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A Hybrid Biometric and Geo – Fencing Based Smart Attendance System

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ABSTRACT: The Smart Classroom Attendance System using Biometric and Location-Based Automation is designed to improve the accuracy and efficiency of attendance management in educational institutions. Traditional attendance methods, such as manual roll calls and paper registers, are time-consuming and prone to errors or proxy attendance. This system uses biometric technology, such as fingerprint or face recognition, to uniquely identify students and ensure that only authorized individuals can mark their attendance.

In addition to biometric authentication, the system incorporates location-based verification using technologies like GPS or Wi-Fi to confirm that the student is physically present inside the classroom. The system automatically checks the student's location and compares it with the predefined classroom location. If both biometric and location verification are successful, the attendance is recorded in the database along with the date and time, ensuring reliable and tamper-proof records.

KEYWORDS: Smart Classroom Attendance System, Biometric Authentication, Location-Based Verification, Automated Attendance Management, Proxy Attendance Prevention.

I. INTODUCTION

Attendance management plays a vital role in educational institutions for tracking student participation and academic discipline. Traditional attendance systems, such as manual roll calls and paper-based records, are widely used but have several limitations. These methods are time-consuming, prone to human errors, and can be easily manipulated. Teachers often spend valuable class time marking attendance, which reduces overall teaching efficiency. Moreover, maintaining and analyzing attendance records manually becomes difficult as the number of students increases. There is also a higher chance of data loss or incorrect record keeping. In addition, proxy attendance is a common issue where one student marks attendance for another. This reduces the reliability of the attendance system. Therefore, there is a strong need for a more efficient and secure solution. An automated system can significantly improve the process.

With the advancement of technology, smart systems have been introduced to overcome the limitations of traditional methods. Face recognition is one of the most effective biometric technologies used for identity verification. It identifies individuals based on unique facial features, making it difficult to manipulate. Similarly, location-based technologies such as GPS and geofencing help verify the physical presence of a person in a specific area. By combining these technologies, it is possible to create a more reliable attendance system. Mobile applications further enhance accessibility and ease of use for both students and administrators.

These technologies work together to ensure that attendance is marked accurately and securely. Automation also reduces manual effort and increases operational efficiency. As a result, institutions can maintain better control over attendance management. The proposed Smart Attendance System uses face recognition and location verification to automate the attendance process. The system captures the student's face using a mobile camera and verifies it using advanced algorithms.

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At the same time, the student's location is obtained using GPS and validated using geofencing techniques. Attendance is marked only when both identity and location are successfully verified. This dual verification approach ensures a high level of security and accuracy. The system stores attendance data in a cloud-based database, allowing easy access and management. It also supports report generation for monitoring and analysis. The integration of multiple technologies makes the system efficient and reliable. This approach eliminates proxy attendance and improves transparency.

II. LITERATURE SURVEY

Ravish Fernando et 1. proposed a real-time attendance system using Haar Cascade for face detection and Local Binary Pattern Histogram (LBPH) for face recognition to improve accuracy in classroom attendance monitoring. Another approach by Balkan et al. used Conventional Neural Networks (CNN), Support Vector Machine (SVM), and K-Nearest Neighbors (KNN) for feature extraction and classification to enhance recognition performance. Kritagya Painuly et al. further improved the system using deep CNN models such as VGG16 and ResNet with transfer learning to achieve better recognition under different lighting and face angles.[1]

In the IRJET paper, several face recognition-based attendance systems were studied to improve student monitoring and reduce manual attendance errors. Jomon Joseph and K.P. Zacharia proposed a system using PCA and Eigenfaces with image processing to recognize faces, but it worked mainly with front-face images and required improvement for different orientations. Ajinkya Patil introduced a system using Viola-Jones algorithm and Haar Cascades for face detection along with neural networks for recognition to enhance accuracy [2]. The Smart Presence system focuses on Wi-Fi-based attendance tracking to overcome limitations of manual and card-based attendance methods. Traditional attendance systems are time-consuming and prone to errors, while card-based systems allow proxy attendance and security issues. This study emphasizes that modern attendance systems should use wireless technology and automation to improve transparency, reduce errors, and provide real-time data for educational institutions. [3] The FCIS paper discusses a web-based attendance management system that includes user management, student management, teacher management, and attendance record modules. The system allows students and teachers to access attendance data, generate reports, and manage leave requests through an automated platform. This research shows that web-based attendance systems can simplify attendance management and improve administrative efficiency in educational institutions. [4] The IJIRT paper presents a modern web-based attendance management system designed to replace traditional manual methods with automated digital solutions. The system uses modern technologies like React.js, Node.js, and database integration to provide real-time dashboards, role-based access, and secure attendance tracking. The study highlights the importance of digital attendance systems in improving institutional efficiency and reducing human errors in attendance tracking.[5].

III. PROBLEM STATEMENT

Attendance management is an essential activity in educational institutions, but the traditional methods used for recording attendance are often inefficient and unreliable. Most institutions still rely on manual roll calls or paper-based attendance systems, which are time-consuming and prone to human errors. Teachers are required to spend a significant amount of time marking attendance, which reduces the time available for teaching and learning activities. In large classrooms, this process becomes even more difficult and inefficient.

Additionally, manual systems are not secure, as they allow proxy attendance, where one student can mark attendance on behalf of another. This leads to inaccurate attendance records and affects the overall discipline of students. Biometric systems such as fingerprint scanners have been introduced to address some of these issues, but they also have limitations. These systems require physical contact, which may not be hygienic, and they depend on dedicated hardware that can be expensive to install and maintain. Moreover, biometric devices may fail due to technical issues such as sensor errors or wear and tear over time. Another major drawback of existing systems is the lack of real-time monitoring and accessibility. Attendance records are often stored locally and are not easily accessible for analysis or reporting. This makes it difficult for administrators to track student attendance effectively.

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IV. RESEARCH METHODOLOGY

The Smart Attendance System follows a structured and automated methodology to ensure accurate and secure attendance tracking within educational institutions. Initially, users access the mobile application through the main interface, which serves as the entry point to the system. At this stage, users are required to log in using valid credentials such as username and password. The login module verifies the entered details by comparing them with the information stored in the system database. This authentication process ensures that only authorized users can access the attendance system. Once the login credentials are successfully validated, the user is granted permission to proceed further. The system then directs the authenticated user to the attendance marking section.

After successful login, the system activates the face recognition module to begin the attendance verification process. The device camera automatically captures the user's facial image in real time. The system then detects important facial features such as eyes, nose, and mouth using image processing techniques. These detected features are compared with the pre-registered facial data stored in the database for identity confirmation. In addition to facial recognition, the system also performs location verification using GPS technology. This ensures that the user is physically present within the authorized area defined by the institution. Attendance is recorded only when both the face recognition and location verification processes are successfully completed. The Head of Department (HOD) module plays an important role in monitoring and managing attendance data within the institution. Authorized personnel can log in to the system to view attendance records of students and staff. The system maintains structured data in the database, which allows easy retrieval and management of attendance information. It automatically generates attendance logs and summary reports for daily, weekly, or monthly analysis. These reports can also be sent through email to faculty members for monitoring purposes. The automated reporting system helps administrators make informed decisions based on attendance trends management.

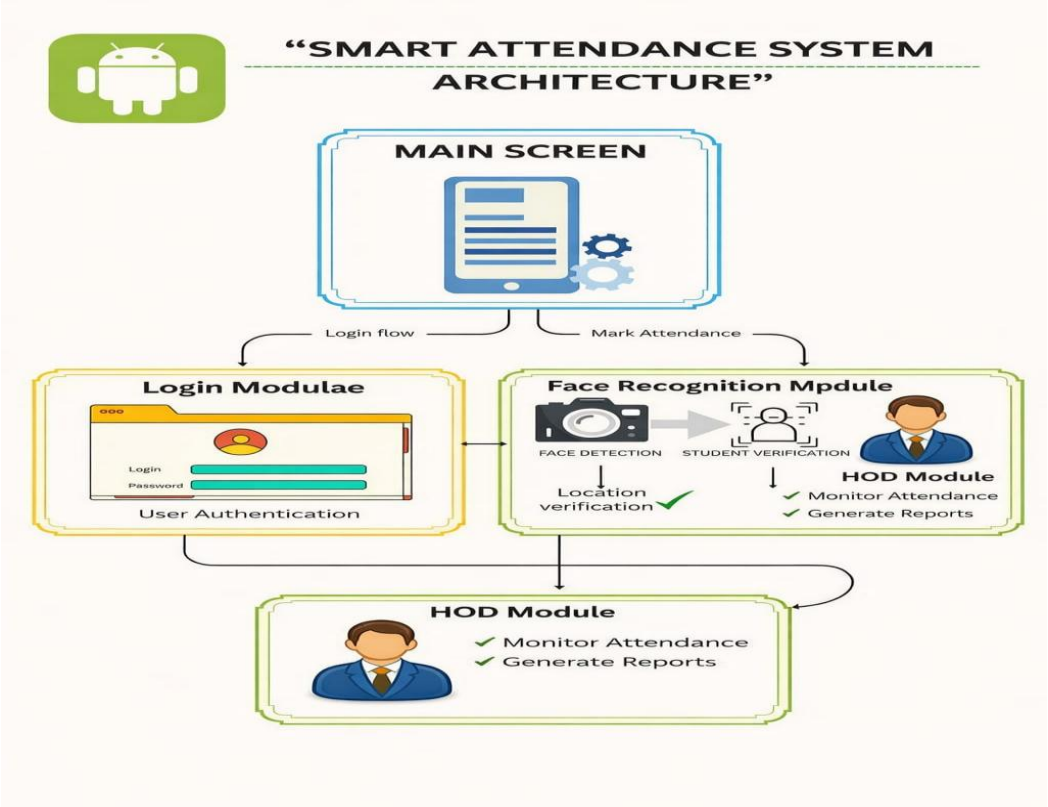

Fig 1 Smart Attendance System

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1.Face Recognition Module.

The Face Recognition Module is a key component of the Smart Attendance System that identifies and verifies students using their facial features. It captures a live image through the mobile camera and processes it using image processing and machine learning techniques. The system first performs face detection to locate the face in the image, and then extracts important features such as eyes, nose, and facial structure. These features are converted into a numerical form called face encoding. The generated face encoding is compared with the stored data in the database using similarity measures like Euclidean distance. If a match is found within a defined threshold, the student is verified and allowed to mark attendance; otherwise, access is denied. This module ensures secure and accurate attendance by preventing proxy entries and improving overall system reliability. Additionally, the module supports real-time processing, which allows quick verification of multiple users without delay. It also maintains a secure database to store facial data safely and efficiently. The system can be updated easily by adding new student records when required. Overall, the face recognition module enhances system performance, accuracy, and security in attendance management.

2. Location Verification Module

The Location Verification Module ensures that the student is physically present within the authorized area while marking attendance. It captures the real-time location of the student using the GPS functionality of the mobile device. The system retrieves the predefined classroom or institution location coordinates from the database and uses them for comparison. This helps in verifying whether the student is attempting to mark attendance from the correct location. The module applies geofencing techniques to define a virtual boundary around the authorized area. The distance between the student's current location and the predefined location is calculated using methods such as the Haversine formula. If the student is within the specified radius, attendance is allowed; otherwise, it is rejected. Additionally, the system continuously monitors location accuracy to prevent false attendance marking. It also records the location details along with the date and time for verification purposes. Overall, the module improves attendance reliability, enhances security, and ensures that attendance is marked only from authorized locations.

3. Attendance Management Module

The Attendance Management Module is responsible for recording and maintaining the attendance details of students in the system. Once the face recognition and location verification processes are successfully completed, the system marks the student as "Present." It automatically captures the current date and time as a timestamp, ensuring accurate tracking of attendance records without manual intervention. All attendance data is securely stored in a cloud-based database such as Firebase, allowing easy access and management. The module maintains attendance logs and supports the generation of reports for analysis by administrators or staff. This helps in monitoring student attendance efficiently and ensures reliable data management within the system. Additionally, the system provides options to view daily, weekly, and monthly attendance summaries. It also reduces paperwork by maintaining digital records in an organized manner. Overall, the module improves efficiency, accuracy, and transparency in attendance management.

4.Report & Dashboard Module

The Report and Dashboard Module provides a clear and organized view of attendance data for administrators and users. It displays important information such as the total number of students present, absent, and overall attendance percentage through an interactive dashboard. This visual representation helps users quickly understand attendance trends and monitor student performance in real time. In addition, the module generates detailed attendance reports on a daily, weekly, or monthly basis. These reports can be accessed, analyzed, and used for decision-making by administrators. The system may also support exporting or sharing reports for further use. This module enhances data visibility, simplifies monitoring, and improves the overall management of attendance records. Furthermore, the dashboard allows administrators to filter attendance data based on class, department, or date. It also provides graphical charts and summaries for better understanding of attendance patterns. Overall, the module supports efficient reporting, improves transparency, and assists in effective academic management.

ACCURACY : Face Recognition Accuracy: 90%-95%, Location Accuracy: High (within 50-100m range), Overall System Accuracy: 92%-96%**.**

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V. RESULTS

Fig 2 login page

This screen allows users to select their role(Student. Teacher, or HOD) to access the system.

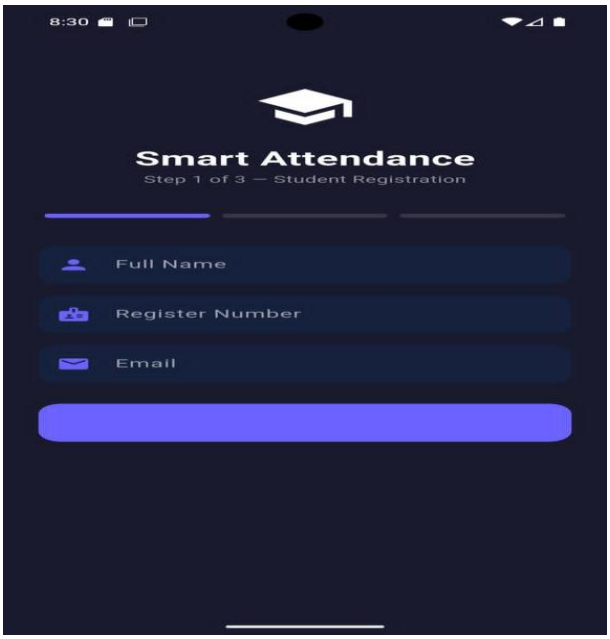


Fig 3 Student Registration

This screen allows students to enter their details like name. Register number, and email for registration.

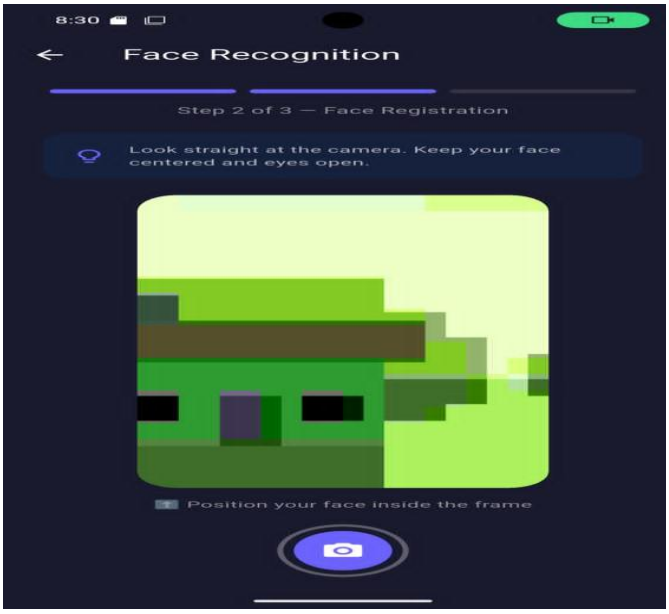
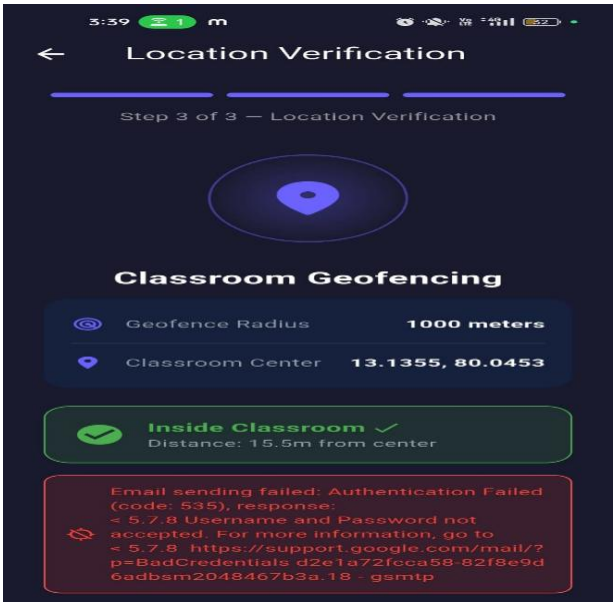


Fig 4 Face Recognition



This screen captures the user's face for attendance using face recognition technology.

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Fig 5 Location Verification

This screen verifies the user's location using Geofencing to ensure they are inside the classroom

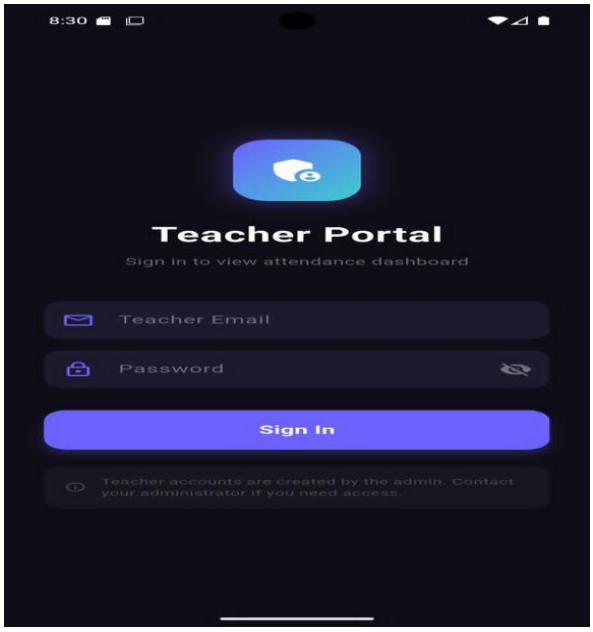

Fig 6 Teacher Portal

This screen allows teachers to login and access the Attendance dashboard

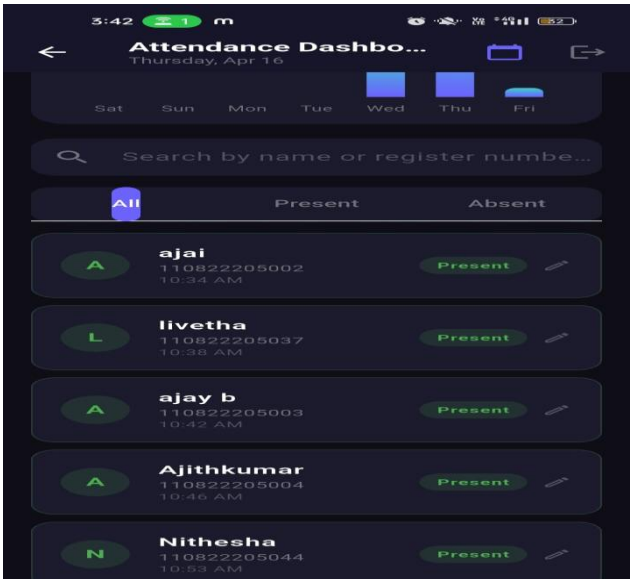

Fig 8 Attendance Dashboard

This screen displays student attendance including present and absent status.

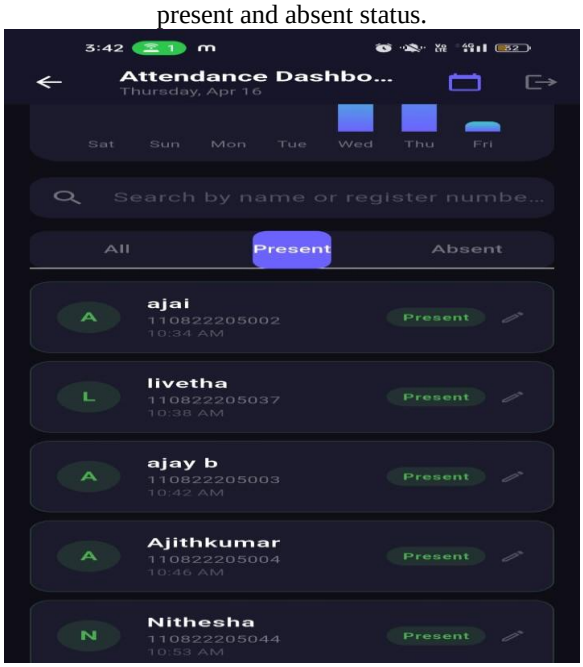

Fig 7Attendance Dashboard(Present)

This screen shows the list of students who are marked as present.

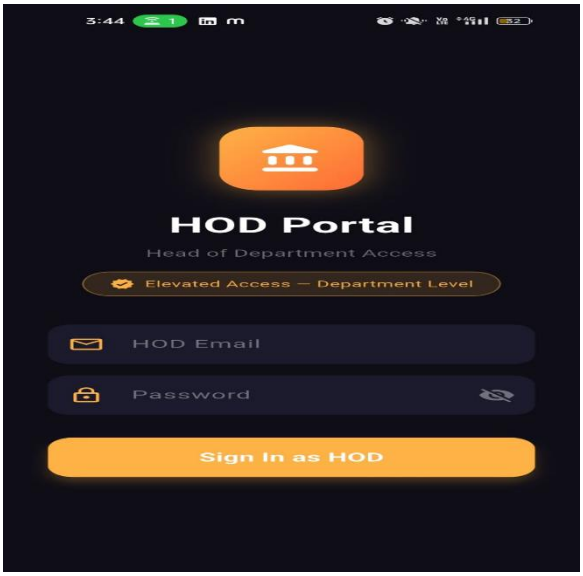

Fig 9 Hod Portal

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This screen allows the HOD to log in and access Department lével attendance data.

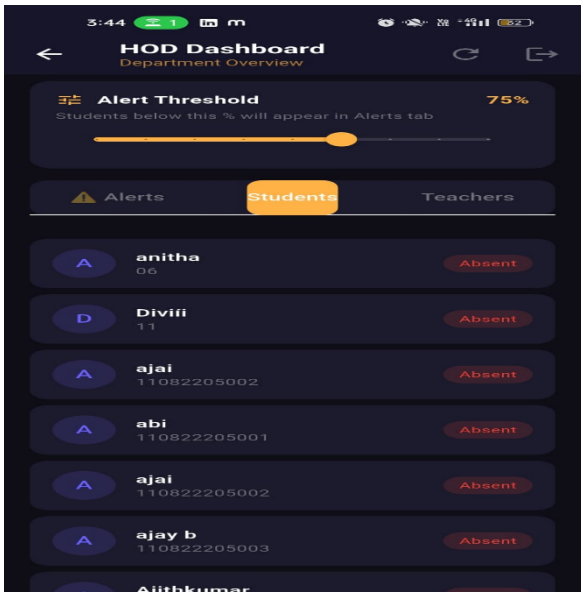

Fig 10 Hod Dashboard(Students)

This screen shows students attendance status with alerts for low attendance

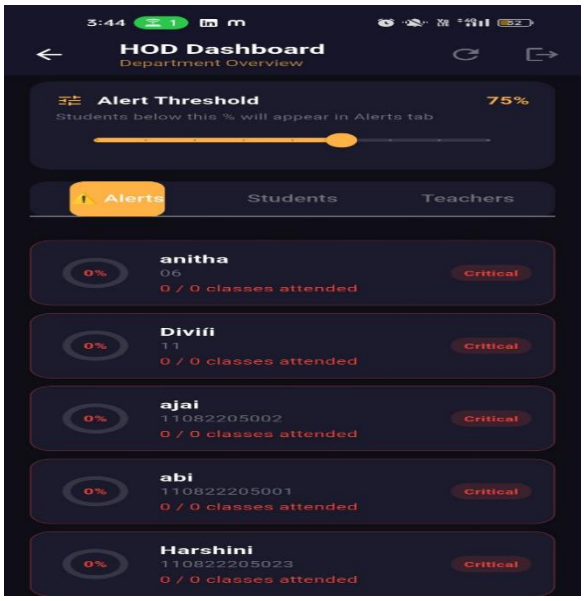

Fig 11 Hod Dashboard(Alerts)

This screen shows alerts for students with low attendance.

VI. CONCLUSION AND FUTURE ENCHANCEMENT

The Smart Attendance System provides an effective and automated approach to attendance management by integrating face recognition and location verification techniques. The system ensures that only authorized students can mark their attendance by validating their identity through facial recognition technology. In addition, it confirms the physical presence of students within the designated area using GPS and geofencing methods. This combination of technologies helps to create a secure and reliable attendance system.

The system plays an important role in reducing manual errors and preventing proxy attendance, which is a common issue in traditional attendance methods. By automating the attendance process, the accuracy and reliability of attendance records are significantly improved. Furthermore, the use of a cloud-based database enhances data security, ensures safe storage of information, and allows easy access to attendance records from anywhere when required.

The proposed system also reduces the workload of teachers and administrative staff by eliminating the need for manual attendance marking. It enables real-time data storage and quick retrieval of attendance information, which helps in monitoring student attendance and performing analysis efficiently. Overall, the system provides transparency, improves management efficiency, and ensures that attendance is recorded only under valid and authorized conditions.

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