Face Recognition Attendance System Based on Real-Time Video Processing

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Abstract*—The attendance system is designed to track and monitor student participation in class. Various methods exist for attendance tracking, including biometric systems, RFID card-based systems, traditional paper-based systems, and face recognition-based systems. Among these, face recognition-based attendance systems stand out due to their enhanced security and efficiency. This study shifts the focus from just improving recognition accuracy to minimizing the false-positive rate by using a confidence threshold with the Euclidean distance metric. The threshold helps effectively identify and store images of unknown individuals. When compared to the Compared to other Euclidean distance-based methods such as Eigenfaces and Fisher faces, the Local Binary Pattern Histogram (LBPH) algorithm demonstrates superior performance. Haar cascade is employed for face detection due to its reliability, while LBPH is preferred for face recognition because of its resilience to monotonic grayscale variations. Real-time images are captured via a webcam for both face detection and recognition. System's effectiveness is evaluated using metrics such as recognition accuracy, false-positive rates, and the impact of the confidence threshold in identifying unknown individuals. The student face recognition accuracy stands at 77%, with a false-positive rate of 28%. It also recognizes individuals with variations like glasses or facial hair. For unknown individuals, The recognition rate is around 60%, with false-positive rates of 14% and 30% when the threshold is applied and not applied, respectively.

Index Terms*—Face detection, Face recognition, LBPH algorithm, Haar Cascade, Webcam-based attendance system.

I. Introduction

Automation refers to the use of computer-based technologies to control machines and processes, significantly improving accuracy and efficiency in various domains. In today's world, such advancements have revolutionized daily life, reduced manual effort and increased productivity[11]. One notable innovation in automation is the development of automated attendance systems, which have replaced the traditional methods of marking attendance. The traditional paper-based method is not only time-consuming but also grows increasingly complex as the number of attendees rises. Automated systems address these challenges by saving time and enhancing security, effectively preventing proxy attendance [10]. The main objective of our system is to create a face recognition-based attendance system that reduces the false-positive rate when identifying unknown individuals by implementing a confidence threshold [9]. Real-time images are captured using a webcam, with face detection performed through the dependable Haar cascade algorithm.

For face recognition, the system utilizes the Local Binary Pattern Histogram (LBPH) algorithm, which is known for its robustness to variations in grayscale intensity. Additionally, the system can detect and store images of individuals not registered in the database, providing a seamless and secure solution for managing attendance in classrooms.

II. Research Review

Several attendance systems have been proposed over the years, utilizing various technologies. In [2], an RFID card-based attendance system was introduced, where RFID tags are powered by energy from the reader. However, a major limitation of this system is the possibility of misuse, allowing unauthorized individuals to use a valid ID card to gain access, which presents security concerns. Additionally, biometric-based attendance systems have also been investigated. In previous research. In [3][9], a fingerprint-based attendance system was proposed, where a biometric sensor captures fingerprints, performs feature extraction, and compares the data with stored records for enrollment or authentication. Despite its benefits, this system has limitations, as students are required to physically approach the hardware device to mark attendance, or the device needs to be passed around during class, these devices could disrupt the learning environment. Similarly, iris-based attendance systems, as there in [4] and [6], utilize iris recognition for authentication. However, these systems are very highly dependent on environmental factors such as lighting and distance, making them less reliable in real-world situations. Face recognition-based attendance systems have also been developed. In [1], the authors introduced a system that employs the Eigenface recognition technique, In this approach, images are converted into eigenfaces, and recognition is carried out by comparing the eigenfaces of the input image with those stored in the database. While this method is effective, these method has some drawbacks: it is sensitive to changes in background, head orientation, and struggles with identifying faces when the person wears glasses or has facial hair.

III. Proposed System

The proposed automated attendance system utilizes Haar-Cascade for facial detection and the Local Binary Pattern Histogram (LBPH) algorithm is used for face recognition. To improve the user experience, a Graphical User Interface (GUI) is incorporated.has been created using Python's Tkinter module, which provides a straightforward and efficient framework for developing GUI-based applications.

This system offers various kinds of features, including capturing student images along with their details for creating a database, training the stored images, and monitoring individuals entering the classroom through a live webcam feed. As students enter, the system captures and detects their faces via the webcam, with the images then pre-processed for recognition. The stages of the system where those attendance has been marks of all the students who were present in the classroom are illustrated in Fig. 2, and the implementation of each stage were explained in the following section of this paper.

IV. Datasets and Approach

We compiled our own dataset as we couldn't find any existing datasets online with 60 images per person. Our dataset includes 18 individuals, each with 60 images captured specifically for this project. An additional 10 individuals are included for testing the recognition of unknown persons.

We tested our system using live real-time video, where students and unknown individuals stand in front of the camera. As shown in Fig. 3, the names of the students whose attendance has been recorded are displayed in a list. This list serves as a database, storing the attendance logs of students present in a particular class, along with the corresponding subject. So from this we came to know that our system is good and having abilities to detect faces and recognize them in a time stamp along with that marking their attendance into the database in which we can able to display that.

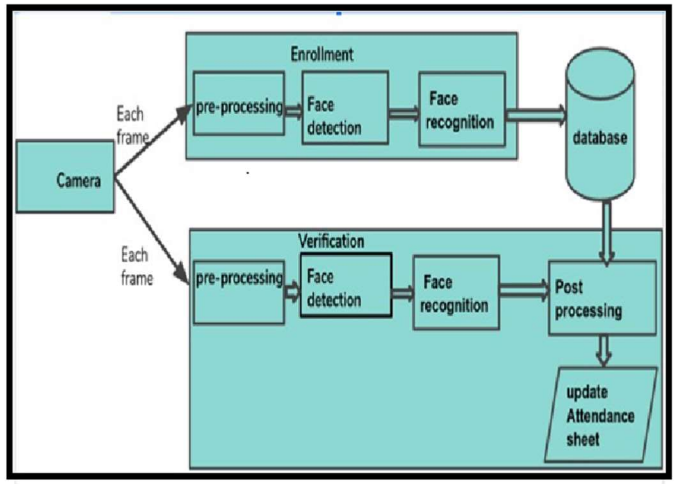

Fig. 1. System Design Architecture

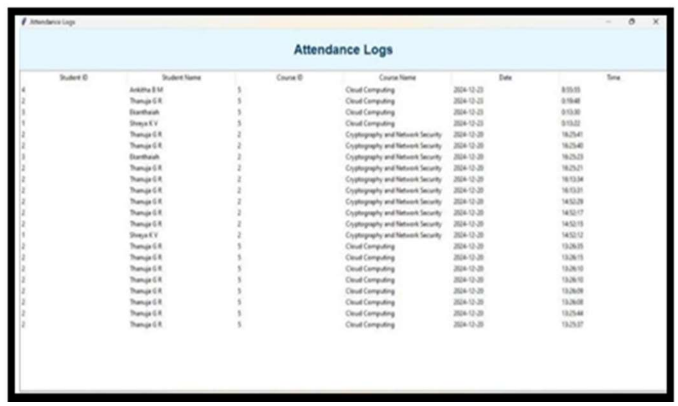

Fig. 2. System's GU Interface

Algorithm 1

Input: Live video visuals showing the student's face

Output: Excel sheet for attendance tracking.

1. Convert each and ever frame from RGB to grayscale.
2. Use the Haar Cascade classifier algorithm for facial detection and extract the necessary Region of Interest (ROI).
3. Apply the Local Binary Pattern Histogram algorithm to the ROI to extract the facial features.
4. Conditions: if it's for enrollment**,** the features are saved in those database.
5. if it's for verification**,** perform post-processing.

Fig. 3. Datasets that has been extracted and pre-processed

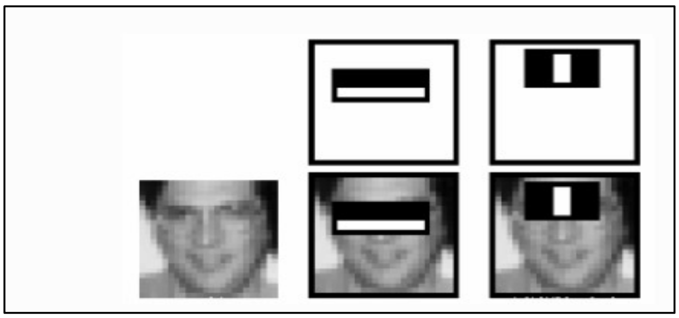

Fig. 4. Example of applicable Haar features

A. Pre-processing and Facial Detection

First, the frame captured by the webcam is converted from colour to grayscale to streamline processing. To detect faces, the Haar Cascade classifier, as outlined in [8], is employed. This classifier will get trained to identify specific features in those images, such are edges, lines, and four-rectangle patterns, using Haar-like features.

For larger images or images with varying sizes, the process requires significant computations, and many features may be irrelevant. However, AdaBoost efficiently selects the most important features, as demonstrated in Fig. 4 [3]. The Region of Interest (ROI), which contains the faces, is then extracted and passed to the next stage.

B. Facial Recognition

For facial recognition, the LBPH (Local Binary Pattern Histogram) algorithm was selected due to its robustness and its ability to recognize faces from both frontal and side perspectives. In comparison to other algorithms such as Eigen-faces and the Fisher faces [6], LBPH offers superior accuracy and flexibility. The Local Binary algorithm identifies distinct facial features that effectively characterize that face in an image [5][11]. When a new, unfamiliar image is presented, the algorithm is applied again, and the results are compared with the existing images in the dataset. This ensures consistent performance, even under diverse lighting and environmental conditions, making it more reliable than other algorithms. That Local Binary Pattern (LBP) operation that generates an image that highlights the characteristics of that image more clearly. It utilizes sliding window concept with the radius and neighbor's parameters [7], as been shown in Fig. 6 [8].

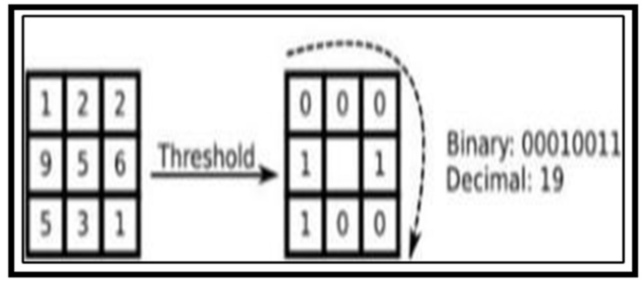

Fig. 5. Process of applying LBP on the 3X3 matrix

First, those frames were converted into 3x3 pixel matrices. If the neighbouring pixel on the matrix is higher than the median pixel, its value is set to 1; otherwise, it is set to 0. The values of those neighbouring pixels are then noted in a line so that it can form a binary number. This binary number is converted to a decimal value and replaces the median pixel in the matrix, it is shown in Figure. 5 [7].

Once that image is transformed into its LBP form, histograms were extracted from each of the grid and concatenated to create a larger, unified histogram. This concatenated histogram captures the key features of the original image. For a new image, the same steps are applied, resulting in a new histogram representing that image.

C. Post-Processing

To recognize that person in that image, the system compares the newly generated histogram with those from the training datasets using Euclidean distance. The histogram which have the lowest confidence score (i.e., the smallest distance) is selected, as lower scores indicate a better match. The ID associated with the chosen histogram is then extracted. If the confidence score is below 50, the details linked to those extracted ID are shown in that frame [1][10], as depicted in Fig. 7. The student's name is subsequently added to an Excel sheet, but only if it isn't already listed to avoid duplicates, as shown in Fig. 8.

If the confidence score exceeds 50, the label "Unknown" appears on the frame, and the person's image will be saved in a separate folder for storage. Those feature aids in identifying intruders and it reduces the likelihood of misclassifying students as unknown.

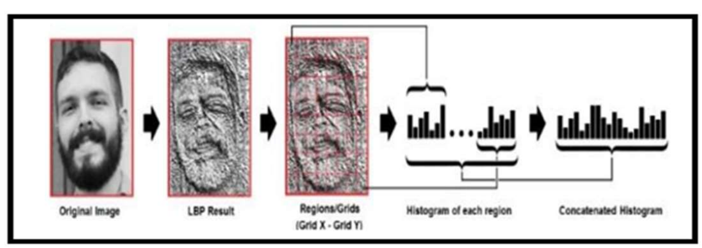

Fig. 6. Application of the Local Binary Pattern Histogram algorithm on an image

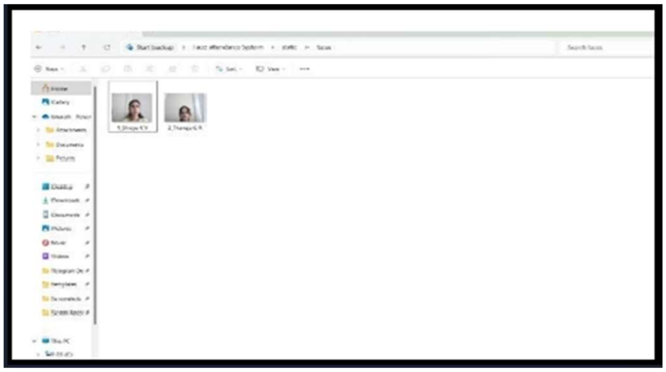

Fig. 7. Identifying the faces

Fig. 8. Attendance sheet generated upon completion.

TABLE I

TABLE 1 : PERFORMANCE EVALUATION OF OUR SYSTEM

Performance Evaluation	percentage
Students Recognition Rate (Live video)	77%
false-positive rate (Students)	28%
Unknown person Recognition Rate (existing model)	60%
Unknown person Recognition Rate (proposed model)	60%
Unknown person false-positive rate (proposed model)	14%

V. OUTCOMES AND ANALYSIS

We set a distance of 3 feet for object recognition. As shown in Table 1, the face recognition rate for students is 77%, with a false-positive rate of 28%. This system effectively recognizes students, even if they wear glasses or have a beard. The face recognition rate for unknown individuals in both the existing and proposed models stands at 60%. This outcome is largely due to the face detection algorithm mistakenly identifying random objects in the background as faces. The false-positive rate for unknown individuals is 14% in the proposed system, compared to 30% in the existing system. The threshold value plays a key role in influencing the false-positive rate for unknown individuals. In the existing system, the confidence value increases when a person turns their head slightly, resulting in them being incorrectly identified as an unknown person with a favorable filter value set at 50. However, in the proposed system, a person is classified as unknown only if the confidence is between 50 and 95, with their image saved as an unknown individual.

VI. CONCLUSION

The LBPH algorithm is a powerful method for face recognition. This algorithm is a highly effective technique for face recognition is highly effective in our system, which accurately identifies students even with minor changes like wearing glasses. However, the limitation of the current system lies in the small dataset being used. In the future, efforts could focus on developing a more extensive dataset, leading to more accurate results in real-world applications. Improvements could also be made by generating additional training examples, potentially boosting the recognition rate for unknown individuals. Additionally, the system could be enhanced with voice and visual alerts when an intruder will be detected in that classroom.

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