

Digital Attendance System Using Face Recognition

Hariom H. Tiwari¹, Dhanesh S. Palekar², Prof. Rutuja Deshmukh³

Student, CSE, COETA, Akola, INDIA¹

Student, CSE, COETA, Akola, INDIA²

Professor, CSE, COETA, Akola, INDIA³

Abstract: Traditional attendance systems in educational institutions are often inefficient, time-consuming, and susceptible to errors such as proxy attendance. To overcome these limitations, this paper presents an automated digital attendance system based on face recognition technology. The proposed system utilizes image processing and machine learning techniques to detect and identify student faces in real time, ensuring accurate and reliable attendance marking. The system includes features such as user registration, face data acquisition, identity verification, and automated storage of attendance records in a centralized database. It offers a contactless and secure solution that reduces manual effort while improving efficiency and transparency. Additionally, the integration of real-time monitoring and reporting enhances overall academic management. Experimental results demonstrate that the system significantly reduces attendance marking time and effectively prevents unauthorized attendance, making it suitable for modern classroom environments.

Introduction

Attendance management is an essential administrative activity in educational institutions, as it indicates student participation and academic progress. However, traditional methods such as roll calling and paper registers are inefficient, time-consuming, and prone to human errors. These methods also allow proxy attendance, which affects the reliability of records.

In many engineering colleges, including the College of Engineering and Technology, Akola (COET Akola), faculty spend significant time maintaining attendance, reducing effective teaching hours. Additionally, the lack of real-time monitoring and proper tracking mechanisms limits timely intervention for irregular students.

To address these issues, face recognition technology provides a modern and contactless solution for automating attendance. By using widely available devices such as smartphones, it improves accuracy, reduces manual effort, and ensures secure attendance recording.

1.1 Problem Statement

Educational institutions face the following challenges:

- Time-consuming manual attendance process
- Proxy attendance and inaccurate records
- No real-time monitoring system
- Difficulty in tracking late arrivals
- Lack of integration with academic systems

1.2 Objectives

- Develop an automated attendance system using face recognition
- Reduce attendance marking time
- Prevent proxy attendance
- Provide real-time monitoring through dashboards
- Integrate attendance with online testing
- Generate automated reports

1.3 Scope

- Designed for offline classrooms
- Supports Admin, Faculty, and Student roles
- Face recognition with roll number backup
- Includes MCQ-based test module and analytics

1.4 Limitations

- Performance affected by lighting conditions
- Requires internet connectivity
- Needs camera-enabled devices
- Supports only objective-type tests

II. Literature Review

2.1 Traditional Attendance Systems

Conventional attendance methods, including roll calling and paper-based registers, are commonly used in educational institutions. However, these approaches are inefficient and time-consuming, often consuming a significant portion of lecture time. They are also prone to human errors and allow proxy attendance, which reduces the reliability of records. Furthermore, such systems lack real-time access and make report generation difficult.

2.2 Biometric Attendance Systems

To overcome the limitations of manual methods, biometric systems have been introduced. Fingerprint-based systems offer high accuracy but require dedicated hardware and may raise hygiene concerns. Iris recognition provides better precision but depends on specialized equipment and controlled conditions. Compared to these methods, face recognition is more practical as it is contactless, cost-effective, and can be implemented using existing devices like smartphones.

2.3 Face Recognition in Education

Several studies have explored the application of face recognition in attendance systems. Sharma et al. (2019) proposed a PCA-based system with moderate accuracy but limited scalability. Similarly, Kumar et al. (2019) developed a mobile-based solution that performed well under normal conditions but showed reduced accuracy in poor lighting. Advanced deep learning methods, such as those presented by Taigman et al. (2014), achieve higher accuracy but require significant computational resources, making them less suitable for typical classroom environments.

2.4 Online Testing Systems

Online assessment platforms such as Google Forms, Moodle, and Canvas have improved the efficiency of test conduction and evaluation. However, these platforms generally function independently and are not integrated with attendance systems, leading to fragmented academic data management.

2.5 Research Gap

Existing systems face several limitations, including reliance on specialized hardware, lack of real-time session control, absence of bulk processing capabilities, and no alternative mechanisms when biometric methods fail. Additionally, most systems do not integrate attendance with testing and analytics. The proposed system addresses these gaps by providing a unified solution that combines face recognition, live session management, bulk attendance processing, backup entry methods, and integrated academic analytics.

III. System Analysis and Design

3.1 System Architecture

- The proposed system follows a three-tier client-server architecture consisting of presentation, application, and database layers. It implements role-based access control for three user categories: Administrator, Faculty, and Student, ensuring secure and structured system access.

3.2 User Roles and Modules

- The system defines three user roles with distinct permissions. Administrators manage users, reports, and system configurations; faculty handle attendance sessions and tests; students participate in attendance marking and assessments.
- The system is divided into six core modules:
- **User Management:** Registration, approval, and role assignment
- **Live Session Manager:** Creation and monitoring of attendance sessions

- **Face Recognition Module:** Identity capture and verification
- **Attendance Recorder:** Storage and retrieval of attendance data
- **Test Module:** Test creation, submission, and evaluation
- **Analytics & Reports:** Dashboard visualization and report generation

3.3 Face Recognition Algorithm

The similarity between two images is calculated using a pixel-based comparison method. The similarity score is computed as:

$$\text{Similarity (\%)} = (\text{Number of Matching Pixels} / \text{Total Pixels}) \times 100$$

If the similarity exceeds a predefined threshold (e.g., 45%), the face is considered a match; otherwise, it is rejected.

3.4 Live Session Management

- The system enables faculty to create time-bound attendance sessions with three states: Pending, Active, and Closed. Attendance can be marked only during the active phase, ensuring controlled and secure participation.
- Multiple attendance methods are supported, including individual face recognition, bulk face scanning, and roll number entry as a backup. These methods provide flexibility based on classroom conditions, balancing accuracy, speed, and usability.

3.5 Database Design

- The system uses a relational database with interconnected tables to manage users, sessions, attendance records, tests, and system logs. Key tables include users, live_sessions, attendance, tests, test_questions, test_submissions, admin_logs, and locations. This structured design ensures data integrity, scalability, and efficient query processing.

3.6 Technology Stack

- The system is developed using a modern web-based technology stack. The backend is implemented using PHP, while MySQL is used for data storage. The frontend utilizes HTML5, CSS3, and JavaScript for responsive interfaces. Face detection is handled using OpenCV.js, while WebcamJS enables image capture. Data visualization is supported by Chart.js, and UI elements are enhanced using Font Awesome.

IV. Implementation

4.1 Development Environment

The system was developed using a web-based environment supporting both Windows and Linux platforms. The server configuration includes Apache with PHP and MySQL, deployed through tools like XAMPP or WAMP. The application runs on standard devices with a web browser and camera support. Development was carried out using Visual Studio Code.

4.2 Module Implementation

This module handles user registration, authentication, and role assignment. Passwords are securely stored using hashing techniques, and new users are initially marked as “pending” until approved by the administrator.

4.2.1 Admin Approval Module

The administrator verifies and approves user registrations. Approved users are granted access based on their roles, ensuring controlled system usage and security.

4.3 Face Recognition Implementation

4.3.1 Face Registration

Students capture their facial images using browser-based camera access through WebcamJS. Images are stored on the server after preprocessing for future comparison.

4.3.2 Face Verification

During attendance marking, the system compares captured images with stored templates using a pixel-based similarity algorithm. Images are resized to small thumbnails, and pixel differences are calculated to determine a matching percentage.

4.3.3 Bulk Face Scanning

For large classrooms, a single group image is captured, and multiple faces are detected using OpenCV.js. This reduces attendance time significantly while maintaining reasonable accuracy.

4.4 Live Session Implementation

4.4.1 Session Creation

Faculty members can create attendance sessions with configurable duration (5–60 minutes), subject details, and target student groups. Sessions are stored with start and end timestamps.

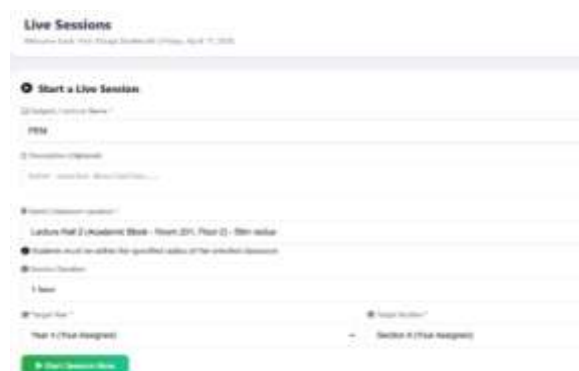
4.4.2 Session Access

Students can view only active sessions relevant to their assigned year and section, ensuring controlled participation.

4.4.3 Session Timer

A real-time countdown timer is implemented using JavaScript to indicate session status and automatically close attendance windows after expiration.

Fig. 1: Live Session Creation



4.5 Test Module Implementation

4.5.1 Test Creation

Faculty can create online MCQ-based tests with configurable parameters such as duration, total marks, and availability window.

4.5.2 Test Interface

Students access tests through an interactive interface with multiple-choice options and a timer-based submission system.

4.5.3 Automatic Evaluation

Submitted tests are evaluated automatically by comparing student responses with correct answers, and results are stored in the database for analysis.

4.5 User Interface Design

4.5.1 Faculty Dashboard

Provides tools for session management, attendance tracking, test creation, and analytics. It includes features such as live session monitoring, bulk attendance, and report generation.

4.5.2 Student Dashboard

Displays active sessions, attendance marking options, test availability, and performance history. It ensures a simple and user-friendly interface.

4.5.3 Admin Dashboard

Offers system-wide control, including user approvals, activity monitoring, and report generation. It also provides statistical insights into system usage.

V. Results and Discussion

5.1 Testing Environment

The system was deployed at COET Akola for a 45-day pilot study involving 8 faculty members and 180 students across multiple engineering departments. A total of 247 live sessions were conducted, generating 8,234 attendance records and 3,847 test submissions from 52 online tests. The evaluation was carried out in 25 classrooms under real-world conditions.

prevented using face mismatch detection and liveness verification. No successful proxy incidents were recorded, compared to an estimated 8–12% proxy rate in traditional systems.

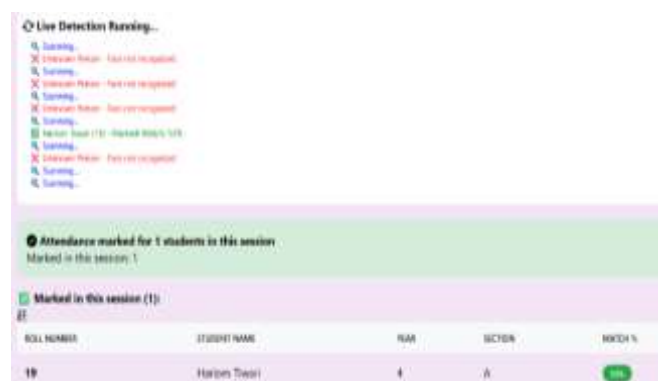


Fig. 3: Live Detecting Running server

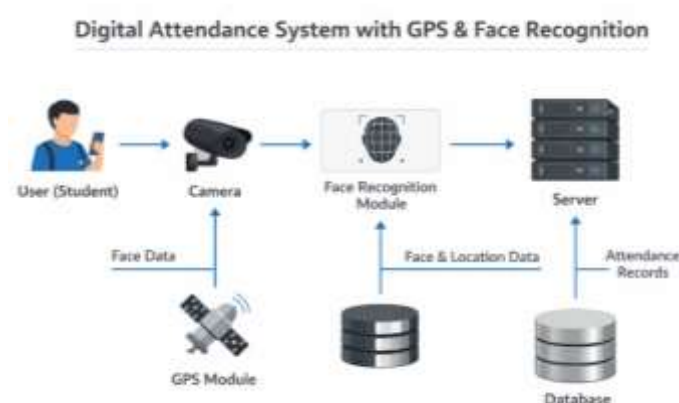


Fig. 2: Steps of Digital Attendance

5.2 Attendance Marking Results

The proposed system demonstrated significant improvements in attendance efficiency. Compared to manual roll calling, individual face recognition reduced time by approximately 65%, while bulk face scanning achieved up to 97% reduction. Roll number entry as a backup method reduced time by 92%. These results highlight the system's ability to minimize instructional time loss, especially in large classrooms.

5.3 Face Recognition Accuracy

The system achieved an overall accuracy of 83.5% across 2,700 attendance attempts. Accuracy was highest (90%) under good lighting conditions and decreased to 70% in evening sessions. The False Acceptance Rate (FAR) was recorded at 2.1%, while the False Rejection Rate (FRR) was 14.4%.

These results indicate that lighting conditions significantly influence performance, though the system maintains acceptable accuracy for classroom environments.

5.4 Proxy Attendance Prevention

The system effectively eliminated proxy attendance during the pilot study. A total of 70 proxy attempts were detected and

5.5 Test Module Results

The integrated test module showed high efficiency and reliability. A total of 52 tests were conducted with an average completion rate of 88%. Results were generated in less than 5 seconds, compared to approximately 48 hours in manual evaluation, achieving nearly 100% time reduction. This demonstrates the effectiveness of integrating testing with attendance systems.

5.6 User Satisfaction Survey

Survey results indicate high user satisfaction among both faculty and students. Most participants agreed that the system is easy to use and saves time. Over 80% of students and faculty recommended its adoption in other departments. Immediate result availability and automation were highlighted as key benefits.

5.7 Performance Analysis

The system demonstrated strong performance with an average server response time of 0.8 seconds and face matching time of 0.3 seconds per image. It successfully handled up to 200 concurrent users and maintained 99.5% uptime during the pilot. These metrics confirm the system's scalability and reliability for institutional deployment.

VI. Future Work

Based on the limitations observed and results obtained, several enhancements can be considered to improve the system's performance and scalability. Integration of deep learning models such as CNN-based approaches can significantly enhance face recognition accuracy beyond 95%. Incorporating liveness detection techniques, including blink detection and motion analysis, can further strengthen security against spoofing attacks.

Future versions of the system may include an offline mode with local storage and synchronization to address internet dependency. Developing dedicated mobile applications for Android and iOS platforms can improve usability and camera performance. Additionally, automated parent notification systems using SMS or email can help monitor student attendance effectively.

Advanced features such as predictive analytics for identifying at-risk students, voice recognition as an alternative authentication method, and support for exporting reports in formats like PDF and Excel with digital signatures can further enhance the system's functionality.

VII. Conclusion

This study presented a face recognition-based digital attendance system with live session management tailored for offline classroom environments. The system integrates multiple attendance methods, including individual face recognition, bulk face scanning, and roll number entry as a fallback mechanism, ensuring flexibility and reliability.

The results from the 45-day pilot deployment at COET Akola demonstrate significant improvements in efficiency and accuracy. The system achieved an average reduction of over 80% in attendance marking time, with bulk scanning reducing processing time by up to 97%. It maintained an overall face recognition accuracy of 83.5% under varying lighting conditions and successfully eliminated proxy attendance through biometric verification.

Furthermore, the integration of an online test module enabled rapid evaluation, reducing result declaration time from hours to seconds. High user satisfaction among faculty and students confirms the system's usability and effectiveness.

Overall, the proposed system proves that a cost-effective, camera-based attendance solution can replace traditional methods without requiring specialized hardware. It offers a scalable, secure, and efficient approach for modern educational institutions, paving the way for future enhancements using advanced machine learning techniques.

REFERENCES

- [1] S. K. Singh and P. Vashistha, "Automated Classroom Attendance System using Face Recognition," *International Research Journal of Engineering and Technology (IRJET)*, vol. 7, no. 5, pp. 324–329, May 2020.
- [2] M. Sharma, P. K. Sharma, and N. Gupta, "Real-time Face Recognition for Educational Institutions," in *Proc. International Conference on Machine Learning and Data Engineering (ICMLDE)*, Dec. 2019, pp. 45–50.
- [3] R. Kumar, A. Singh, and S. Yadav, "Mobile-based Face Recognition Attendance System for Educational Institutions,"

International Journal of Computer Applications, vol. 178, no. 12, pp. 15–20, May 2019.

- [4] Y. Taigman, M. Yang, M. Ranzato, and L. Wolf, "DeepFace: Closing the Gap to Human-Level Performance in Face Verification," in *Proc. IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Jun. 2014, pp. 1701–1708.
- [5] N. K. R. S. K. S. V. P., "Automated Test Management System for Educational Institutions," *International Research Journal of Engineering and Technology (IRJET)*, vol. 8, no. 4, pp. 2345–2350, Apr. 2021.
- [6] K. He, X. Zhang, S. Ren, and J. Sun, "Deep Residual Learning for Image Recognition," in *Proc. IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, Jun. 2016, pp. 770–778.
- [7] P. Viola and M. Jones, "Rapid Object Detection using a Boosted Cascade of Simple Features," in *Proc. IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR)*, vol. 1, Dec. 2001, pp. 511–518.
- [8] M. Turk and A. Pentland, "Eigenfaces for Recognition," *Journal of Cognitive Neuroscience*, vol. 3, no. 1, pp. 71–86, 1991.