International Journal of Engineering Research and Science & Technology

www.ijerst.org

ISSN : 2319-5991

Vol. 22 No. 1 (2026)

ijerst.editor@gmail.com

editor@ijerst.com

International Journal of Engineering Research and Science & Technology

ISSN 2319-5991 www.ijerst.com
Vol. 22, No. 1, 2026

Peer Reviewed, Referred & Indexed Journal

Research

REAL TIME AUTOMATED ATTENDANCE SYSTEM USING FACIAL RECOGNITION AND MACHINE LEARNING

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Abstract: In order to replace manual approaches, this study proposes an automated biometric attendance management system that uses facial recognition technology. Traditional attendance methods consume significant time, are prone to human errors, and may interrupt classroom activities. The proposed system utilizes a fixed surveillance camera to capture real-time images of students and applies image processing techniques such as Haar Cascade for face detection and LBPH (Local Binary Pattern Histogram) for face recognition. The extracted facial features are matched with a pre-stored database to accurately identify individuals and automatically record attendance. The system operates without human intervention, ensuring a contactless and efficient process. It significantly reduces the time required for attendance marking while improving overall accuracy and reliability. Unlike traditional methods, the proposed system can detect and recognize multiple faces simultaneously, allowing attendance to be marked for more than one person at a time. The system compares detected faces with a pre-trained dataset and marks attendance automatically when a match is found within a predefined confidence threshold. Additionally, the system can generate attendance logs and maintain structured records. The proposed solution minimizes proxy attendance, enhances classroom management, and provides a scalable approach for educational institutions.

Index terms *- Face Recognition, Attendance Management System, Biometrics, LBPH Face Recognition, Image Processing, Machine Learning, Computer Vision, Face Detection, Automated Attendance, Real-Time Monitoring.*

Received: 22-01-2026 Accepted: 26-02-2026 Published: 06-03-2026

1. INTRODUCTION

To monitor student attendance, performance, and behavior, educational institutions require attendance management. Calling out student names or roll numbers is the traditional method of taking attendance, which disturbs the class and takes up a lot of lecture time. Record reliability is decreased by manual processes, which are subject to errors, manipulation, and proxy attendance. Growing class numbers and academic pressure necessitate the use of an automated, precise, and efficient attendance tracking system.

In recent years, attendance systems based on fingerprints and RFID have been developed to address these problems. These technologies still need physical contact or human participation, which causes delays and frustration even while they improve accuracy over manual alternatives. Students lose time and become less productive in lines. Such systems may also be beset by issues with cleaning, maintenance, and hardware dependence, particularly in large institutions.

Computer vision, machine learning, and artificial intelligence have made it possible to create effective, frictionless facial recognition

systems. Face recognition technology uses a person's distinctive facial features to identify them without having to touch them. In this system, face detection is performed using the Haar Cascade algorithm, and face recognition is carried out using the Local Binary Patterns Histogram (LBPH) algorithm, which is suitable for real-time applications. Automated attendance systems and other real-time applications are perfect for face recognition.

This project suggests an automated attendance management system that uses facial recognition. Continuously collecting student photographs, classroom cameras identify faces and compare them to a database. When a match is found, the system logs attendance and saves it digitally for analysis. The system is capable of detecting and recognizing multiple faces simultaneously, enabling attendance marking for more than one student at a time. Time savings, the removal of proxy attendance, and a seamless, non-intrusive attendance process are all advantages of the proposed method in contemporary educational environments.

2. LITERATURE SURVEY

The research projects completed by various researchers that are relevant to the proposed work are reviewed in this part. Several researchers have developed automated attendance systems using face recognition techniques to eliminate manual attendance marking and proxy attendance problems.

Face recognition–based attendance systems typically use image processing and machine learning algorithms to detect and recognize faces in real time. These systems rely on camera-based image acquisition instead of mobile-based manual entry systems.

V. Somasundaram et al. proposed a face recognition–based attendance management system that automatically identifies students using facial features and stores attendance records digitally [1]. The system improves efficiency and reduces manual errors. K. Akhila et al. developed a real-time face detection and recognition system for classroom environments. Their system used computer vision algorithms to detect faces and compare them with a stored database for attendance marking [3]. Rakhi Joshi et al. implemented an automated attendance monitoring system using facial recognition techniques integrated with a database management system for storing attendance records [2]. The system demonstrated improved reliability compared to manual attendance systems. Additionally, a survey on "smart connect," an Android and web-based tool for college management systems, was given by Amita Dhale and colleagues. SQL Server is used in its development. Its primary function is to store the information needed by the institutions [8].

Since an application designed for one mobile operating system (MOS) is incompatible with another, the MOS plays a crucial role in the creation of mobile applications. Consequently, the MOS must be taken into account before creating a mobile application for a certain application, and the application must be created for the same. As a result, the Android MOS is used to construct the student attendance management and monitoring systems. Using the Android platform, Akshay A. Kumbhar et al. demonstrated an automated attendance monitoring system. It is then utilized to consistently maintain the student's attendance [9]. A student activity record system based on Android was presented by Jessenth Ebenezer et al. In order for teachers or higher administrators to evaluate student attendance and take appropriate action if students are not attending classes regularly, it is used to record attendance and save student information [7]. Organizations also use the mobile application-based attendance management system to record employee attendance. J. Albert Mayan and S.P. Avinaash Ram demonstrated a mobile application for mobile attendance and staff

registration. It is used to track and update staff attendance on a regular basis. Additionally, taking attendance is beneficial to the authorities and personnel. This approach is also used to track whether employees are consistent with the company and to readily determine the number of employees. Additionally, this system offers each employee's details [4].

3. METHODOLOGY

i) Proposed Work:

The proposed system is capable of detecting and recognizing multiple faces simultaneously in a single frame. During testing, the system successfully marked attendance for two individuals at the same time, making it suitable for real classroom environments.

ii) System Architecture:

Multiple interconnected modules make up the system architecture of the suggested facial recognition-based attendance system, which operates in a sequential manner to accomplish automatic attendance marking. First, children in the classroom are photographed in real time by a security camera. The face detection module receives these input pictures and uses the Haar Cascade Classifier to locate and identify faces inside the frame. In order to guarantee consistency for subsequent processing, the identified faces are then normalized (facial angle and scale correction). Following preprocessing, the facial feature extraction module uses the Local Binary Patterns Histogram (LBPH) algorithm to extract significant texture-based features from the detected faces. The extracted significant characteristics from the identified faces. The current face database is compared to or saved with these extracted characteristics.

The face recognition module then does a comparison between the retrieved facial features and the training dataset that is kept in the person database. The system decides whether to accept or reject the identified face based on similarity matching. The system automatically assigns attendance and adds time and date information to the attendance database if a match is discovered. The face is rejected and no attendance is recorded if there is no match. A completely automated, real-time, contactless attendance system that minimizes human interaction, lowers mistakes, and boosts productivity in school settings is guaranteed by this design.

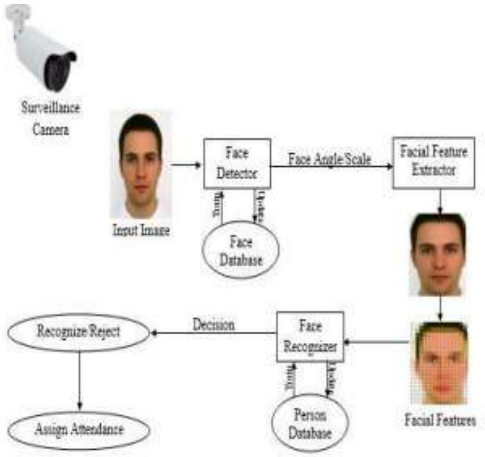

Fig.1. Proposed Architecture

iii) MODULES:

1. Data Acquisition Module:

The Data Acquisition Module captures real-time images using a surveillance camera. It collects student face images under different conditions such as lighting variations, facial expressions, and different angles to improve system performance. These images are stored in an organized format for further processing and training.

2. Face Detection Module:

The Face Detection Module detects and locates human faces from the captured images. It separates the face region from the background using image processing techniques such as the Haar Cascade Classifier. This ensures that only the relevant facial portion is extracted for further analysis.

3. Image Preprocessing Module:

In this module, the detected face images are normalized to maintain uniformity. The preprocessing steps include resizing the image to a fixed size, converting it into grayscale, and

adjusting brightness and contrast if necessary. This improves image quality and enhances recognition accuracy.

4. Feature Extraction Module:

The Feature Extraction Module extracts important facial features from the preprocessed images using LBPH Algorithm. The system converts facial data into feature representations that uniquely describe each individual. These extracted features are stored for comparison during the recognition process.

5. Face Recognition Module:

The Face Recognition Module compares the extracted facial features of the input image with the stored features in the database. Based on similarity matching, the system identifies the student. If the match is successful, the student's identity is confirmed; otherwise, the system marks the face as unknown.

6. Database Management Module:

The Database Management Module maintains student information such as ID, name, and facial data. It stores, updates, and retrieves the records required for recognition and attendance marking. The database ensures secure and organized management of student details.

7. Attendance Management Module:

Once a face is recognized, the Attendance Management Module automatically records the attendance along with the current date and time. The attendance data is maintained in a structured format such as an Excel sheet for future reference and reporting

iv) ALGORITHMS:

1 **Haar Cascade Classifier for Face Detection:**

The Haar Cascade Classifier is a machine learning–based approach used for object detection, especially face detection. It works by using Haar-like features, which are rectangular patterns that detect contrast differences in an image. The algorithm first converts the input image into grayscale to reduce computational complexity. It then calculates an integral image to quickly compute the sum of pixel values in rectangular regions. During training, AdaBoost selects the most important features and forms weak classifiers, which are combined into a strong classifier. These classifiers are arranged in a cascade structure, where simple stages quickly eliminate non-face regions and complex stages confirm the presence of a face. If a region passes all cascade stages, it is detected as a face.

2 **LBPH (Local Binary Pattern Histogram) Face Recognizer:**

The LBPH Face Recognizer is used for identifying or recognizing a detected face. It works by analyzing the texture of the face image. First, the detected face is converted into grayscale. For each pixel, the algorithm compares the center pixel value with its neighboring pixels. If the neighbor pixel value is greater than or equal to the center pixel, it assigns 1; otherwise, it assigns 0. This generates a binary number known as the Local Binary Pattern (LBP). The image is divided into multiple small grids, and a histogram of LBP values is calculated for each grid. All histograms are then combined into a single feature vector representing the face. During recognition, the histogram of the test face is compared with stored histograms from the trained dataset to find the closest match.

3 **Confidence Score Based Matching (Threshold Comparison):**

After prediction, the LBPH recognizer returns a label and a confidence value. The confidence score represents the distance between the input face and the stored trained face images. In LBPH, a lower confidence value indicates a better match. A predefined threshold value is used to determine whether the face is recognized or not. If the confidence score is less than the threshold, the system confirms the identity and displays the person's name. If the confidence score is greater than the threshold, the system classifies the face as unknown. This threshold-

based comparison improves the reliability and accuracy of the recognition system

4. EXPERIMENTAL RESULTS

The experimental findings show that the suggested facial recognition-based attendance system operates efficiently across a number of useful displays. The user may first register student information such ID, name, and email using the system interface. Next, they can utilize the "Take Images" option to take pictures of the students' faces. The "Train Images" function uses these photos, which are saved in the dataset, to train the model. Following successful training, the system uses a camera to identify and recognize faces in real time. The system correctly recognizes a student and presents their information in the interface after their face is recognized and compared to the training dataset. Furthermore, the attendance module automatically records the recognized student's information, including ID, name, and timestamp, and stores it in a structured Excel sheet. The output displays demonstrate that several pupils have been successfully identified and that their attendance has been recorded accurately. The technology keeps a digital record for later use and manages real-time recognition effectively with little latency. These outcomes demonstrate that the suggested system offers a dependable and user-friendly automated attendance management solution while lowering human labor and increasing accuracy.

Accuracy: The ability of a test to differentiate between healthy and sick instances is a measure of its accuracy. Find the proportion of analysed cases with true positives and true negatives to get a sense of the test's accuracy. Based on the calculations:

Accuracy = TP + TN /(TP + TN + FP + FN)

$$Accuracy = \frac{(TN + TP)}{T}$$

Precision: The accuracy rate of a classification or number of positive cases is known as precision. Accuracy is determined by applying the following formula:

Precision = True positives/ (True positives + False positives) = TP/(TP + FP)

$$\Pr e\,cision = \frac{TP}{(TP + FP)}$$

Recall: The recall of a model is a measure of its capacity to identify all occurrences of a relevant machine learning class. A model's ability to detect class instances is shown by the ratio of correctly predicted positive observations to the total number of positives.

$$Recall = \frac{TP}{(FN + TP)}$$

F1-Score: A high F1 score indicates that a machine learning model is accurate. Improving model accuracy by integrating recall and precision. How often a model gets a dataset prediction right is measured by the accuracy statistic..

$$F1 = 2 \cdot \frac{(Recall \cdot \Pr e\,cision)}{(Recall + \Pr e\,cision)}$$

Fig2 Main User Interface for Face Recognition System

This figure2 illustrates the main graphical user interface of the face recognition attendance system. It provides options to enter student details such as ID, name, and email, along with functional buttons like "Take Images," "Train Images," and "Take Attendance." The interface acts as the control panel where users can register students, capture facial data, train the recognition model, and initiate attendance

marking.

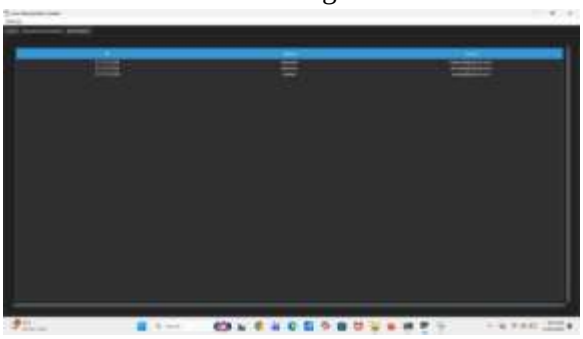

Figure 3: Registered Students Database Display

This figure3 shows the registered students' details stored in the system database. It displays essential information such as student ID, name, and email in a tabular format. This module ensures that all registered users are maintained properly and can be accessed during the face recognition process for accurate identification.

Fig 4: Attendance Record Stored in Excel Sheet

This figure4 represents the attendance records generated by the system and stored in an Excel sheet. It includes student details such as ID, name, and email, along with attendance status and timestamps. The Excel file serves as a permanent record for tracking student attendance and can be easily accessed for reporting and analysis purposes.

5. CONCLUSION

The computer vision and machine learning-based facial recognition-based attendance management system automates the traditional attendance procedure. Face detection and identification algorithms like Eigenfaces are used to reliably identify pupils and record attendance in real time. The implementation shows that the solution decreases manual labor, mistakes, and proxy attendance. Excel's interface and automatic data storage improve usability and record management.

The experiments show that the system is efficient, dependable, and ideal for real-time classrooms. It works without physical touch or disruption to instruction, making it a viable alternative for modern schools. The suggested attendance management system increases accuracy, saves time, and is scalable and cost-effective, with possibilities for deep learning integration and cloud deployment.

6. FUTURE SCOPE

The proposed face recognition-based attendance system can be further enhanced by integrating advanced deep learning techniques such as Convolutional Neural Networks (CNNs) to improve recognition performance under varying lighting conditions, facial expressions, partial occlusions, and real-world challenges. Implementing real-time video analytics can enable continuous monitoring in large classrooms, seminar halls, or campus environments. The integration of cloud storage and cloud-based processing can provide centralized data management, improved scalability, secure backup, and remote access to attendance records.

In the future, mobile application support can be introduced to provide instant notifications to students and parents regarding attendance status. GPS-based location verification can also be incorporated to ensure authenticity of presence. For enhanced security, multi-modal biometric systems may combine facial recognition with additional authentication methods such as voice recognition or iris recognition. Furthermore, implementing anti-spoofing techniques and mask detection mechanisms can significantly improve system reliability and prevent fraudulent attempts in real-time scenarios.

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She developed the project titled "Automated Attendance System using Facial Recognition with Machine Learning," where she worked on dataset preparation, face detection, and implementation of the recognition system using Python and machine learning techniques. Her research interests include machine learning, computer vision, and backend web development.

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