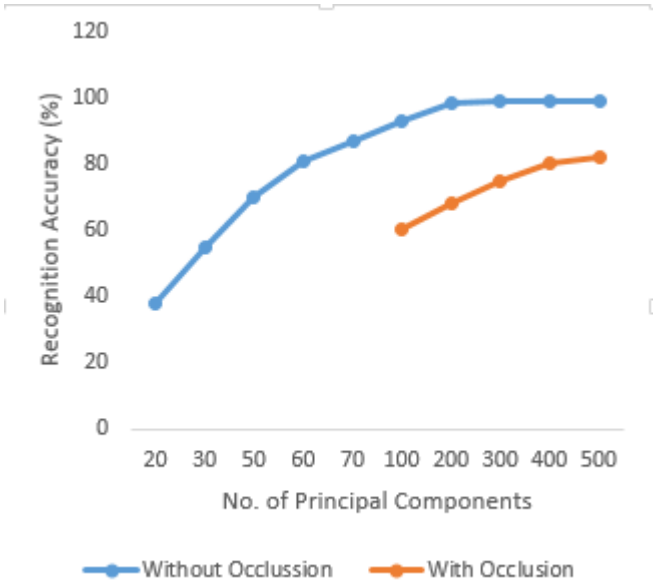

Fig. 5. Graph showing relationship between K and RA with and without occlusion

V. CONCLUSION

Face recognition based on PCA is incorporated in this attendance management system. The impact of the Viola-Jones algorithm in face detection has been highlighted in the paper. From the experimental results, it has been found that Recognition Accuracy of the proposed algorithm is 98.2% for the database without occlusion and 75% with Occlusion for K ideal. Results also show that ideal value for RR for database 1 without occlusion is 0.267 and with occlusion, it is 0.4. Results also show that varying lighting conditions will degrade the performance of the algorithm.

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