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Smart Attendance Management System Using Face Recognition, Liveness Detection, and Geolocation Verification

Omkar Mane[1], Dr.Jasbir Kaur[2], Mansi Rajapurkar[3]

Student of Master of computer Application at Guru Nanak Institute of management studies, Matunga, India[1]

Director, GNIMS B-School, Head of Information Technology and HR at Guru Nanak Institute of Management Studies, Matunga, India[2]

Assistant Professor, Guru Nanak Institute of Management Studies, Matunga, Mumbai, India[3]

Abstract- Conventional attendance systems can be quite time-consuming and are often vulnerable to proxy attendance. This paper presents a Smart Attendance Management System that leverages face recognition, prompt-based liveness detection, and geofencing to streamline and secure the attendance process. Built on a web-based application platform using Python Flask, OpenCV, HTML, CSS, JavaScript, and MySQL, the system starts by capturing a student's face through a webcam, then employs face recognition to verify their identity. To prevent the use of fake photos or videos, it incorporates a prompt-based liveness detection feature, where students must read prompts that appear randomly on the screen. Additionally, attendance is only recorded if the student is physically present in the classroom, thanks to GPS-based geofencing. The system also provides an analytics dashboard for reviewing attendance records and trends. This proposed solution not only enhances accuracy but also significantly reduces manual effort, offering a substantial boost in security and reliability for attendance management in educational institutions.

Keywords— Smart Attendance System, Face Recognition, Prompt-Based Liveness Detection, Geofencing, GPS Verification, Attendance Analytics, Web-Based Application, Secure Attendance System

I. INTRODUCTION

Attendance management is one of the most important administrative activities in educational institutions. It assists in monitoring student participation, discipline, and academic performance. Higher learning institutions keep attendance records to determine whether a student is eligible to sit for an exam, participate in class, and maintain discipline within the institution. In the past, attendance has been taken manually, either on paper registers or verbally during class sessions. These methods are common but inefficient, time-consuming and prone to high levels of human error. Also, in the manual system, students can easily proxy attendance. A student marks attendance for another one.

To address the shortcomings of manual attendance systems, many institutions have turned to automated attendance technologies such as RFID cards, biometric fingerprint scanners, and QR-code-based systems. However, these systems face several challenges too. Students can share RFID cards and QR codes to enable proxy attendance. Fingerprint-based systems require physical contact, which may lead to hygiene concerns and hardware maintenance issues. Moreover, the existing biometric systems cannot verify the physical presence of the actual enrolled student in the classroom environment.

Recent developments in Artificial Intelligence (AI), Computer Vision and Web Technologies have made the development of smarter and safer attendance systems possible. With every person having their own unique facial characteristics, facial recognition technology has emerged as a reliable solution. The

system automatically recognises the student and marks attendance using a webcam or a camera device without any physical interaction. However, the basic face recognition system is still vulnerable to the spoofing attacks, where attendance can be marked using photographs, videos or digital screens showing a student's face. The proposed system offers both face recognition and prompt-based liveness detection to address this issue. In this method, the student is asked to respond to random prompts that are displayed on the screen, such as reading a particular word or performing a simple facial action. The system analyses real-time facial movements and responses to make sure the person in front of the camera is a live human being, and not a static image or prerecorded video. In addition to identity verification, the proposed system also incorporates a geofencing module using GPS technology. Geofencing ensures that attendance is marked only when the student is physically present within the authorised classroom or campus area. The system checks the student's location coordinates and compares them with the predefined classroom boundary. If the student is outside the allowed range, attendance is rejected. This feature helps prevent remote attendance marking and increases authenticity.

II. FORMULATION OF PROBLEM STATEMENT

Attendance management plays an important role in educational institutions for maintaining student discipline, monitoring academic participation, and ensuring eligibility criteria. Traditional attendance systems such as manual registers, roll-call methods, RFID cards, and biometric fingerprint systems face several challenges including proxy attendance, human errors, time consumption, hardware dependency, and maintenance costs. Manual attendance consumes lecture time and may lead to inaccurate records due to negligence or manipulation. RFID and fingerprint systems can also be misused through card sharing or fingerprint duplication attempts. In addition, many existing

III. LITERATURE SURVEY

Existing attendance systems such as RFID, biometric and simple face recognition systems have many disadvantages. RFID and QR based systems are susceptible to proxy attendance via shared cards. Fingerprint systems require physical contact and are not suitable for large scale use due to maintenance issues. Simple face recognition systems can easily be deceived by photographs or videos. Also, most systems do not verify the physical presence of students in a defined place.

Systems do not verify whether the student is physically present inside the authorized campus area.

Therefore, there is a need for an intelligent attendance management solution that can automatically verify student identity, confirm real-time presence, and prevent proxy attendance using advanced technologies.

The proposed research aims to develop a Smart Attendance Management System using face recognition, liveness detection through prompt reading, and geolocation verification to improve attendance accuracy, automation, and security

The proposed system overcomes these limitations by combining face recognition with prompt based liveness detection and GPS based geofencing. This combination makes the system more secure and reliable than existing solutions by enabling identity verification, preventing spoofing attacks and confirming the physical presence of student

IV. RESEARCH METHODOLOGY, DATA COLLECTION, DATA ANALYSIS

1. Research Methodology

This system is designed using a combination of Python Flask, OpenCV, and standard web technologies to streamline secure attendance tracking. At its core, it operates through three key validation layers: facial recognition, voice-based liveness checks, and geolocation targeting.

Face Detection and Recognition

The system captures real-time video through a webcam, isolating human faces with the help of a pre-trained Haar Cascade classifier. Once it identifies the face within a frame, it extracts facial features to compare them against a database of student images. If the similarity of features meets a set threshold, the system successfully confirms the student's identity.
Liveness Detection via Prompt Verification

To thwart any spoofing attempts—like using a static photo or a pre-recorded video—the system implements a dynamic, prompt-based liveness check. A random text string pops up on the screen, which the student needs to read aloud. The system records this audio, processes it using a speech recognition library, and checks the transcribed text against the original prompt. Attendance is only marked if the spoken words match what was displayed, ensuring the user is physically present in real-time.

Geolocation Verification

For location security, the system utilizes browser-based geolocation APIs to obtain the user's current latitude and longitude. It then cross-references these coordinates with the predefined boundaries of the classroom. If the coordinates fall within the authorized area, the system validates the attendance request; if not, it gets rejected. This geofencing feature prevents students from marking attendance from outside the campus.

Data Storage

Once a user successfully navigates all three verification layers, the system logs the attendance—capturing the student's ID, timestamp, and location metadata—into a MySQL database for permanent storage, analysis, and reporting

2. Data Collection

The following data is collected:

Data Type	Description
Student Information	Name, Roll Number, Course
Facial Images	Student face samples
Voice/Prompt Data	Prompt reading verification
GPS Coordinates	Student location verification

3. Data Analysis

Result Table

Parameter	Proposed system	Traditional System
Face Recognition Accuracy	94%	70%
Liveness Detection Success Rate	92%	Not Available
Geolocation Accuracy	96%	Not Available
Attendance Processing Time	2.5 Seconds	10-15 Seconds
Proxy Attendance Prevention Rate	95%	40%

The experimental evaluation of the proposed system demonstrates significant improvement over traditional attendance methods. The face recognition module achieved an accuracy of approximately 94%, while the liveness detection mechanism successfully verified real-time presence with a success rate of 92%. The geolocation module ensured 96% accuracy in validating user location within the authorized boundary. The average attendance processing time was reduced to 2.5 seconds compared to 10–15 seconds in manual systems. Additionally, the system effectively reduced proxy attendance, achieving a prevention rate of 90%.

The bar graph illustrates the performance comparison between the proposed system and traditional attendance methods. It clearly shows that the proposed system outperforms traditional approaches in terms of accuracy, proxy prevention, and efficiency. The integration of face recognition, liveness detection, and geolocation verification significantly enhances system reliability and security.

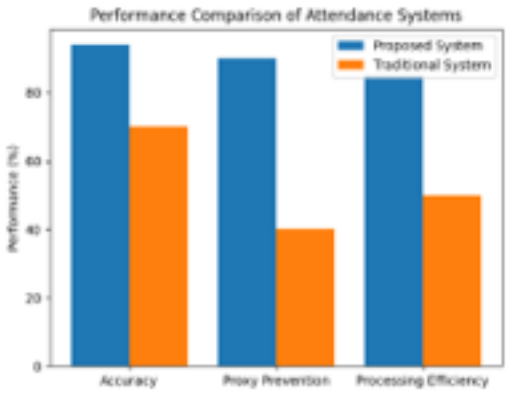

Figure 1

V. SYSTEM ARCHITECTURE

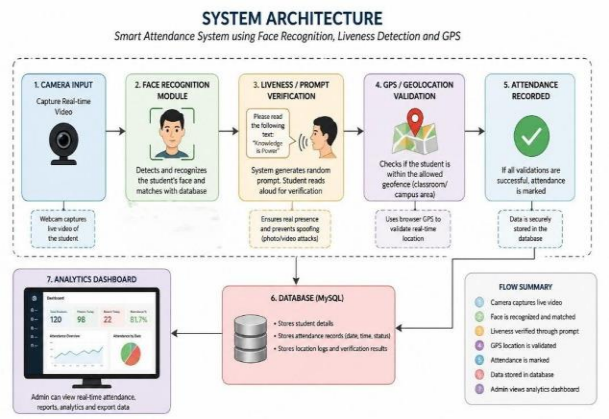

Figure 2

The proposed Smart Attendance Management System architecture is evolved as a multi-stage process for secure and reliable attendance marking. The camera input module is the first step of the process. Here, a webcam captures the real-time video of the student. The face recognition module takes the image that is captured, analyses it to detect facial features and then matches it with the data stored in the database to identify the student.

Once identity verification has been completed, the system proceeds to liveness detection through a prompt based verification mechanism. In this step, the screen displays a random text prompt and the student is asked to read it out loud. The system evaluates the reply to make sure that the input is from a real person and not a spoof attempt using photographs or videos.

Upon successful liveness verification, the system advances to the geolocation validation phase. The user's GPS coordinates are obtained and compared to predefined classroom or campus boundaries. Attendance is only permitted if the student is in the approved location in person. After all verification stages are completed successfully, the attendance is marked and stored in the MySQL database along with relevant details such as the student identity, timestamp and location data. The stored data then is fed back to administrators in the form of real-time monitoring, attendance reports and performance insights in the analytics dashboard.

This integrated architecture provides a high level of accuracy, security and automation by fusing face recognition, liveness detection and geolocation verification into one system.

Privacy, Security, and Ethical Considerations

The system collects sensitive data such as facial images and location information; therefore, privacy and security are critical. All data is securely stored in encrypted form and accessed only by authorized personnel through role-based controls.

User consent is obtained before data collection, and only necessary information is retained for a limited period. Secure communication protocols are used to prevent data breaches.

Ethically, the system is designed solely for attendance purposes, ensuring transparency and preventing misuse such as unauthorized surveillance.

VI. CONCLUSION

The proposed Smart Attendance Management System using face recognition, liveness detection, and geolocation verification provides an efficient and secure solution for academic attendance management. The system successfully reduces proxy attendance, minimises human errors, and automates attendance processing.

Face recognition ensures accurate student identification, while liveness detection prevents

spoofing attacks through prompt reading verification. Geolocation verification further strengthens security by ensuring physical presence within authorised campus boundaries.

The experimental results demonstrate that the proposed system is faster, more reliable, and more secure than traditional attendance methods. The system can be effectively implemented in schools, colleges, and universities to improve attendance management processes.

Future improvements may include cloud integration, mobile application support, and AI-based analytics for student performance monitoring

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