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A Facial Recognition System for Student Attendance Management

Nicholas Simeon Dienagha[1]; Okoria Ebiabowei David[1]; Biralatei Fawei[1*]

[1]Department of Computer Science, Niger Delta University, Wilberforce Island, PMB581, Bayelsa State, Nigeria

Corresponding Author: Biralatei Fawei[*]

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Abstract: Managing attendance represents a significant and essential operational task within academic institutions. The conventional paper-based attendance taking system consumes substantial amount of time and it is prone to human errors and falsification. Most importantly, a high growth in class size may reduce the quality of class attendance data and making it more difficult to ensure compliance and track students participation. The Facial Recognition Attendance System is a web-based platform designed to record classroom attendance automatically while preventing impersonation. The system integrates biometric face enrollment, real-time facial matching, threshold-based attendance decision logic, and comprehensive event logging for recognizing student attendance in a class. By combining facial biometrics with real-time capture and automated analysis, the system improves the trustworthiness of attendance data, reduces opportunities for fraud, and establishes a digital audit trail suitable for compliance and academic reporting. It supports two main user roles: administrators (who manage students, lecturers, courses, classrooms, semesters, reports, and settings) and lecturers (who start and stop attendance sessions, perform live facial recognition, capture attendance evidence, review records, and export session data).

Keywords*: Facial Recognition, Attendance, Manual Attendance, Biometric.*

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I. INTRODUCTION

Attendance refers to the act of being present and taking part in a class, meeting, or gathering. The mode of attendance is dependent on the classroom settings. In most institutions students are required to maintain at least a certain percentage of class attendance with respect to course policy. More importantly it is a general perception that regular attendance in a class significantly contributes academic performance. Class attendance taken either physical or virtual is an efficient way to evaluate students regularity and provides their academic success, engagement and persistence. Consistent participation enable students interaction with course lecturers as well as deepenning understanding of basic topics and stronger performance in achieving higher grades. Attendance taken plays a vital role in maintaining discipline among students within an higher institution setting and in upholding quality educational standards. When a sudent fall short of the required standard, the requisite appropriate measure can be taken to address the situation to enable them retrace their steps back. Moreover, student's academic performance is often dependend on how regular they attend classes. A research result from (Landin and Perez, 2015; Lukkarinen et al. 2016) shows that there is a positive correlation between class attendance and better academic achievement. In most institution, attendance taken is done manually, where attendees write their names, rgistration number and sign their signatures in a piece of paper or attendance diary. Whereas in some other situations attendance is taken by calling names one after the other while the officer in charge ticks the name of those present. These approaches require considerable processing time and they are not efficient. Also, it is challenging to handle handwritten records to find out attendance statistics of students such as sorting attendance and calculating attendance percentage and rate, and stored for later references if necessary. More recently, digital techniques have been adopted in most organization for attendance taken. Methods like Radio Frequency Identification (RFID) cards, biometric finger print, face and palm gesture recognition systems and so on. When most of these technologies are implemented together with GSM mobile communication devices, student parents and guidance are informed through messages of their wards absence in class. These systems update attendance in web server for administrators to access in real time. More so, these tools reduces the amount of time a teacher spend to take class attendance manually. These systems operate more efficiently thereby providing access to student class information in real

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time through a user friendly interface. The application of most of these techniques leads to reasonable extended waiting time due to queue movements. Also, most students beats these tools by leaving the class after successfully signing in. This indicates that a stydent is present in a particular class while he or she absent in reality. Especially, in RFID tools, a student may ask his her colleague to sign-in with their RFID cards for them, which also indicates the students' presence in class but in reality the student is absent. This research seeks to address these issues by implementing a web based facial recognition system for classroom attendance taking while preventing imperaonation and fruadulent acts. The system incorporates biometric facial registration, live identitity verification, criteria for marking attendance and thorough logging of all system activities and events.

II. LITERATURE REVIEW

Recording and monitoring attendance is a challenging task for many organizations and establishments. Establishing a reliable technique for attendance tracking is an important activity in educational institutions. Often student academic performance has always been associated to class attendance in some discuss. Several studies have sown this correlation in their reports (Purcell, 2007; Chen and Lin, 2008; Landin and Perez, 2015; Lukkarinen et al. 2016) which depict that class attendance is one variable that has significant impact on student academic outcome. To facilitate attendance taking several researchers have experiment and implemented different tools and techniques to facilitate class attendance taken such as face and finger print recognition (Mekala et al., 2019; Raghuwanshi & Swami, 2017; Bah & Ming, 2020; Rahman et al., 2018; Rahman et al., 2023), Radio Frequency Identification system (Rjeib et al. 2018; Joshi et al., 2021), Quick Reponse (QR) code (Nuhi et al., 2020; Liew & Tan, 2021) and barcode technique (Al Sheikh et al., 2019; Siew et al. 2023; Elaskari et al., 2021).

An integration of Radio Frequency Identification technology with web-based application was implemented in (Rjeib et al. 2018). Student class attendance information was recorded using RFID cards and stored in a database for online application access. The study demonstrated the tools ability to curb manual errors and saves time. Joshi et al,. (2021) implemented an automated attendance taking system using RFID technology. The idea of the research is to replace the traditional method of attendance taking. Patel and Priya (2014) presents a hybrid approach combining RFID technology with face recognition system for attendance tracking.

The research also investigated the advantages, working theory and the complication nature of the technologies for managing attendance tracking in an higher institution. However, the combination of RFID and face recognition will incur more processing cost. A systematic review of Internet of Things enabled smart devices that are combined with RFID technology for attendance taking was investigated in (Ishaq & Bibi, 2023). The report expatiated the strength of the integration with respect to automation enhancement, and remote accessibility in attendance management. The problem associated to this combination is need for improved security. RFID based attendance system was implemented in (Salunkhe et al., 2025). The study highlights the efficiency and effectiveness of using RFID techniques for attendance tracking. The challenge with this approach is cost, security and scalability.

An automated attendance system that applies Quick Response (QR) Code implemented in (Nuhi et al., 2020) for recording and managing student attendance. Here, each student is given a unique QR code that can be automatically scanned with a camera or mobile phone. The scanned information is directly transmitted to the centralised database. The research underscore enhanced record management and ease of implementation. Liew and Tan (2021) presents an efficient QR code-based attendance tracking system for recording students class attendance. Their approach automatically generates QR codes for students at the point of registration and same codes are transmitted to the central database for future reference. It provides an efficient and easy to use method for recording students daily attendance with respect to academic achievement.

Elaskari et al (2021) implemented a barcode technique uniquely assign barcodes to both students and equipments which be quickly and easily scanned barcode reader or mobile device. Their implementation show that barcode-based systems are inexpensive but are practically efficient for attendance recording. An integrated approach that combines face recognition system with QR code was proposed in (Siew et al., 2023). The technique eliminate the issues of proxy attendance recording thereby reducing amount of time spent in manual attendance recording system. Al Sheikh et al., (2019) presents a barcode-based attendance taking system where students are given identification card that contains scannable barcode which can be used to register attendance during class session. The approach minimized common errors in attendance systems. However, these approaches heavily rely on the token such as the identification cards for recording attendance, which may damaged or can interrupt the attendance process in case of forgetfulness.

III. METHODOLOGY

This approach of face recognition system differs from the traditional and other approaches where live-scanning system is carried out. Instead of the continuous streaming process, here, faces are captured periodically at fixed intervals, The captured faces are analysed and used to update the attendance database with respect to recognition results and configuration thresholds. The approach is implemented on a three-tier web application that allows for automated attendance recording based on facial recognition. Attendance is conducted based on real time data using web browser and an attached webcam. In this case the lecturer logs in and starts a session. The browser then capture images in a stipulated interval from video frames, identify the faces, generate embeddings and use them to compare already enrolled student face templates. Any recognised result is sent to the server, which ultimately detect the logs and records the student attendance status. The user interface communicate

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with a centralized php application and MySQL/ MariaDB database. This architectural design employed the standard LAMP/XAMPP stack running on commodity hardawre (webcam and desktop). See the architectural design of the system in figure 1.

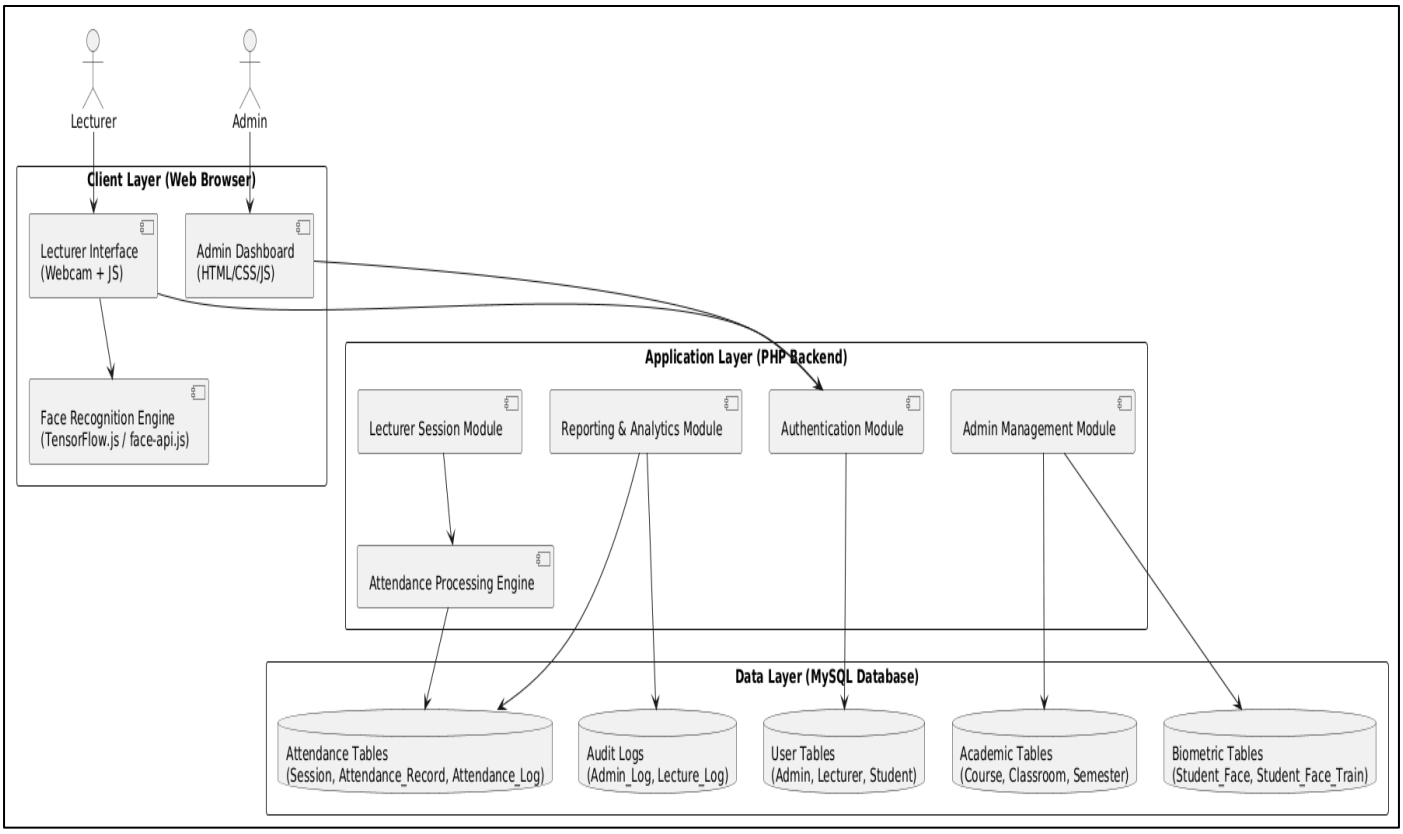

Fig 1 Architectural Design

For client-side detection and recognition, we applied the cosine similarity and Euclidean distance measuring metrics to compute the similarity between captured faces to stored faces (see equation 1 and 2). Here, cosine similarity is used to measure the resemblance of the snopshots to that of the stored image, This evaluates how similar or alike of the captured faces and stored faces when compared, whereas Eucidean distance was used to measure the distances between captured points. Using Euclidean distance measure entails that smaller distances between points means a greater degree of accuracy.

$$cos\ \theta = \frac{\vec{a}.\vec{b}}{\left\|\vec{a}\right\| \left\|\vec{b}\right\|} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq\ 1.$$

$$d(x,y) = \sqrt{\sum_{k=1}^{n} |(x_k - y_k)^2|} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots eq\ 2$$

The application applies a one hundred and twenty-eight vector embedding of the human face with respect to their facial features (see figure 2.3 for live capture). A treshold of 6.0 matching is used in this computation. As more snapshots are captured during the lecture, each of these images from the snapshots collected at different intervals are also continuously computed and recomputed to show the transition level of moving from “not attended” to “attended” of a given student. This transition level is computed at 70% continuous and consitent capture of students during a class session to move to class attended stage. However, the transition level can be modified by the lecturer via dashboard.

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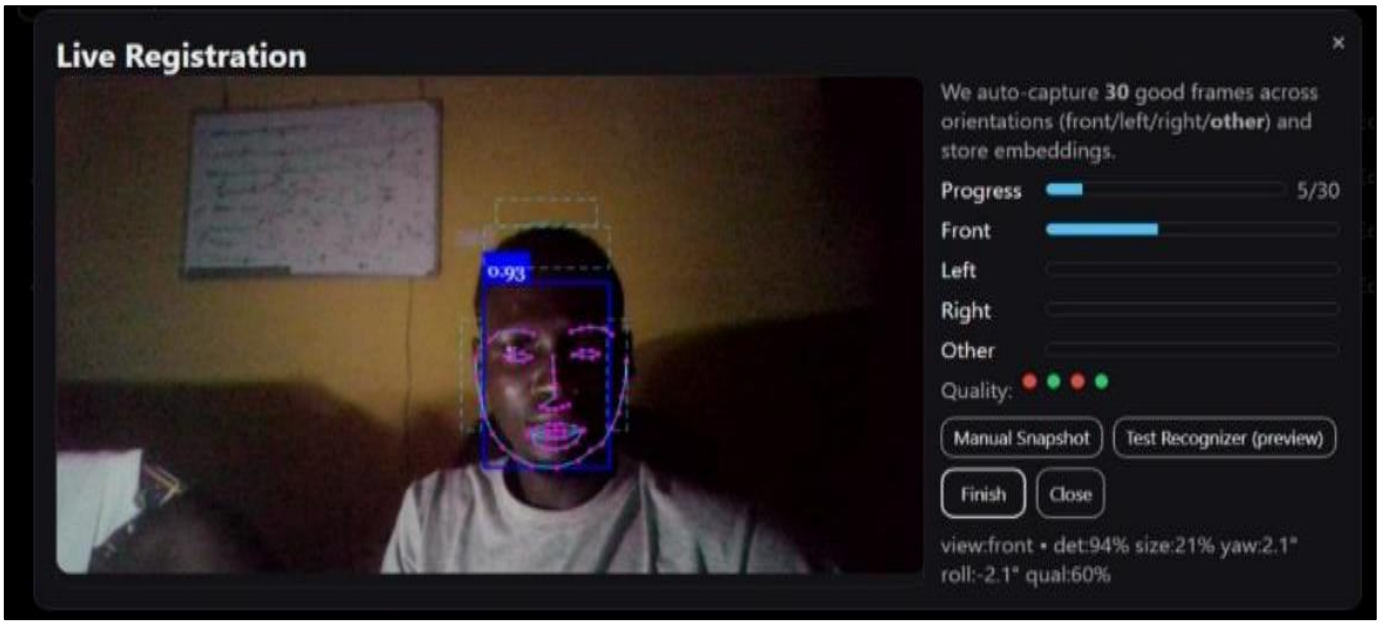

Fig 2 Live Capture Screen Showing Webcam Feed with Face Boxes and a Running Shot Counter.

For each request received by the server about faces captured, is treated as a frame submission. The data sent to the server from the client contains the session identifer, the captured face image and the recognised student identificaion number. The server saves the image into the attendance_capture and records one row per recognized student into the attendance_record. More inportantly, while the session is going on statistical information about the session is displayed live in the dashboard that is update in real time. This information includes number of snapshots taken, how many students have been recognised, and how often each student has been captured (see Fig 3.3 for analytics dashboard output, Fig 3.4 for dashboard information and Fig 3.5 for analytics and report with charts and graphs). Finally, the system aggregates attendance information across sessions and generates a comprehensive analytics, general attendance rate per student history and per course summary.

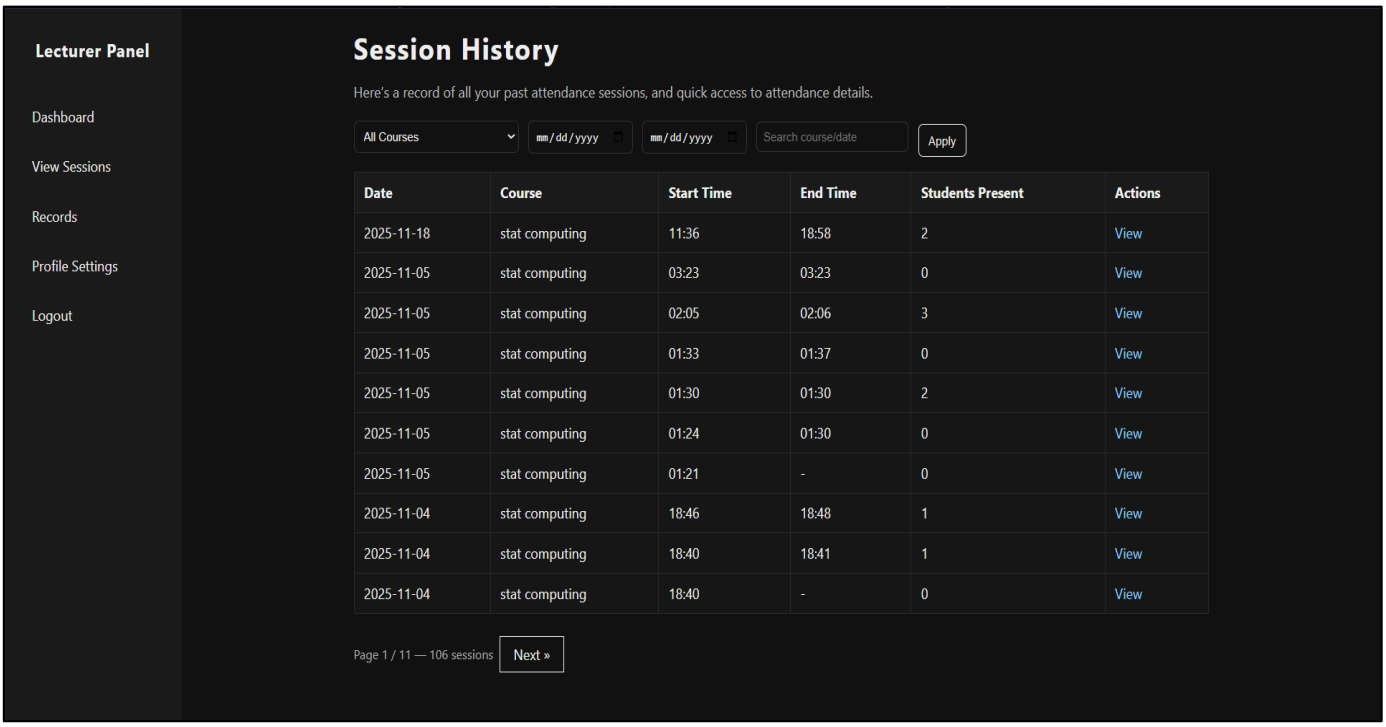

Fig 3 Analytics Dashboard Output

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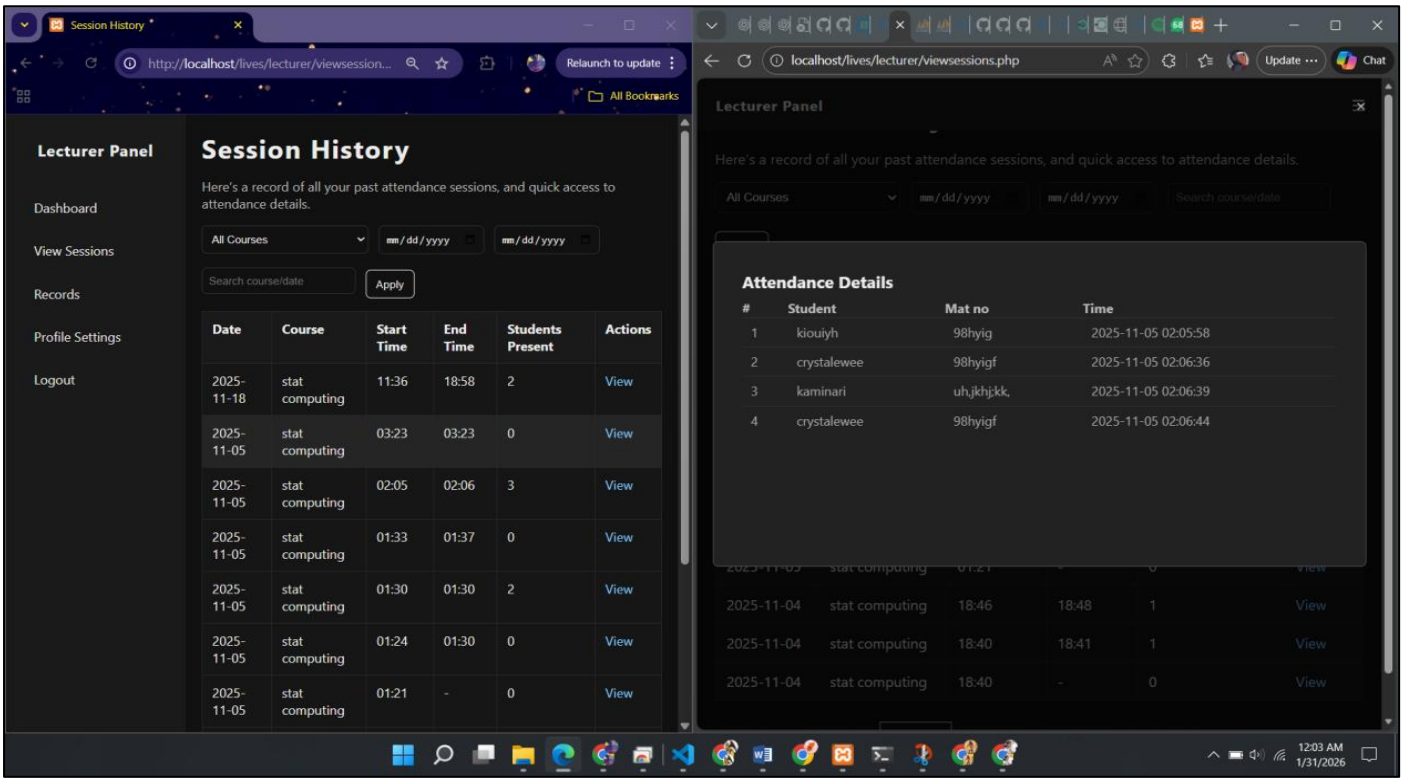

Fig 4 Dashboard Information

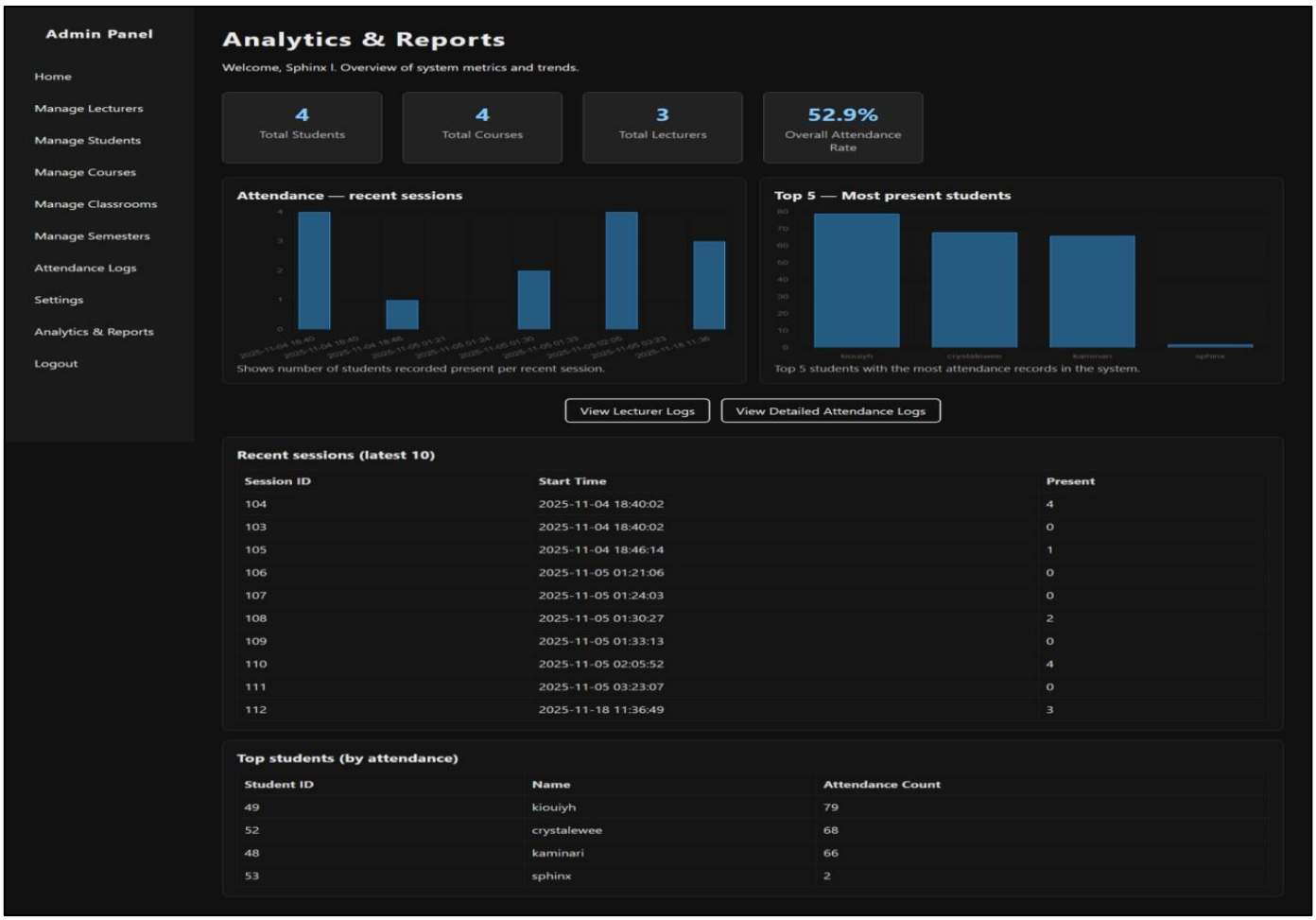

Fig 5 Analytics and Report with Charts and Graphs

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IV. EVALUATION

The system was evaluated using different evaluation criteria. The functionallity of the system was evaluated with respect to create, update, and delete (CRUD) operation with uniqueness constraints in varying sessions and scenarios. Attendance logic was evaluated based on different capture counts and threshold settings. Reporting features were also validated based on session list, filters and CSV exports. For security checks different security measures were applied to evaluate the system. To thwart SQL injection, all state changing request were protected with CSRF tokens as well direct URL access which was tested to ensure role checks. Thus, lecturer page cannot be accessed by admin and vice versa, password hashing and update flows were tested for correctness. In addition, consistency check was carried by comparing counts that is, if the sum of attendance_record entries matched the final attendance_log. Finally, camera initialization was tested as per low-light and high-occupancy scenarios to evaluate recognition tolerance. The latency of the capture-persist cycle was measured to ensure it remains within acceptable bounds for real-time use. However, the accuracy of the system depends on some external factors, that is recognition quality can degrade under poor lighting or suboptimal camera angles. Running face models in browsers can be demanding on low-space devices. Also, because the project began with a static SQL dump, there may be risk of schema drift if code and database versions get out of synchronization. Moreso, the deployed database must match the application expectations. For example, the code expects a student_face_train table and a view enumeration value that may be missing. A proper migration is required to align the SQL schema with the code. Also, all mutation endpoints needs to enforce CSRF tokens consistently. The attendance_capture table stores image blobs which can grow large overtime. An archival policy or moving image to object storage should be implemented to control database size as recommended in this research.

V. CONCLUSION

The facial recognition attendance system implemented in this research provides a practical deployable platform for automating lecture class attendance. It addressess critical integrity gaps in manual attendance taking by combining biometric verification, session-based capture and statistical decisioning. The system maintains an audit trial (with logs and snapshots) to ensure accountability. Its modular 3-tier architecture makes it maintainable and scalable. Overall, the implementation offers a solid baseline for institional adoption and future enhancements. In future we will develop formal migration scripts and version control for the database schema to prevent drift and integrate liveness detection (depth or motion-based checks) to strengthen security against presentation attacks as well as offload large image blobs to a separate storage service (or apply retention policies) to preserve database performance.

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