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Smart Attendance Management System Using Face Recognition

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Abstract - *The traditional methods for recording attendance through pen and paper are inefficient, waste valuable time from the lecture period, and continue to be susceptible to proxy attendance. In this paper, a Smart Attendance Management System will be designed using computer vision and face recognition. The system will use OpenCV and face recognition software using Python, which will record video frames in real-time, detect faces, and identify them against a pre-entered database. The system will automatically save the verified records in the central database at accurate timestamps. Apart from the above, the system also has some other academic administrative functionalities like tracking IA eligibility, marks management, and parent e-mail notification.*

Key Words: Face Recognition, OpenCV, Smart Attendance, Computer Vision, Academic Monitoring, MySQL

1. INTRODUCTION

Attendance of students is one of the key activities performed in colleges and universities and it serves as one of the important criteria of their eligibility for examination processes in the respective courses. Academic institutions have used traditional paper-based or manual systems to record attendance of students. Such systems have been consuming much teaching time in classrooms, have recording inaccuracies and are susceptible to proxy attendance.

Systems such as fingerprints need students to stand in line at the class entry gates and systems involving RFID-cards are not able to prevent proxy attendance among friends.

1.1 Problem Statement and Research Gap

Most existing computer vision attendance prototypes function merely as isolated scripts that log recognized names into local flat files or CSV spreadsheets. They fail to address academic governance requirements, such as restricting attendance logging strictly to teacher-initiated lecture windows, storing data in a structured relational database, evaluating attendance percentages against Internal Assessment (IA) eligibility criteria, and providing institutional reporting mechanisms.

1.2 Objectives of the Proposed System

To overcome these limitations, this project implements a Smart Attendance Management System based on computer vision and relational data tracking. The key objectives are:

- To implement an automated student face recognition pipeline using OpenCV and the Python face recognition library.
- To support flexible video acquisition through laptop webcams and network-based camera streams.
- To enforce teacher-controlled attendance sessions that record timestamps directly into a MySQL database.
- To integrate an administrative dashboard for attendance threshold monitoring, IA evaluation, internal assessment marks recording, and notifications to parents via email.

2. LITERATURE SURVEY

The recent advancements in automatic attendance monitoring have seen a clear shift from traditional paper-based manual methods to intelligent computer vision and machine learning systems. Various algorithms have been explored to address issues surrounding detection latency, pose invariance, and ambient illumination variance in real-time academic settings.

Mohana et al. [1] proposed an AI-driven framework incorporating OpenCV routines for automated classroom attendance logging. While their architecture demonstrated marked improvements in processing speed and logging consistency over traditional methods, the detection pipeline exhibited performance drops under fluctuating ambient illumination and acute non-frontal head angles. Rawat et al. [2] have proposed a tracking method in python based on KNN algorithm to compare facial features obtained from image data sets against locally saved data sets, storing the attendance data in flat CSV files. Although lightweight during preliminary evaluations, classification latency increased significantly as cohort sizes scaled, and the pipeline lacked broader institutional administrative features.

In order to overcome the challenges posed by multi-person tracking in a crowded classroom scenario, Senthil et al. [3]

have proposed a pipeline that combines HOG, PCA and deep neural networks. This combination enhanced feature extraction across diverse facial profiles; however, the model imposed significant computational overhead that limited deployment on standard classroom hardware. Kumar et al. [4] and Anilkumar et al. [5] evaluated the Local Binary Pattern Histograms (LBPH) classifier coupled with Haar Cascade detectors for live webcam-based attendance recording into spreadsheets. While computationally efficient for resource-constrained systems, LBPH accuracy degrades markedly when students wear accessories, such as spectacles or masks, or when subject-to-camera distance varies.

Further evaluations by Rajawat and Suxena [6] demonstrated that deep learning architectures yield higher facial feature discrimination compared to conventional statistical classifiers. Nevertheless, these deep models require extensive image training corpuses and high-end processing hardware, presenting deployment hurdles for routine academic infrastructure. Similarly, foundational implementations studied by Sawhney and Kacker [7] using PCA-Eigenfaces, alongside work by Patel and Mehta [8] using basic OpenCV pipelines, underscored that basic face-matching models often operate in isolation without secure multi-subject tracking, automated parent absentee alerts, or centralized academic performance evaluation modules.

2.1 Research Gap

A significant limitation across existing literature is the focus on standalone face-matching scripts that log entries into unstructured CSV files or local spreadsheets without administrative governance. Current implementations generally lack instructor-governed session boundaries, relational database indexing, automated Internal Assessment (IA) eligibility calculations, and parent communication channels. The solution to this problem in operation will be the integration of OpenCV/Dlib/face recognition technology with a centralized MySQL database, IA threshold automatic monitoring, and email alert service for parents.

3. PROPOSED SYSTEM ARCHITECTURE

The designed system has a modular design approach involving real-time computer vision processing, data management with MySQL, and an academic management portal. The design decouples visual processing from administrative logic to maintain system efficiency during active classroom sessions.

3.1 Architectural Framework

The overall architectural framework of the proposed platform is shown in Fig - 1. The design is organized into five interconnected components that coordinate camera acquisition, facial recognition, secure database management, and administrative portal interactions.

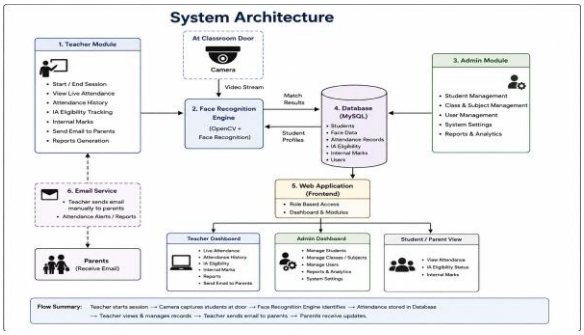


Fig - 1: System Architecture of Smart Attendance Management System

1.Camera Acquisition Unit: Captures the live video stream using an integrated laptop camera or an external network camera situated at the classroom entrance.

2. Face Recognition Engine: The system uses OpenCV to continuously decode video frames and detect faces in those frames, in addition to the use of face recognition library to capture 128-dimensional encoding of faces.

3. MySQL Database: The centralized database which stores the data including student profiles, their facial encodings, attendance logs per each session, Internal Assessment Eligibility List, internal examinations marks, and the details of the system users.

4. Administrative Web Portal: This is the interface through which system administrators and course faculty can control the sessions and view attendance logs in real-time, as well as adding the marks of internal assessments.

5. Parent Communication Service: This module enables teachers to send automatic notifications regarding students' attendance to their parents through email.

3.2 Student Registration and Face Dataset Creation

Before recognition can occur, a registration process enrols each student:

- Academic details, including Student Name, University Seat Number (USN), semester, section, and parent email address, are registered through the user management interface.
- Face images are captured through the camera interface under varying facial orientations and lighting conditions.
- Extracted facial vectors are indexed and securely linked to the student's unique USN in the MySQL database.

3.3 Teacher-Controlled Attendance Sessions

Spurious recognition and uncontrolled logging are avoided by making sure that attendance logging works strictly within the periods where the session is active under supervision from instructors. This is done as follows: The subject lecturer starts the attendance session by logging into the teacher dashboard and specifying the course and section. This makes the system turn on the recognition pipeline along with opening the live video stream.

In case a recognized face is found and matched, the attendance data record is inserted into the database, where the student's USN, subject code, date, and time of the record are specified. There is cooldown logic which makes sure that no one is logged twice within one class interval.

3.4 Academic Monitoring and Alert Services

The recorded attendance is processed by built-in institutional tracking modules:

- Checking of Eligibility for IA: It helps in determining the cumulative percentage of attendance by students depending on the subject matter and compares them against the attendance policy of the institution, such as 75% or 85%, and hence marks the students eligible for IA.
- Mark Entry: The teacher can input the marks scored by students in IA tests.
- Parental Emails: It helps the teachers to correspond with the parents via email regarding the attendance of their kids.

4. IMPLEMENTATION AND RESULTS

The working prototype was built using Python together with OpenCV, Dlib, and face recognition packages for image processing and feature extraction. The image processing chain communicates directly with a central MySQL database and a web-based administration interface where professors and administration can easily manage class records.

4.1 System Setup and User Management Interface

The web application provides dedicated portals for administrators and faculty members. Course information is set by the administrators, teachers are allocated to subjects, and attendance policies are established for the institution (with some policies including minimum attendance thresholds of 75% or 85%).

Using the registration page, the faculty member will register the student using the name, USN, semester, section, and parent's email ID.

During the registration process, facial references of the individual are captured using the camera and 128-dimensional encodings are computed and indexed in MySQL.

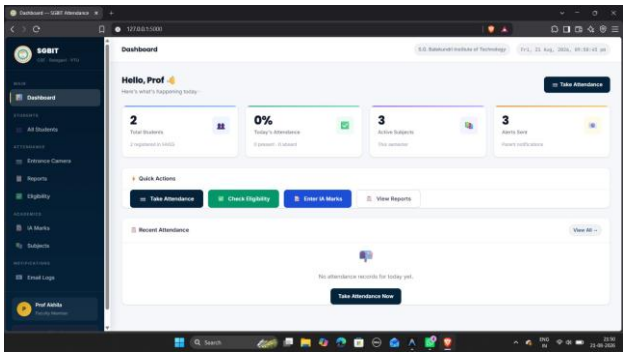


Fig - 2: System Interface showing Faculty Dashboard

4.2 Attendance Session Execution

To ensure accurate record-keeping, attendance logging runs strictly during scheduled lecture windows:

1. The subject teacher signs in on the dashboard, selects the subject, and presses Start Session on the camera console.
2. Live images captured through laptop camera or HTTP video stream from the phone are processed on a frame-by-frame basis.
3. If an enrolled student is identified, their attendance is marked, their details appear on the display screen, and their USN, subject code, date, and precise time stamp are written into MySQL. The Cooldown feature prevents duplicate attendance of any particular student within a lecture. Any unregistered person will be classified as "Unknown" without altering the attendance list.
4. The session ends with the teacher pressing End Session, thereby stopping video capture and freezing the attendance list for that particular class.

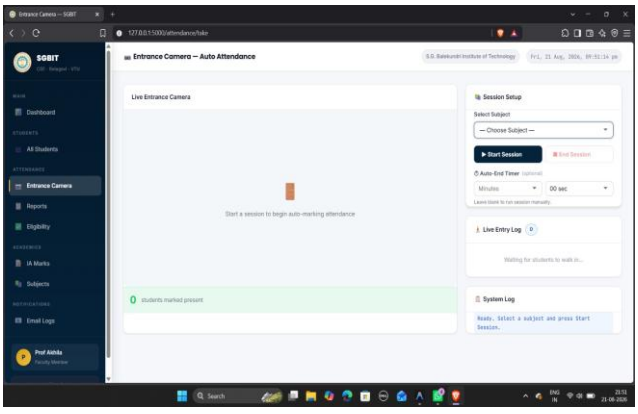


Fig - 3: Auto-Attendance Session

4.3 Academic Tracking and Parent Notifications

Once records are logged, the platform automates routine academic calculations:

- IA Eligibility Monitoring: The system monitors the total attendance percentage throughout the enrolled courses, alerting those that either qualify or don't qualify based on the minimum percentage necessary to sit for IA exams.
- Recording of Internal Marks: Marking by teachers can be done directly into the system portal, along with the attendance statistics.

  Parental Emails: Faculty members have the ability to send emails to the guardians directly from the system portal without any need for paper work involved.

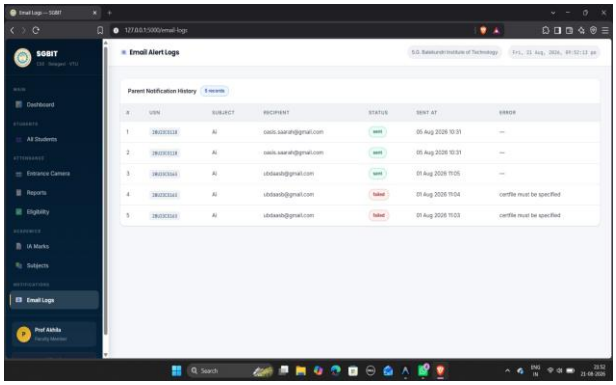


Fig - 4: Email Alert Logs

5. ADVANTAGES AND LIMITATIONS

5.1 Advantages

- No Contact and Quick Authentication: Eliminates time wastage due to paper registers and eliminates the queues that might be created using fingerprints on sensors,
- Prevention of Proxy Signing: Makes use of live camera feed and checks the individual's facial characteristics thus reducing proxy signing.
- Multi Input Sources: Works using webcams of the laptop as well as the camera of smartphone connected via HTTP video stream.
- Unified Process: Combines the functions of controlling the active sessions, storing the data in MySQL, calculating attendance percentage, checking IA Eligibility, and emailing the parents.

5.2 Limitations

- Environmental Sensitivity: Face detection and recognition get less accurate when there is a poor lighting condition in the environment and when the faces are not positioned correctly relative to the camera lens.
- Obstructing the Face: Objects such as a face mask, scarf, or tilting head obscure the facial features, thus hindering the recognition of an individual.
- Scalability of Hardware: At present, the system uses only one computer to work on, but in the case of surveillance of multiple doors of classrooms at once, more edge devices will be needed.

6. CONCLUSIONS

The Smart Attendance Management System offers a better way than manual attendance taking using OpenCV, Dlib and face recognition techniques alongside the relational MySQL database and web interface. This system allows capturing attendance during supervised class periods only, thus providing no chance to take attendance manually and use proxy attendance and digital timestamps correctly. The combination of attendance percentages and Internal Assessment (IA) eligibility criteria, as well as internal marks tracking and parent email notifications, offers all departments the means to monitor attendance effectively.

6.1 Future Scope

To extend implementation on the wider campus, future research will concentrate on:

- Fixing special IP cameras on the entrance of classrooms where students walk in naturally.
- Liveness detection to ensure that spoof attacks by printing of photographs or use of digital screen are not entertained.
- Deployment of SMS gateways automatically and linking up of the entire system with the institution's ERP database.

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