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RESEARCH ARTICLE

Attendance Monitoring System Design Based on Face Segmentation and Recognition

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Abstract: ***Aim*:** The proposed work aim was to monitor real-time attendance using face recognition in every institutional sector. It is one of the key concerns in every organization.

***Background*:** Nowadays, most organizations spend a lot of time marking attendance for a large number of individuals manually. Many technologies like Radio Frequency Identification (RFID) and biometric systems are introduced to overcome the manual attendance system. when using these RFID and biometric people need to stand in queue to make their presence.

***Objective*:** The main objective of the system is to provide an automated attendance system with the help of face recognition owing to the difficulty in the manual as well as other traditional attendance systems.

***Methods*:** The proposed work was done through face recognition using Machine Learning. Face recognition is a part of biometric characteristic of a human. It was easy to process than other biometric measurements like fingerprint, iris scan, hand scan, retina scan. The Haarcascade classifier will detect a face, and the LBPH algorithm will recognize the face. The experiment performs on the creation of real-time face data.

***Results*:** Using the web camera connected to the computer, face detection and recognition are performed, and recognized faces mark as attended. Here, the admin module and teacher modules are implemented with different functionalities to monitor attendance.

***Conclusion*:** Experiment results get 94.5% accuracy in face detection and 98.5% accuracy in face recognition by using the Haarcascade classifier and LBPH algorithm. This application system will be simple to implement, accurate, and efficient in monitoring attendance in real-time.

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1. INTRODUCTION

Face recognition technology [1] is essential research in computer vision and pattern recognition [2-4]. This technology determines data consistent visual features [5] of the face image. It is part of criminal investigation, authentication, and video surveillance [6]. There are many technologies [7, 8] introduced in the biometric system to overcome the manual attendance system [9] which is shown in Table **1**. However, all these technologies are not automatic and need to stand in a queue to mark the people present.

To avoid these discomforts of biometric systems in a pandemic situation, introducing face recognition. There is no need to have any physical contact with the system.

Face recognition is a measurable characteristic that extracts facial features [10] of the human and uniquely acknowledges an individual. It is healthier than various alternative biometric techniques like fingerprint [11, 12], palm-print [13], and iris scan [14]. It will detect the person's face from a distance. Presently, facial recognition techniques [15] are ready to figure fine on the individuals in one frame, which is incredibly few illuminations.

The purpose of face recognition [16] desires massive data sets and complicated features to determine various contents by manipulating distinct barriers such as illumination [17], pose, and ageing. Thus, many facial recognition systems are

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Table 1. Disadvantages of biometric attendance system

Attendance System	How it Works	Disadvantage
RFID based	Based on electronic waves	Fraudulent usage
Iris scan based	Captures and compares iris patterns	Cost & invades the privacy of the user
Finger print based	Thumbnail of the human being	Time consuming

proposed using restricted face images in a frame. The present work face recognition is for an attendance system. That can acknowledge the multiple facial images in a frame with different light conditions and various face poses.

2. RELATED WORK

In the past decades, various kinds of face recognition algorithms have been proposed in the research field. Ranjan *et al.* introduced a deep pyramid single shot face detector [18] that is fully convolutional, and mainly is used for tiny face detection and verification. The theoretical understanding required for the development of face recognition and the training of convolutional neural networks takes several hours to days.

Viola and Jones [19, 20] presented a method for object detection, minimizing the computation time when it achieves high accuracy. Integral images are used for the computation of rectangular features and the adaboost algorithm is used for classifier learning and finding the features, which will have high differentiation [21]. Here, the experiments are performed on large and complex datasets that are very difficult and time-consuming.

Mantoro *et al.* introduced a technique [22] that includes the haar featuring as a cascade classifier. Eigenface method [23, 24] is used for feature extraction and will obtain some characteristic values. Multiple faces were recognized at once, but it developed only for square faces. Shekhar *et al.* developed an application of sparse coding to image classification [25]. The method exploits the structure of face images, and it can learn meaningful sparse codes. Here, the structural similarity was measured by the classification and analyzed signals.

Kas. *et al.* proposed work on face images [26], the image was divided into different regions, after that, a local binary pattern algorithm [27] was used to extract the features of an image. These extracted features of the histogram were computed based on region wise and used as a face descriptor. It will be evaluated under different challenges.

Awais *et al.* introduce a video surveillance system [28] with enhanced accuracy and less computational complexity. By using real-time faces through the video, it computes face localization and recognition. The proposed method used a histogram of oriented gradient (hog) features.

Surasak *et al.* presented a study for face detection in a video frame [29]. This application includes human detection, counting, and histogram generation. The hog method was used to analyze people in a video frame, counting the number of people present. Here each pixel value is compared with neighboring pixels [9].

Gao and Leung [30] proposed the method line edge map algorithm. Here the features map by using the line. The method mainly focuses on the eyes, nose, and mouth with high characteristics. Sobel edge detection algorithm [31] was used to encode the grayscale images converted into binary edge maps.

Hadi and Mahdi addressed the difficulty of partial face recognition using knn algorithm [32]. It is highly informative for facial occlusion [33]. Cuimei *et al.* introduced a paper on a haarcascade classifier for face detection classification [34]. It uses several types of haar features like line, edge features to detect the face.

Kadir and Nasir [35] describes a comparative study between the lbp algorithm and haar cascade classifier using Opencv. The difference between these two is determining the calculated speed of the detection rate. Aruni Singh *et al.* proposed a lbph algorithm [36] to recognize faces. Compared to pca, lda, wavelet, and svm [37], the local binary pattern gives the highest accuracy rate (60-94.5%). lbph algorithm can recognize both front and side faces as well.

3. PROPOSED METHODS

The proposed system mainly includes image acquisition, pre-processing, image detection, and image recognition modules. Fig. (**1**) represents the process diagram of the proposed work. In the image acquisition module, the facial scan mechanism will get face images from a static camera, and these images are generated with sufficient quality and resolution.

In the preprocessing module, the color images are usually converted to facilitate initial comparison, supporting grayscale characteristics, and then the image size will compress. Generally, the color images are in the form of the RGB channel, OpenCV reads the RGB image. It stores the image in the BGR channel. Thus, for image recognition, we need to convert the BGR channel to the grayscale.

3.1. Haar cascade Classifier

OpenCV provides a Haar cascade classifier [38] used for face detection based on face and nonface features. If the classifier detects faces, it will draw a rectangle frame with the detected face. Otherwise, it will continue to check another image.

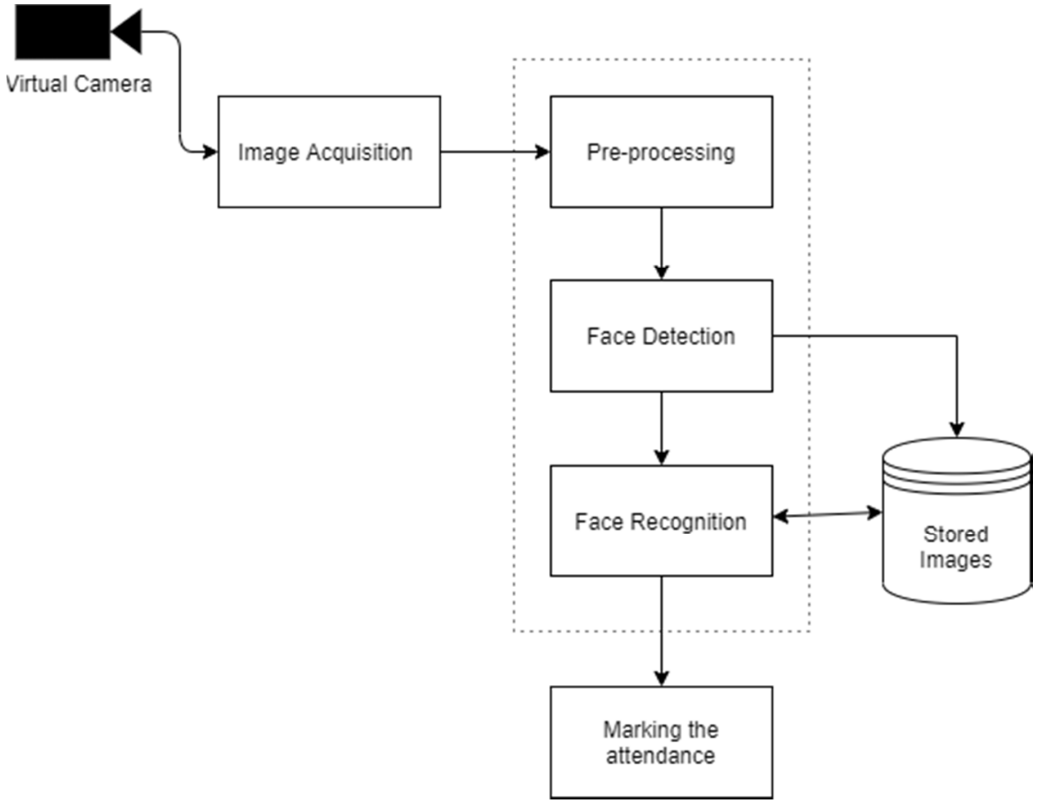

Fig. (1). The architecture of the proposed system. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

This classifier is used to train both positive and negative images. Here positive images mean specific objects like face or bikes *etc.* Example of positive images: when we want to detect a face, it needs to train facial images of human being. Here negative images mean the detected image doesn't contain facial images. The classifier is used to train and apply on the ROI in an input image.

3.2. LBPH Algorithm

After that, its needs to perform dataset training. The Local Binary Pattern Histogram algorithm [39] is a straightforward method for face recognition. The LBPH recognizer was used for training the dataset and applied to extract histograms. It is simply addressing the neighbor features of a face image. Here, LBP operator joins with the HOG descriptor to enhance acknowledgement execution impressively on data for classification.

The functions followed by the LBP operator are shown in Fig. (**2**). It describes 9-pixel values of image which is defined after labeling was binary values larger than center pixel receives 1 or 0 otherwise the value will be decimal, binary values. The local binary pattern partitions the face into pixels and recognizes the esteem between white and black pixels. Every pixel related to eight neighbor pixels surrounds it, compared to the encircling neighbor element [40, 41]. The Euclidian distance is used to test the facial images which is stored in datastore Eq. (1).

$$Euclidean\ Distance\ =\ sqrt\ (\sum\ (xi - yi)\text{^}2) \qquad (1)$$

where i = 1 to n (number of vectors)

Fig. (**3**) represents the use case diagram of the proposed system, and it shows the function of the admin module and teacher module for monitoring the attendance of the student. It describes the sequence of activities and it measures the value to the value and it shows in the horizontal ellipse. Here the actor is the person or an organization and it plays one or more interactions with the attendance monitoring system.

3.3. Data Set

The database stores our color images in grayscale images with different facial expressions and postures by using the Haar cascade classifier. Here the Fig. (**4**). shows some created face database images with different expressions with the user id. Each subset stores 60 images of an individual. The normalization technique [42] was used to remove some noise and to set the alignment positions of images. These unique faces were detected by using a static camera and stored in the database based on the id of the individual.

4. RESULTS AND DISCUSSION

This section is the result of the proposed work and explanation. Here the implementation was done in two modules. One is the admin module and another one is the teacher module. Fig. (**5**). shows the initial GUI system of the login page of the admin. When the admin successfully login, the dashboard of the admin will appear on the screen shown in Fig. (**6**). Here is the left side menu functionality performed by the admin. The new teacher was added by the admin and added teacher record displayed when the admin wanted to

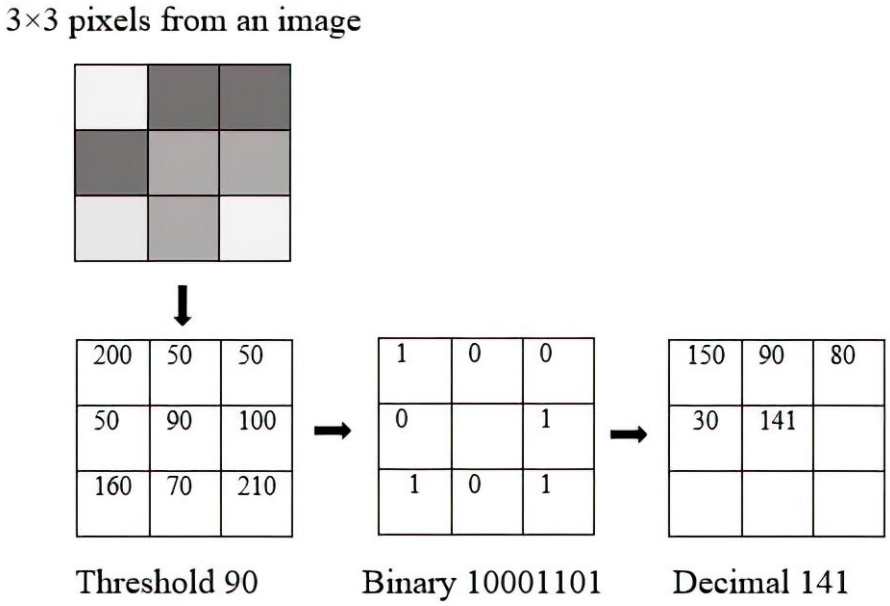

Fig. (2). Steps followed by using the LBP operator. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

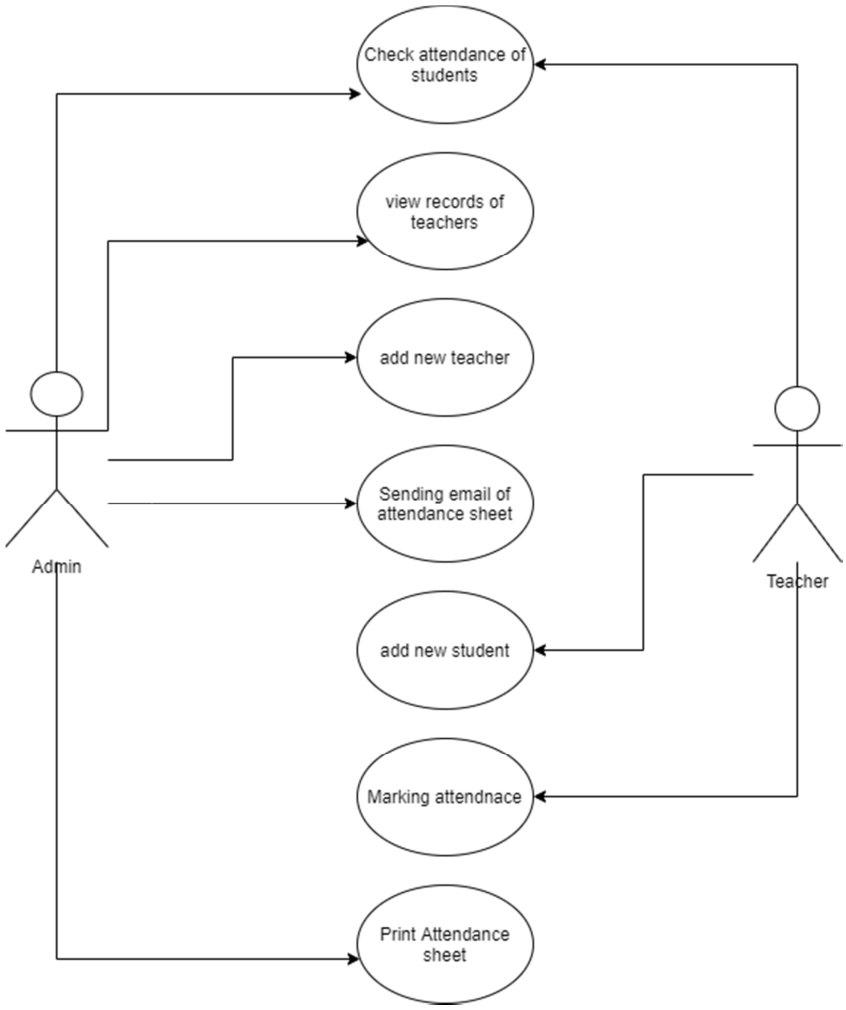

Fig. (3). Use case diagram of proposed system.

Fig. (4). Some images of the created database are stored in gray scale. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

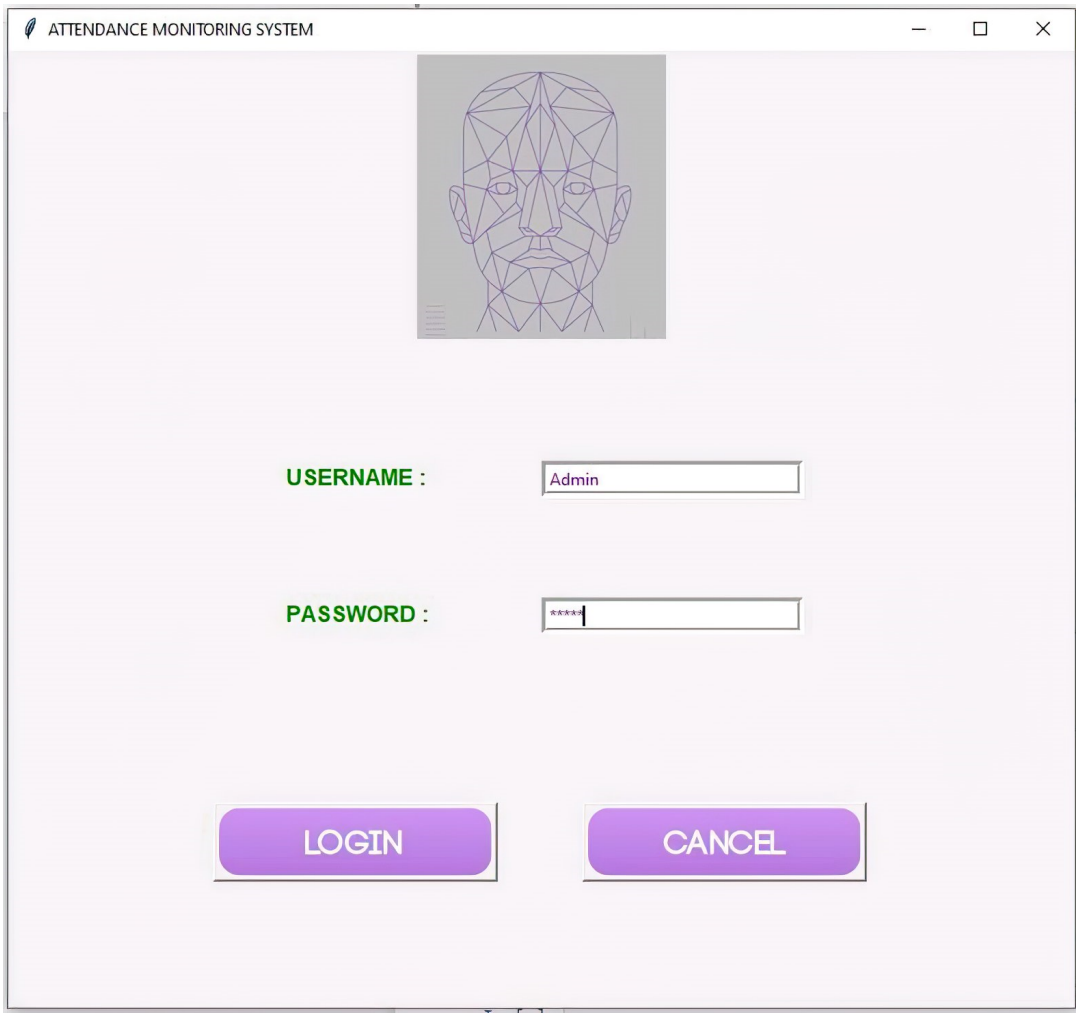

Fig. (5). GUI interface of admin login. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

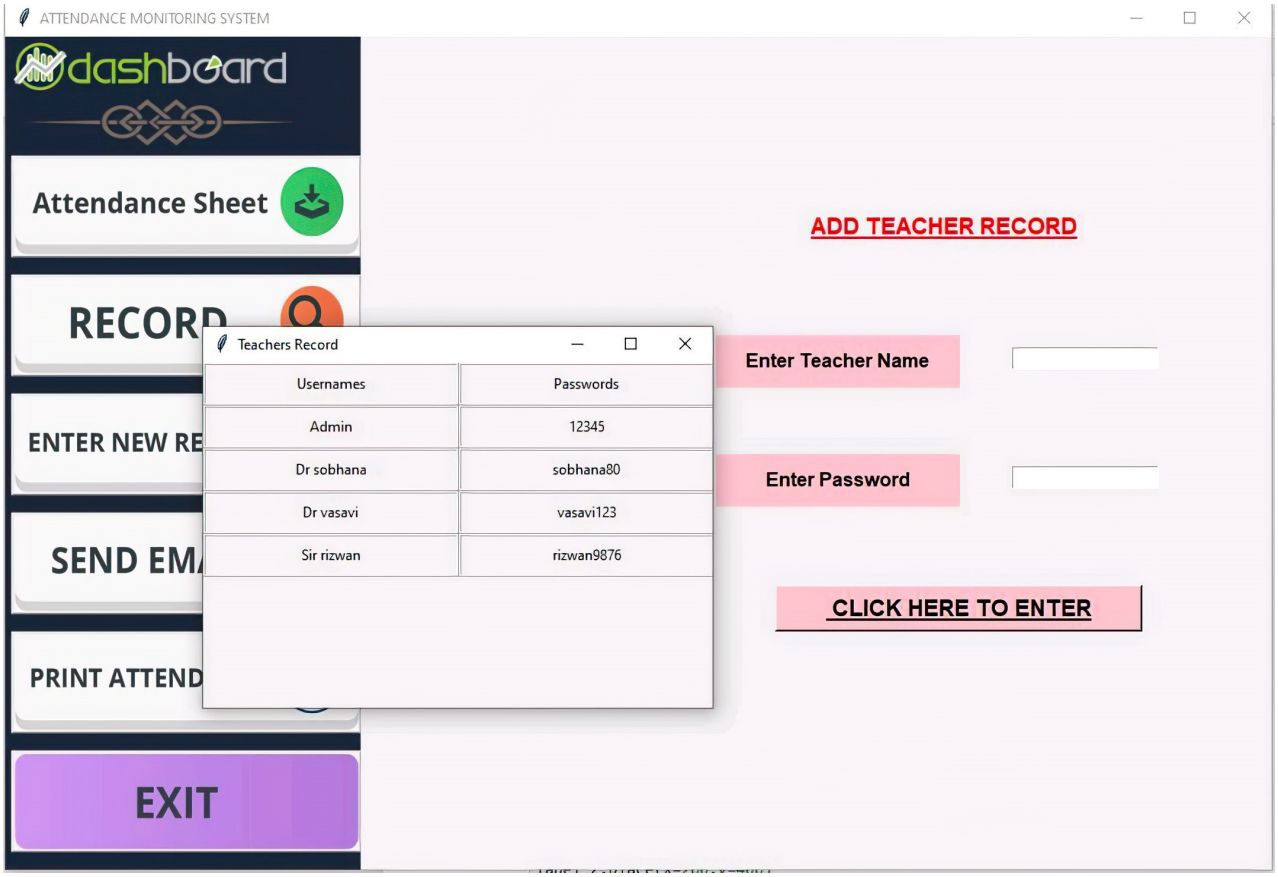

Fig. (6). Dashboard and functionality of admin. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

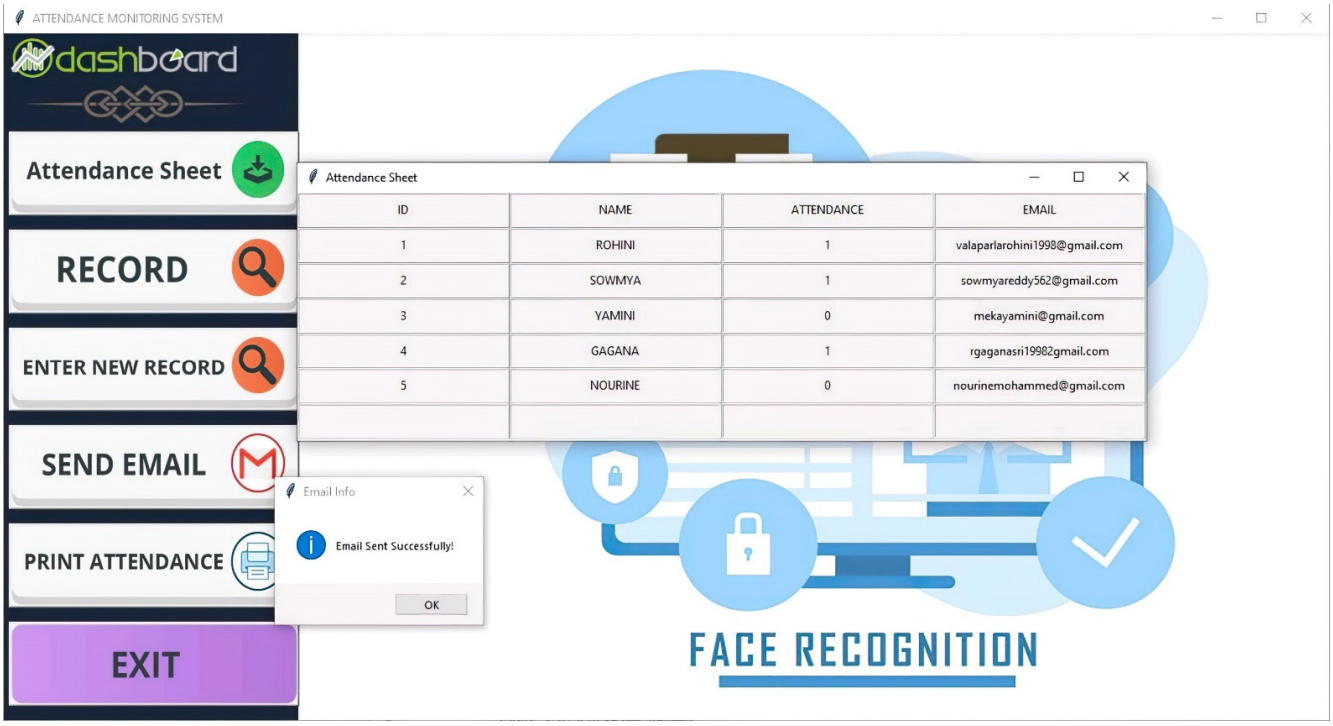

Fig. (7). Attendance view and send attendance sheets to students through e-mail by admin. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

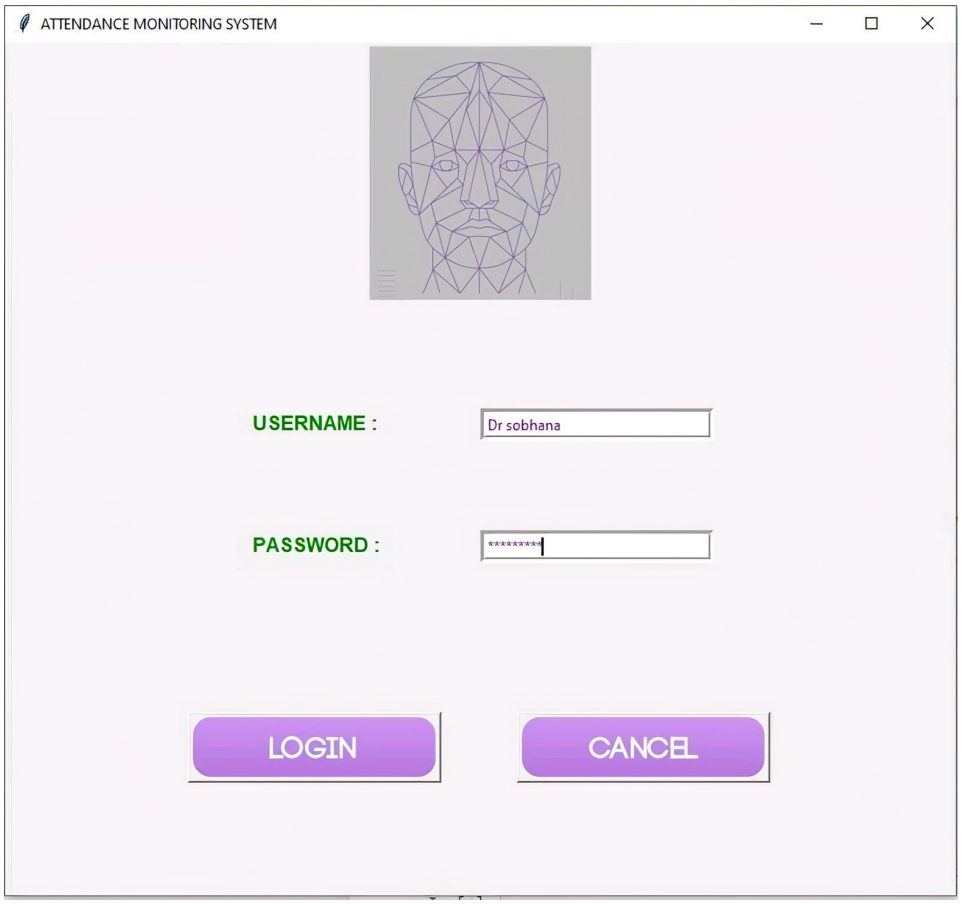

Fig. (8). Login page of teachers. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

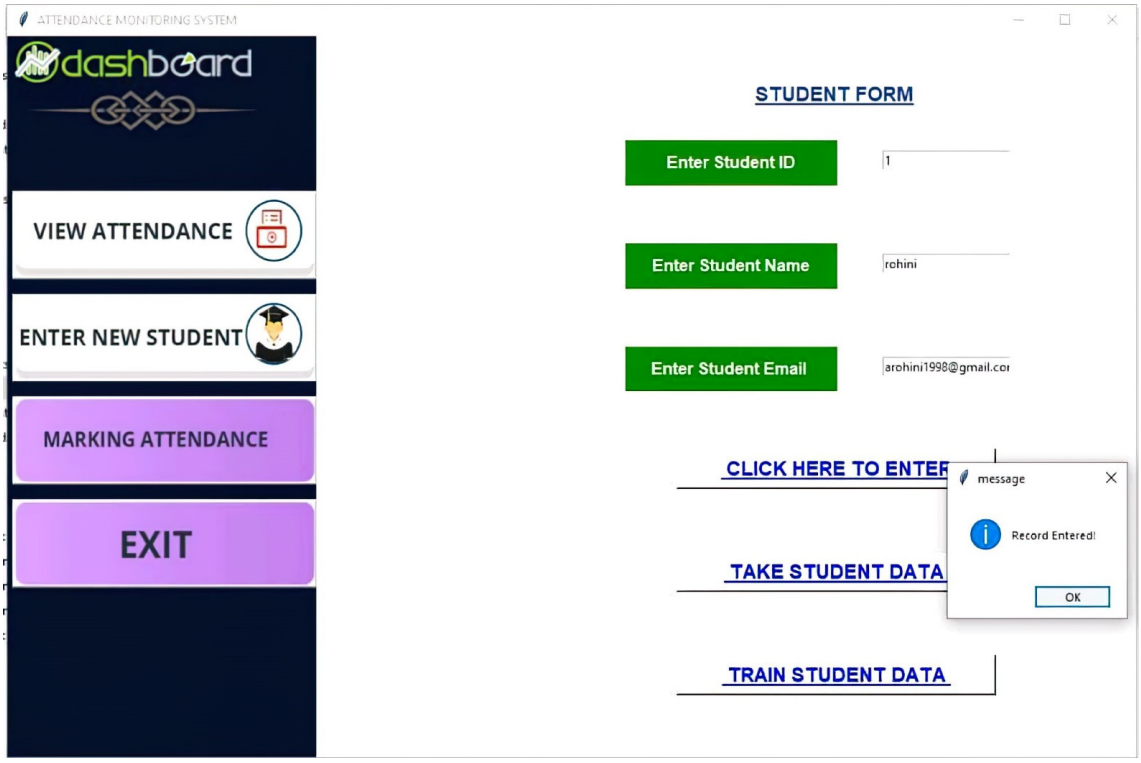

Fig. (9). Dashboard and new student details entering. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

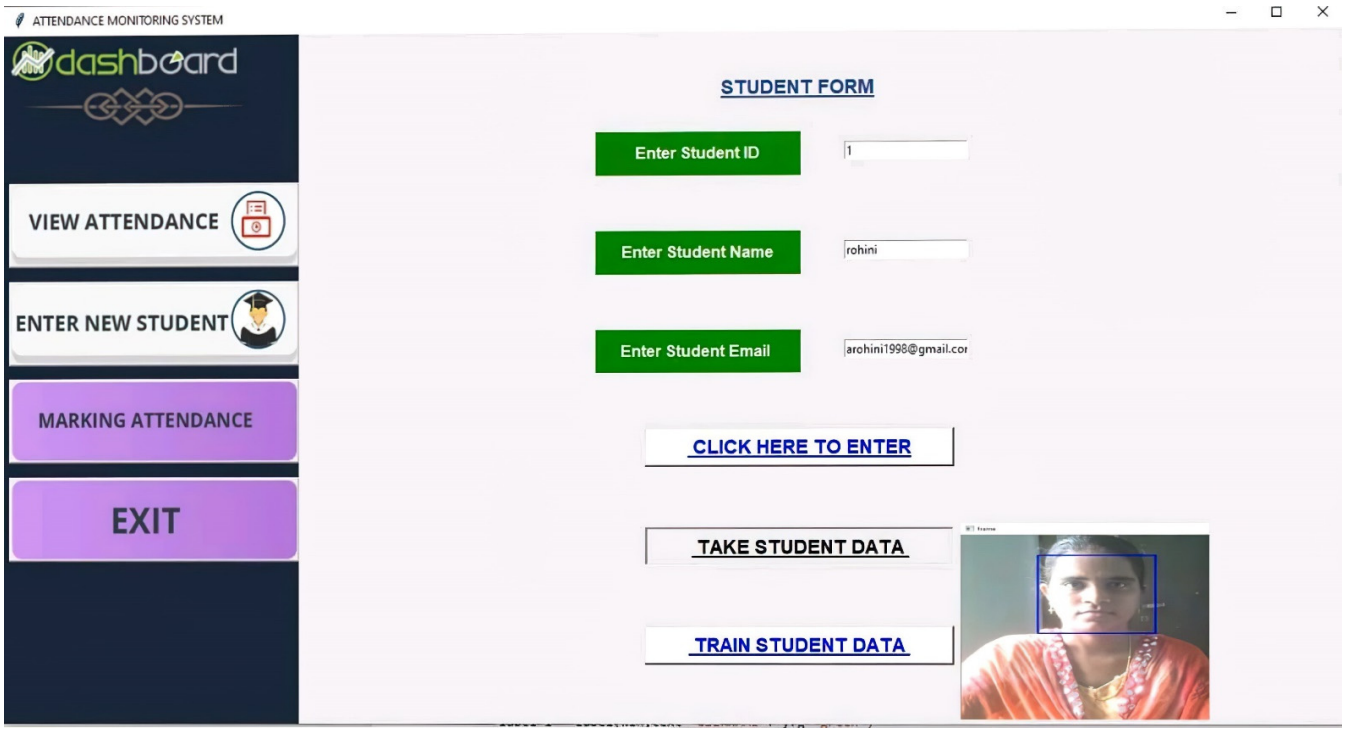

Fig. (10). Detection of face data by teacher. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

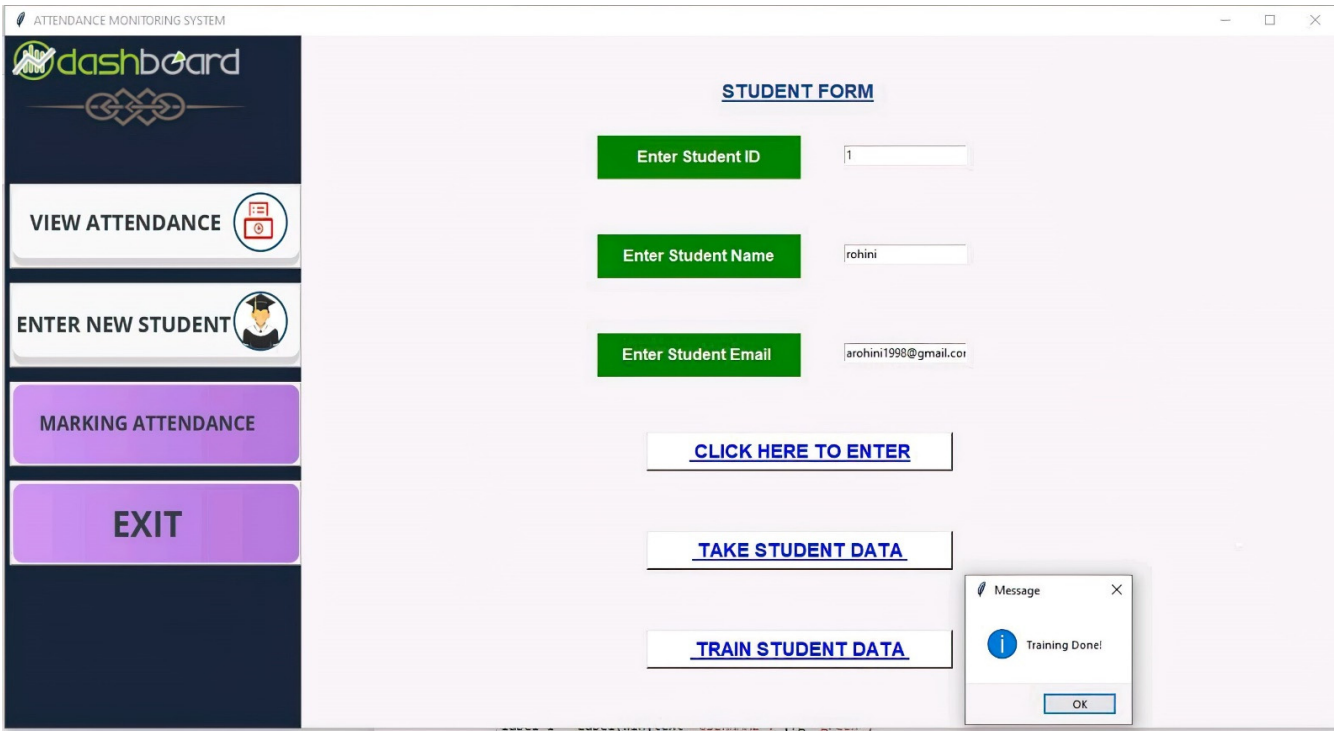

Fig. (11). Training of collected data. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

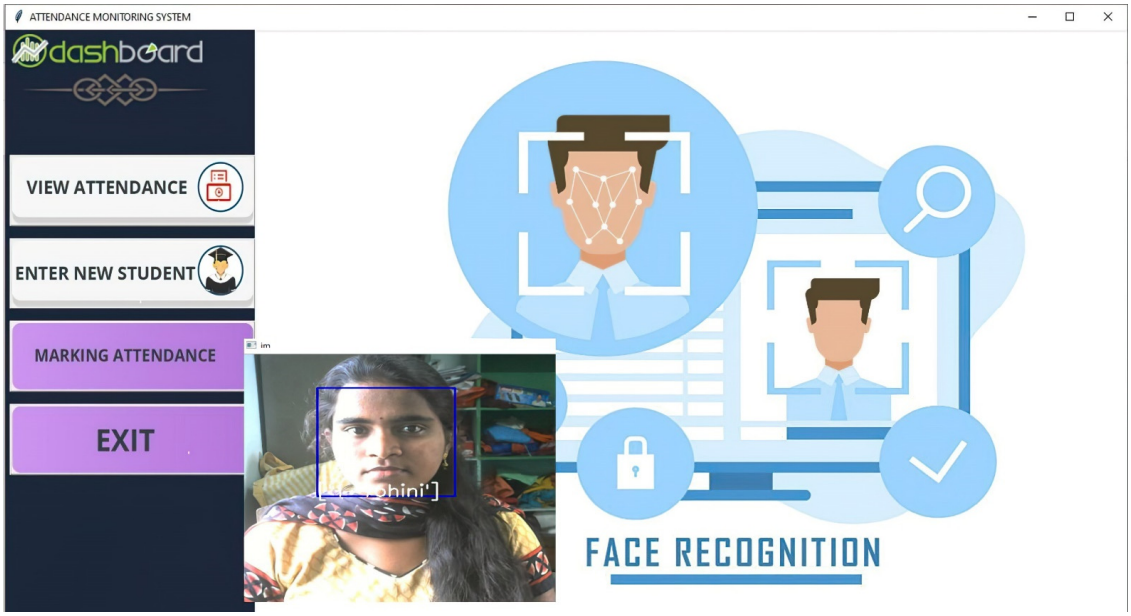

Fig. (12). Face recognition and marking attendance. (*A higher resolution / colour version of this figure is available in the electronic copy of the article*).

view. Fig. (**7**). shows the attendance view of the admin. The attendance sheet was sent to the students by e-mail. Here attendance shows 0, 1 means '0' is absent and '1' is the present student. The teacher record and attendance sheet were created in the database in excel format. The print option of the attendance sheet is also available for admin.

After the admin module discussion, here is the explanation of the teacher module and its functionality. Fig. (**8**) shows the teacher login page. When the teacher successfully login, the dashboard will display shown in Fig. (**9**). New Students were added to id, name, and e-mail. Here it is unique. Successfully added student face images collected through the static camera shown in Fig. (**10**). Collected data is trained and the message will appear on the screen as shown in Fig. (**11**). Another functionality is marking attendance. To mark attendance, the face is recognized with the name shown in Fig. (**12**). The recognized student's attendance mark as '1', the absent student's attendance is '0'. The updated attendance sheet appears in the teacher dashboard and the admin dashboard.

CONCLUSION

The proposed system presents a framework of real-time monitoring attendance for the institutional sector. Monitoring attendance uses facial recognition, which is part of the biometric system. The system mainly requires software in python3 programming language, Tkinter for making GUI, OpenCV and hardware is a static web camera, 8 GB RAM, and windows10 operating system for implementation. The work done contains three parts, face detection, recognition, and attendance marking. The detection was done for straight and side faces by using a haar cascade classifier. LBPH algorithm recognized under illumination and expression change of the person's face. An everyday attendance sheet was shared with the students *via* e-mail notification. It obtained 94.5% accuracy of detection, 98.5% accuracy of face recognition, and 98.5% accuracy of marking attendance. When compared to other biometric technologies face recognition system recommends quick, secure, automatic, and flawless verification. It will help to identify unknown persons present in the surveillance area. It reduces the manipulation of attendance records done by students and saves time as well. Here trained and tested on small facial data. In further, we train and test with more people. However, lens distortion and twin's recognition problems are not solved. This problem reduced the accuracy of detection and recognition. Thus, we will try to implement a web application by adding these features to get accurate attendance.

AUTHORS' CONTRIBUTION

Valaparla Rohini: Project administration, methodology, Conceptualization, data curation, resources, formal analysis, writing - original draft, revising, editing.

M Sobhana: Methodology, review, editing, Supervision.

Ch Smitha Chowdary: Formal analysis, writing-review, editing, Investigation.

CONSENT FOR PUBLICATION

Not applicable.

AVAILABILITY OF DATA AND MATERIALS

Declared none.

FUNDING

None.

CONFLICT OF INTEREST

The author(s) declare no conflict of interest, financial or otherwise.

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Declared none.

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