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AI-Based Smart Attendance System Using Face Recognition

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***Abstract-** Attendance management is a critical ad- ministrative task in educational institutions. Traditional attendance systems such as manual registers, RFID cards, and fingerprint biometrics suffer from several limitations including time consumption, proxy attendance, and lack of real-time analysis. This paper presents an AI-based smart attendance system that uses face recognition to automate attendance marking in higher education classrooms. The proposed system captures live video through a webcam, detects faces using Haar-cascade classifiers, and identifies students using 128-dimensional deep face embeddings. Attendance data are securely stored in a local SQLite database and analyzed using an analytics dashboard to visualize attendance trends. In addition, a lightweight rule-based emotion detection mod- ule classifies student expressions into Happy, Neutral, and Tired categories, providing insights into class- room engagement. The experimental evaluation con- ducted on a 50-student dataset achieved a recognition accuracy of 96.7% with an average processing time of approximately one second per frame, demonstrat ing the suitability of the system for real-world deployment.*

***Keywords–** Smart attendance; Face recognition; Emotion detection; Computer vision; Artificial intelligence; Student analytics Smart attendance; Face recognition; Emotion detection; Computer vision; Artificial intelligence; Student analytics*

I. INTRODUCTION

Attendance monitoring plays a vital role in maintaining academic discipline, evaluating student participation, and meeting institutional and regulatory requirements. Conventional attendance methods, such as roll calls and paper registers , consume valuable classroom time and are prone to human errors and proxy attendance. Al- though RFID and fingerprint-based biometric systems provide partial automation, they still require physical interaction and manual supervision, making them inefficient for large classrooms.

Recent advances in artificial intelligence and computer vision have enabled contactless biometric technologies that improve both accuracy and usability. Among these technologies, face recognition has gained significant attention due to its non-intrusive nature and high identification accuracy. Using real-time video streams, face recognition systems can automatically identify individuals without requiring physical contact. In addition to identity recognition, facial expressions offer valuable cues about student participation and attentiveness. Analyzing emotions during lectures can help instructors understand classroom dynamics and improve teaching strategies. Motivated by these factors, this paper proposes an AI-based smart attendance system that integrates face recognition with basic emotion detection to automate attendance marking and provide insights into student behavior.

II. SYSTEM OVERVIEW

The proposed system is designed as a modular desk- top application implemented using Python, OpenCV, and SQLite. It works in real time and requires minimal user intervention from the faculty. The major functional components of the system are listed below:

- Live video acquisition using a standard USB web- cam
- Face detection using Haar-cascade classifiers
- Face feature extraction using deep 128- dimensional embeddings
- Identity matching and attendance log-in to an SQLite database
- Rule-based emotion detection

- Analytics dashboard and report generation

Figure 1: System architecture of the AI-based smart attendance system

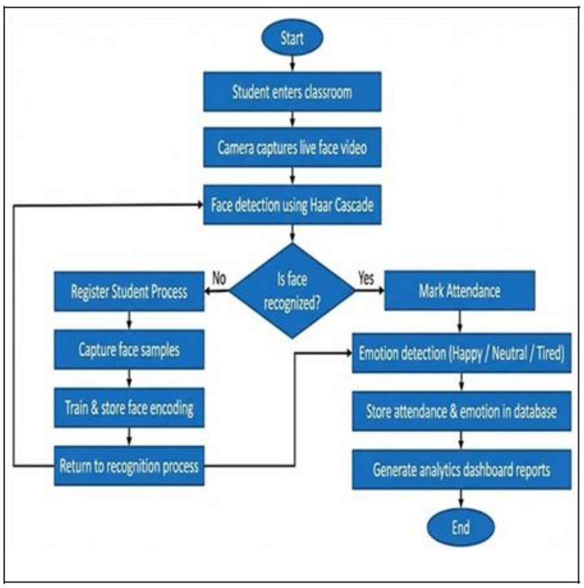

Figure 2: Flow diagram of the AI-based smart attendance system

The modular architecture allows individual components to be updated or enhanced independently. For ex- ample, the emotion detection module can be replaced with a deep learning-based model in future versions without affecting the core attendance functionality.

III. SYSTEM FLOW DIAGRAM

The flow diagram illustrates the step-by-step operational sequence of the AI-based smart attendance system. Describes how the system processes live video in- put, identifies students, marks attendance, and generates analytics.

The system operation begins with capturing real-time video from a classroom webcam. Each video frame is analyzed to detect faces using Haar-cascade classifiers. Once a face is detected, facial features are extracted and compared with stored embeddings in the database.

If a valid match is found, the student's attendance is marked automatically along with the date and time. Simultaneously, the emotion detection module analyzes facial expressions to classify the student's emotional state. All collected information is stored in the database and later used by the analytics module to generate at- tendance reports and engagement statistics.

IV. METHODOLOGY

4.1 Face Detection and Recognition

The system captures continuous video frames from the classroom webcam using OpenCV. Each frame is con- verted into RGB format and processed using a frontal-face Haar-cascade classifier to detect faces. Once a face is detected, a 128-dimensional facial embedding is generated using a pre-trained deep learning model provided by the face recognition library. These embed- dings are stored during the student registration phase and later used for identification.

During attendance marking, the generated embed- ding is compared with stored embeddings using Euclidean distance. A predefined threshold determines whether the detected face matches a registered student. If a valid match is found, the corresponding student de- tails are forwarded to the attendance logging module.

4.2 Emotion Detection

To analyze student engagement, a lightweight rule-based emotion detection approach is employed. Facial regions such as eyes and smile areas are analyzed using Haar-cascade features. Based on parameters such as smile detection, eye openness, and brightness of the face region, the system classifies emotions into three categories: Happy, Neutral, and Tired. Although simpler than deep learning-based approaches, this method provides fast and reliable results suitable for real-time classroom environments.

4.3 Attendance Logging and Analytics

Attendance records are stored in an SQLite database with fields including student ID, name, date, time, at-tendance status, and detected emotion. To maintain data integrity, duplicate attendance entries for the same student on the same day are prevented.

An analytics module processes stored attendance data and generates visual reports such as daily at- tendance percentage, student-wise attendance history, and late arrival patterns. These reports assist teachers and administrators in monitoring attendance trends and overall classroom participation.

V. RESULTS AND DISCUSSION

The proposed system was evaluated using a dataset of 50 registered students under normal classroom lighting conditions. Performance metrics such as recognition accuracy, processing time, and duplicate prevention were analyzed. Table 1 summarizes the experimental results.

Table 1: Performance of the proposed system

Metric	Result
Face recognition accuracy	96.7%
Emotion detection accuracy	90.2%
Average processing time	≈ 1.05 s/frame
Duplicate prevention	100% successful

The results demonstrate that the system can accurately recognize students and mark attendance automatically with minimal delay. The achieved processing speed is sufficient for real-time classroom usage. Emotion analysis further provides useful insights into student engagement levels, helping instructors identify sessions with reduced attention.

VI. CONCLUSION AND FUTURE WORK

This paper presented an AI-based smart attendance system using face recognition and basic emotion detection. The proposed solution automates attendance marking, minimizes human error, and eliminates proxy attendance. By integrating emotion analysis, the system also provides additional insights into classroom engagement.

Future work will focus on integrating cloud-based storage for multi-classroom deployments, developing mobile and web interfaces, and adopting deep neural networks for more accurate and fine-grained emotion recognition.

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