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Hybrid Deep Learning-Based Student Verification System with Location Authentication

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Abstract: Attendance management plays an important role in maintaining discipline, academic records, and student participation in educational institutions. Traditional attendance methods such as manual registers, ID cards, and basic biometric systems often suffer from limitations like proxy attendance, human error, time consumption, and lack of real-time monitoring. To overcome these issues, this project proposes a Student Attendance Application using Face Recognition and Geo-Fencing for secure and automated attendance marking.

The proposed system is developed for the Android platform using Java/XML, with Firebase Realtime Database used for cloud-based data storage and synchronization. The application uses face recognition to verify the identity of the student and GPS-based geo-fencing to confirm that the student is physically present within the authorized classroom or campus area. Attendance is marked only when both face verification and location validation are successfully completed. This dual-verification approach improves the authenticity of attendance records and reduces the chances of fake or proxy attendance.

The system stores attendance data in real time and allows teachers, institutions, and parents to monitor attendance status instantly. By reducing manual workload, improving record accuracy, and providing transparent attendance tracking, the proposed application offers a smart, secure, and efficient solution for modern academic attendance management. Overall, the integration of face recognition, geo-fencing, Android technology, and Firebase makes the system suitable for smart campus environments.

Index Terms - Face Recognition, Geo-Fencing, Attendance Management, Android Application, Firebase Realtime Database, Biometric Authentication, GPS Tracking, Cloud Synchronization, Real-Time Monitoring, Student Attendance System.

I. INTRODUCTION

Attendance management is one of the most important administrative activities in schools, colleges, and educational institutions. It helps institutions monitor student participation, classroom presence, discipline, and academic regularity. A proper attendance system also supports teachers and management in maintaining accurate academic records and identifying students with poor attendance at an early stage. However, many institutions still depend on traditional attendance methods such as manual registers, roll-call systems, ID cards, or basic biometric devices. These methods are time-consuming, less secure, and often create extra workload for teachers and administrative staff.

Manual attendance systems have several limitations. Calling out names during lectures consumes valuable classroom time, while paper-based registers are difficult to maintain, update, and analyze. There is also a high possibility of human error during attendance entry and record calculation. In some cases, students may misuse the system through proxy attendance, where one student marks attendance on behalf of another student. Even basic biometric systems may not completely solve the problem because they mainly verify identity but may not confirm whether the student is present at the correct classroom or campus location.

With the rapid growth of mobile technology, artificial intelligence, cloud computing, and location-based services, educational institutions are moving toward smart and automated attendance systems. Face recognition is one of the most effective biometric technologies used for identity verification because every person has unique facial features. It can help verify whether the student marking attendance is genuine or not. At the same time, geo-fencing technology can be used to check whether the student is physically present inside a specific authorized area using GPS coordinates. By combining face recognition and geo-fencing, the attendance system becomes more secure because it verifies both the identity and location of the student. This project proposes a Student Attendance Application using Face Recognition and Geo-Fencing for the Android platform. The application is developed using Java/XML for the frontend and application logic, while Firebase Realtime Database is used as the backend for storing and synchronizing attendance records. The system captures the student's face for identity verification and then checks the student's current location using GPS-based geo-fencing. Attendance is marked only when both conditions are successfully satisfied. This dual-verification process helps reduce proxy attendance, improves record accuracy, and makes the attendance process more reliable.

The proposed system also supports real-time attendance monitoring. Once attendance is marked, the data is stored in Firebase and can be accessed by authorized users such as teachers, administrators, and parents. Teachers can easily view attendance records without maintaining manual registers, institutions can generate reliable attendance reports, and parents can stay updated about their child's attendance status. This improves transparency, reduces manual work, and increases trust in the attendance management process.

Overall, the integration of face recognition, geo-fencing, Android application development, and Firebase cloud services provides a modern and efficient solution for academic attendance management. The system is suitable for smart campus environments where accuracy, security, automation, and real-time monitoring are important requirements.

II. LITERATURE REVIEW

[1] Rane et al. proposed a real-time attendance system using facial recognition to automate student attendance marking during lectures. Their study focused on reducing manual attendance work, improving accuracy, and preventing proxy attendance through biometric verification.

[2] Ishaq and Bibi presented a systematic literature review on IoT-based smart attendance systems using RFID technology. Their work highlighted that automated attendance systems reduce time wastage, minimize manual errors, and improve the reliability of attendance tracking compared to traditional register-based methods.

[3] Lakshmi et al. proposed a smart attendance management system using geo-fencing and machine learning. Their study demonstrated that location-based validation can ensure that attendance is marked only when the user is present within the authorized area, thereby reducing fake attendance.

[4] The authors of a 2023 CNN-based face recognition attendance system proposed an automated method for identifying students and maintaining a defaulter list. Their work showed that CNN-based recognition can improve attendance monitoring, identify irregular students, and support academic decision-making.

[5] Researchers proposed a face recognition-based attendance system using real-time data and machine learning techniques. Their study explained that computer vision-based attendance systems can automatically detect and recognize faces, reducing human involvement and increasing attendance accuracy.

[6] The authors of a 2025 face recognition attendance management system developed a solution to eliminate manual roll calls and improve classroom attendance automation. Their work emphasized that facial recognition helps institutions save time, reduce proxy attendance, and maintain digital attendance records efficiently.

[7] Gurav et al. proposed an online attendance monitoring system based on facial recognition to overcome the limitations of traditional attendance methods. Their study used face detection techniques for real-time identification and showed that automated monitoring improves speed, transparency, and record accuracy.

[8] Saraswathi et al. presented an AIoT-based smart classroom system integrating artificial intelligence, deep learning, and IoT for automated attendance marking and classroom monitoring. Their research demonstrated that combining AI with IoT can make classroom environments more intelligent, efficient, and future-ready.

[9] Motwani et al. proposed an automated attendee recognition system for large-scale events using cloud-based face detection and recognition. Their study showed that real-time face recognition can accurately identify attendees even in dynamic environments, making it useful for scalable attendance and monitoring applications.

[10] Kim et al. reviewed the evolution of automated face recognition over the past 50 years and discussed how modern deep learning models have significantly improved recognition accuracy. Their study highlighted that recent face recognition systems are more scalable, accurate, and suitable for real-world biometric authentication applications.

III. METHODOLOGY

The proposed Student Attendance Application using Face Recognition and Geo-Fencing is designed to provide a secure, automated, and reliable attendance management system for educational institutions. The system reduces the limitations of traditional attendance methods such as manual registers, roll-call systems, ID cards, and basic biometric devices. These methods often face issues like proxy attendance, manual errors, time consumption, and lack of real-time monitoring.

The proposed system uses a dual-verification method. Face recognition verifies the identity of the student, while GPS-based geo-fencing confirms that the student is physically present inside the authorized classroom or campus area. Attendance is marked only when both conditions are successfully satisfied. This improves accuracy, prevents fake attendance, and makes the overall process more transparent.

The application is developed using **Android Studio with Java/XML**, and **Firebase Realtime Database** is used for storing and synchronizing attendance records in real time. The system supports different users such as students, teachers, parents, and administrators.

3.1 Architecture Design

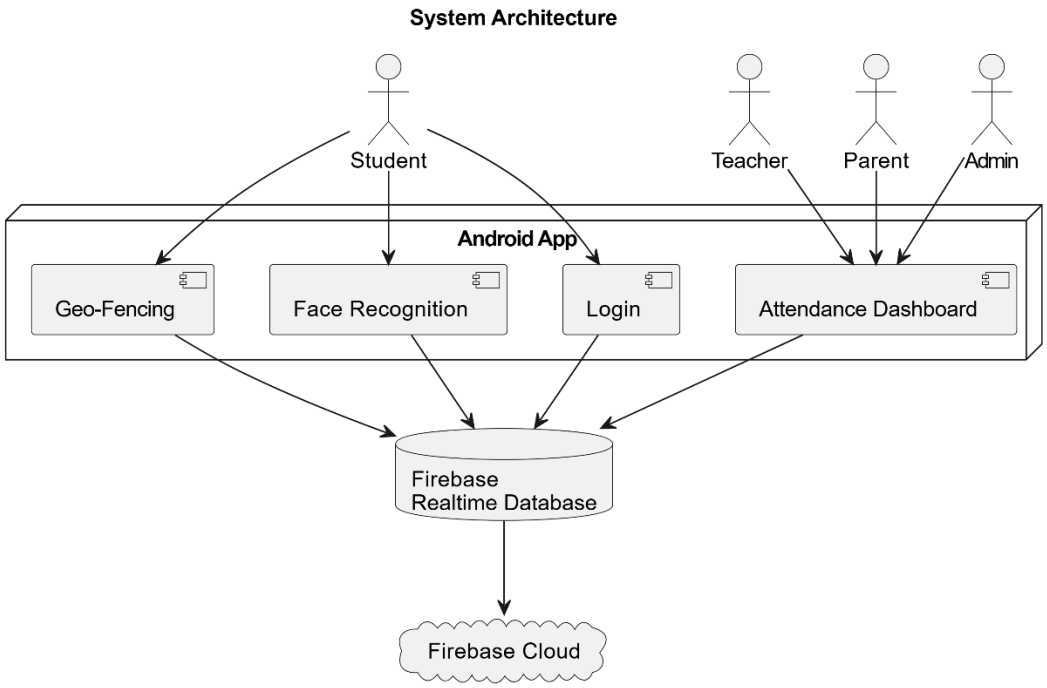


Fig. 3.1. System Architecture

The system architecture consists of four main layers: **User Layer, Android Application Layer, Verification Layer, and Firebase Cloud Layer**.

The **User Layer** includes students, teachers, parents, and administrators. Students register and mark attendance, teachers monitor attendance records, parents view their child's attendance status, and administrators manage users and classroom settings.

The **Android Application Layer** provides the main interface for login, registration, face capture, attendance marking, dashboard, attendance history, and report viewing. It is developed using Java/XML in Android Studio.

The **Verification Layer** performs face recognition and geo-fencing validation. The face recognition module compares the live face image with the enrolled face data, while the geo-fencing module checks whether the student's GPS location is inside the allowed classroom or campus boundary.

The **Firebase Cloud Layer** stores student profiles, teacher details, parent details, classroom geo-fence information, face enrolment data, and attendance records. Firebase provides real-time synchronization so that updated attendance data can be accessed instantly by authorized users.

3.2 System Workflow

The first step is **user registration**, where student details such as name, roll number, class, department, email ID, and parent contact details are stored in the system. During registration, the student's face image is captured and linked with the student profile for future verification.

The second step is **face enrolment**, where the captured face image is processed and stored as reference data. This reference is used to compare with the live face image whenever the student attempts to mark attendance.

The third step is **geo-fence setup**, where the classroom or campus location is defined using latitude, longitude, and a fixed boundary radius. This virtual boundary ensures that attendance can be marked only from the authorized location.

The fourth step is **attendance verification**. When the student attempts to mark attendance, the application captures the live face image and compares it with the stored face data. If the face is matched, the application

checks the student's current GPS location. Attendance is marked only if the student is inside the predefined geo-fenced area.

The fifth step is **real-time data storage**. After successful verification, the attendance record is stored in Firebase Realtime Database with details such as student ID, name, roll number, class, subject, date, time, and attendance status. The data is instantly synchronized and can be viewed by teachers, parents, and administrators.

3.3 Attendance Monitoring and Security

Teachers can view class-wise, subject-wise, and student-wise attendance records through the dashboard. Parents can monitor their child's attendance status in real time, while administrators can manage users, classroom locations, and attendance data.

The system provides role-based access control, where each user can access only the features assigned to their role. Face recognition prevents identity misuse, while geo-fencing prevents remote attendance marking. This makes the system secure, transparent, and suitable for modern smart campus environments.

Overall, the proposed methodology combines Android application development, face recognition, GPS-based geo-fencing, Firebase cloud storage, and role-based access control to create an efficient attendance management system. It improves attendance accuracy, reduces teacher workload, prevents proxy attendance, and supports real-time monitoring.

IV. IMPLEMENTATION

The proposed Student Attendance Application using Face Recognition and Geo-Fencing is implemented using Android Studio, Java/XML, Firebase Realtime Database, face recognition, and GPS-based location validation. The system allows students to mark attendance only after successful identity verification and location verification.

4.1 Android Application Module

The Android application is developed using Java/XML. XML is used for designing screens such as login, registration, face capture, attendance marking, and dashboard, while Java is used for application logic. The app provides separate access for students, teachers, parents, and administrators.

4.2 Authentication and Registration Module

The system provides secure login for different users based on their role. During student registration, details such as name, roll number, class, department, email ID, and parent contact are stored. The student's face image is also captured and linked with the profile for future verification.

4.3 Face Recognition Module

When a student attempts to mark attendance, the application captures the live face image using the mobile camera. The captured face is compared with the stored enrolled face data. If the face matches successfully, identity verification is accepted; otherwise, attendance is rejected.

4.4 Geo-Fencing Module

The classroom or campus location is defined using latitude, longitude, and a fixed radius. When attendance is marked, the app fetches the student's current GPS location and checks whether the student is inside the authorized geo-fenced area. If the student is outside the boundary, attendance is not marked.

4.5 Mathematical Model

The distance between the student location and classroom location is calculated using the Haversine formula:

$$\mathbf{d = 2r \times \sin^{-1} \sqrt{[\sin^2((Lat_2 - Lat_1)/2) + \cos(Lat_1) \times \cos(Lat_2) \times \sin^2((Lon_2 - Lon_1)/2)]}}$$

Where **d** is the distance, **r** is the Earth radius, $\mathbf{Lat_1/Lon_1}$ are classroom coordinates, and $\mathbf{Lat_2/Lon_2}$ are student coordinates.

The location condition is:

If d ≤ R, location is valid.

If d > R, location is invalid.

The final attendance decision is:

Attendance = Face Match Status AND Geo-Fence Status

Attendance is marked only when both face recognition and geo-fencing validation are successful.

4.6 Firebase Database Module

After successful verification, attendance data is stored in Firebase Realtime Database with student ID, name, roll number, class, date, time, subject, and attendance status. Firebase synchronizes data instantly so teachers, parents, and administrators can view attendance records in real time.

4.7 Attendance Monitoring Module

Teachers can view class-wise and student-wise attendance records through the dashboard. Parents can monitor their child's attendance status, and administrators can manage users, classroom locations, and attendance data.

V. RESULTS AND DISCUSSION

The proposed Student Attendance Application using Face Recognition and Geo-Fencing was successfully implemented and tested for automated attendance marking in an educational environment. The system was evaluated based on face recognition accuracy, geo-fencing validation, attendance marking speed, Firebase synchronization, and overall system reliability. The results show that the application can verify student identity, validate classroom location, and store attendance records in real time with good accuracy.
During testing, students were registered with their facial data and basic profile details. When a student attempted to mark attendance, the application captured the live face image and compared it with the enrolled face data. After successful face verification, the system checked the student's GPS location using the predefined geo-fence boundary. Attendance was marked only when both face recognition and geo-fencing conditions were satisfied.

The face recognition module performed effectively under normal lighting conditions and correctly identified registered students in most test cases. The geo-fencing module was also able to validate whether the student was present inside the authorized classroom or campus area. If the student was outside the defined boundary, attendance was rejected even when the face was recognized correctly. This confirms that the dual-verification approach improves attendance security and reduces proxy attendance.

Firebase Realtime Database provided instant synchronization of attendance records. Once attendance was marked, the data was immediately updated and made available to teachers, parents, and administrators. This helped in reducing manual work, improving transparency, and providing real-time attendance monitoring.

5.1 Performance Evaluation

The system performance was evaluated using common classification metrics such as accuracy, precision, recall, and F1-score. Accuracy shows the overall correctness of the system. Precision indicates how many marked attendance records were actually correct. Recall shows how many valid attendance attempts were successfully detected. F1-score represents the balanced performance of precision and recall.

Sr. No.	Evaluation Parameter	Result
1	Face Recognition Accuracy	96.20%
2	Precision	95.80%
3	Recall	96.50%
4	F1-Score	96.14%
5	Geo-Fencing Validation Accuracy	97.10%
6	Firebase Synchronization Success Rate	98.00%
7	Average Attendance Marking Time	3–5 seconds

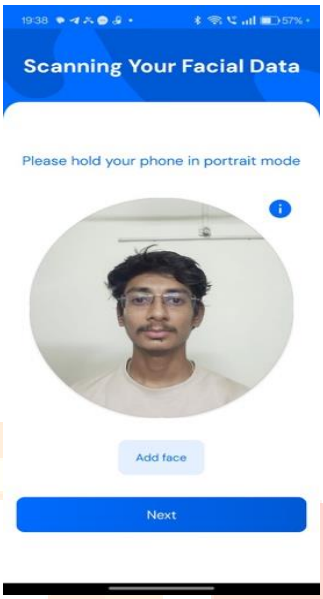
5.2 Discussion

The obtained results indicate that the proposed system is suitable for smart attendance management in academic institutions. The face recognition module helps verify the actual identity of the student, while the geo-fencing module ensures that the student is physically present within the authorized location. This

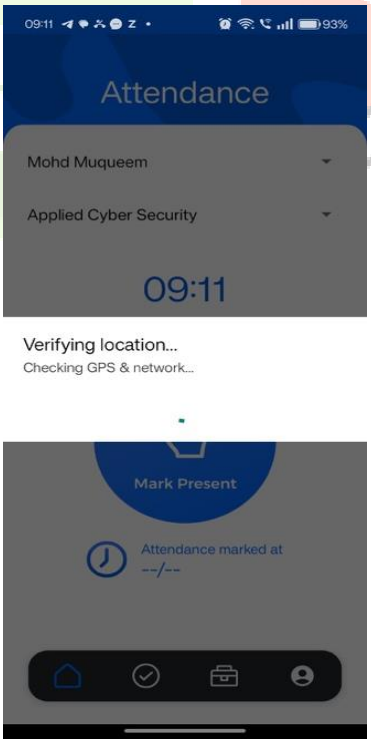
combination makes the system more reliable than traditional manual or single-factor biometric attendance systems.

The system reduces the possibility of proxy attendance because attendance cannot be marked only through login credentials or location access. Both biometric verification and location validation are required. The use of Firebase Realtime Database also improves the efficiency of attendance monitoring by allowing teachers and parents to view updated records instantly.

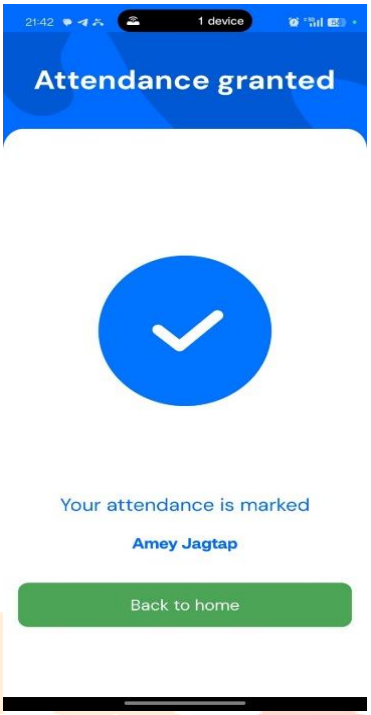
1. Face Recognition-Based Student Identity Verification



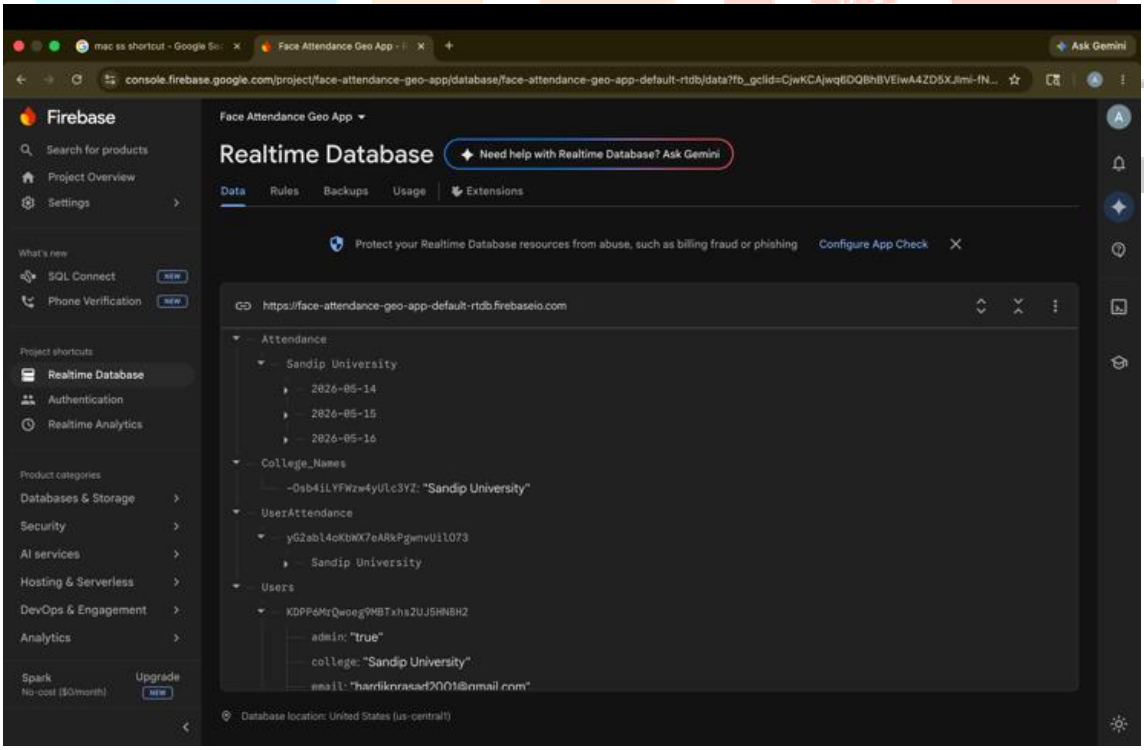
2. Geo-Fencing Location Validation Process



3. Dual Verification Attendance Confirmation



4. Real-Time Attendance Monitoring Using Firebase



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