



Faculty of Computer Science and Information Technology

FACE RECOGNITION FOR SMART ATTENDANCE

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FACE RECOGNITION FOR SMART ATTENDANCE

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The project is submitted in partial fulfilment of the
requirements for the degree of Bachelor of Computer Science with Honours
(Information System)

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UNIVERSITI MALAYSIA SARAWAK

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DECLARATION

I hereby declare that the report is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at University Malaysia Sarawak.



.....

(JANANI A/P MUNUSAMY)

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ABSTRACT

Attendance tracking is an essential function in educational environments, yet traditional and semi-automated methods like manual registers, QR code scanning, and fingerprint recognition often suffer from inefficiencies and vulnerabilities such as proxy attendance. This project introduces a smart attendance system that integrates facial recognition with QR code scanning and GPS-based location verification to provide a secure, contactless, and accurate attendance process. Developed as a mobile-accessible web application using modern technologies including TensorFlow.js, Vue.js, and Node.js, the system enables role-based access for admins, lecturers, and students. Admins manage users and facial data, lecturers create attendance sessions with QR codes, and students authenticate attendance by scanning QR codes, verifying their location, and performing real-time facial recognition. The system was tested with real users and shown to significantly reduce attendance fraud while improving efficiency and user experience. Limitations include the need for HTTPS and stable internet connectivity. Future enhancements will focus on developing a native mobile app and improving facial recognition in low-light conditions.

Keywords: Face recognition, Smart attendance, GPS verification, QR code attendance, web-based system, Real-Time Verification.

ABSTRAK

Penjejakan kehadiran merupakan fungsi penting dalam persekitaran pendidikan, namun kaedah tradisional dan separa automatik seperti daftar manual, imbasan kod QR, dan pengecaman cap jari sering mengalami ketidakcekan dan kelemahan seperti kehadiran proksi. Projek ini memperkenalkan sebuah sistem kehadiran pintar yang menggabungkan pengecaman wajah dengan imbasan kod QR dan pengesahan lokasi berasaskan GPS untuk menyediakan proses kehadiran yang selamat, tanpa sentuhan, dan tepat. Sistem ini dibangunkan sebagai aplikasi web yang boleh diakses melalui peranti mudah alih menggunakan teknologi moden seperti TensorFlow.js, Vue.js, dan Node.js. Ia menyokong akses berasaskan peranan bagi pentadbir, pensyarah, dan pelajar. Pentadbir mengurus pengguna dan data wajah, pensyarah mencipta sesi kehadiran dengan kod QR, dan pelajar mengesahkan kehadiran dengan mengimbas kod QR, mengesahkan lokasi mereka, serta menjalankan pengecaman wajah secara masa nyata. Sistem ini telah diuji bersama pengguna sebenar dan terbukti dapat mengurangkan penipuan kehadiran dengan ketara sambil meningkatkan kecekapan dan pengalaman pengguna. Antara kekangan yang dikenalpasti termasuk keperluan untuk sambungan internet yang stabil dan akses melalui HTTPS. Penambahbaikan masa hadapan akan memberi tumpuan kepada pembangunan aplikasi mudah alih asli serta meningkatkan ketepatan pengecaman wajah dalam keadaan pencahayaan rendah.

Kata Kunci: *Pengecaman Wajah, Kehadiran Pintar, Pengesahan GPS, Kehadiran Kod QR, Sistem Berasaskan Web.*

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LIST OF ABBREVIATIONS

API	Application Programming Interface
CSS	Cascading Style Sheets
DFD	Data Flow Diagram
ERD	Entity Relationship Diagram
GPS	Global Positioning System
HTML	HyperText Markup Language
HTTP	Hypertext Transfer Protocol Secure
JS	JavaScript
QR	Quick Response
UNIMAS	University Malaysia Sarawak

CHAPTER 1: INTRODUCTION

1.1 Introduction

This chapter discusses the project background and provides a more detailed explanation of the problem statement that led to the idea of this project. It will be followed by the objectives, scope, limitations of work and expected outcome.

1.2 Project Background

Attendance monitoring plays a vital role in ensuring academic integrity and student accountability in educational institutions. Conventional methods, such as paper-based registers and manual sign-in, are often inefficient, prone to errors, and vulnerable to manipulation, particularly in the form of proxy attendance. While QR code and fingerprint-based systems have improved the speed of attendance-taking, they still present loopholes that allow dishonest practices to persist (Majeed et al., 2022). To overcome these limitations, facial recognition technology has been identified as a viable biometric solution for accurately identifying individuals based on unique facial features.

This project introduces a smart attendance system called FaceAtten, which aims to automate the attendance process by integrating three layers of verification QR code scanning, GPS based location verification, and facial recognition. The system is designed with role-based access where admins register students and lecturers, assign students to classes, and upload their facial data. Lectures generate attendance sessions and monitor attendance lists and students log in, scan a session-specific QR code, verify their location, and complete facial authentication. This multi-step process significantly reduces the possibility of proxy attendance and ensures that attendance is marked only when the student is physically present and properly identified.

Unlike some complex systems that rely on custom trained algorithms, FaceAtten utilizes TensorFlow and existing facial recognition models to provide reliable performance without the need for algorithm training. This approach allows for balance between accuracy, speed and system simplicity. The application also records metadata such as time, location, and session identifiers to further improve the reliability and auditability of the attendance data. Overall, this system is designed to be user-friendly, secure, and easily deployable within academic settings, addressing the shortcomings of traditional and single factor attendance solutions (Sundar et al., 2024; Muhathir et al., 2023).

1.3 Problem Statement

Various challenges emerged among lecturers and students when using traditional methods to take attendance. Traditional attendance-taking methods rely on physical record-keeping methods, such as pen-and-paper registers where students or teachers need to manually hand-write students' attendance records one by one. This method consumes a lot of time and record-keeping this attendance can be tedious. It is also more prone to loss of data or misplacement of these records.

Hence, smart attendance systems were created to solve this problem. Along with technological advancement, the method of taking attendance records has evolved through the years. Biometric systems using fingerprints are the most common way of taking attendance that is used by companies to ensure that employees are truly present by scanning their fingerprints or handprints. Nowadays people are more likely to use the latest technology for their workplace. That is why you should take advantage of technology in your workplace. The newest way of taking attendance involves scanning a QR code and taking photos of your employees when they check in or out of work. This is like the future

of tracking employee attendance. Companies can use an installed tablet or PC with attendance software or ask employees to install attendance software on their mobile phones.

However, using fingerprints and QR codes to take attendance has proven to be less reliable because recent studies have shown that it is a problem to detect fingerprints in certain circumstances where detection gets harder and data collected are inaccurate. Moreover, smart attendance systems such as QR code smart attendance systems are prone to proxy attendance and cheating. So, face recognition-based smart attendance systems are the most reliable and accurate approach for a smart attendance system but some smart attendance systems also face challenges where high-resolutions cameras and high-specification hardware are needed for them for them to function optimally.

So, the goal of this project is to create a new intelligent attendance system based on a facial recognition system to address the previously mentioned issue. The new system will be specially made to make sure that attendance can be tracked more effectively and accurately. Another goal of this system is to assist lecturers in tracking and recording student attendance in their classes.

1.4 Objectives

The objectives of this project are as follows:

1. To develop a smart attendance system in the form of a mobile-accessible web application, integrated with facial recognition technology to enable accurate and contactless student attendance tracking.
2. To evaluate the system's effectiveness in detecting and reducing attendance fraud by analyzing user interaction data and attendance records, and comparing its performance to that of traditional attendance methods.

1.5 Brief Methodology

The methodology employed in this project follows a structured approach to ensure the effective development of the face recognition-based smart attendance system. The project utilizes the Waterfall model, which is characterized by a sequential design process. This model begins with the requirements gathering phase, where the specific needs of the system are identified and documented. Following this, the design phase outlines the system architecture and user interface. The implementation phase involves coding and integrating the facial recognition algorithms, followed by rigorous testing to ensure functionality and accuracy. Finally, the maintenance phase addresses any issues that arise post-deployment, ensuring the system remains effective and up-to-date.

1.6 Scopes

The scope of this smart attendance system is defined by its functionalities and the interactions between the system user's, students and lecturers. It outlines the specific features available to each user type and the operational parameters under which the system will function.

1.6.1 Students

- **Facial Recognition for Attendance:** Students will utilize the app to scan their faces for quick and accurate attendance marking.
- **Attendance Records:** Students can monitor their daily attendance and review historical attendance records.
- **Profile Management:** Student will be able to check and update their full name and set a new password.

The app is designed to offer students a straightforward, efficient, and precise method for making attendance through facial recognition. The user interface will be intuitive to facilitate ease of use, it is important to note the following constraints:

- Users must have stable internet connectivity for the proper functioning of the app's features.

1.6.2 Lecturers

- **Profile Management:** Lecturers will be able to check and update their full name and set a new password.
- **Attendance Monitoring:** They will have access to real-time attendance lists of students for effective class management.
- **Attendance Platform Creation:** Lecturers can create attendance sessions for their classes, allowing students to mark their presence seamlessly.

Lecturers will be empowered to manage attendance effortlessly through this system, enhancing classroom management and reducing administrative burdens. Constraints include:

- Specific hardware specifications may be required for optimal functionality, which could limit the deployment of the system in certain environments.

This scope clearly delineates the system's intended functionalities for both students and lecturers while also pointing out the limitations that could affect user experience and accessibility.

1.7 Significance of the Project

The significance of this project lies in its potential to revolutionize attendance management in educational institutions. By leveraging advanced facial recognition technology, the proposed system aims to enhance the accuracy and efficiency of attendance tracking, reducing the time and effort associated with traditional methods. This innovation not only streamlines administrative tasks but also minimizes human error, providing a reliable solution for educators and students alike. Furthermore, the implementation of such a system can lead to improved data management and reporting capabilities, ultimately contributing to a more effective educational environment.

1.8 Project Schedule (GANTT CHART)

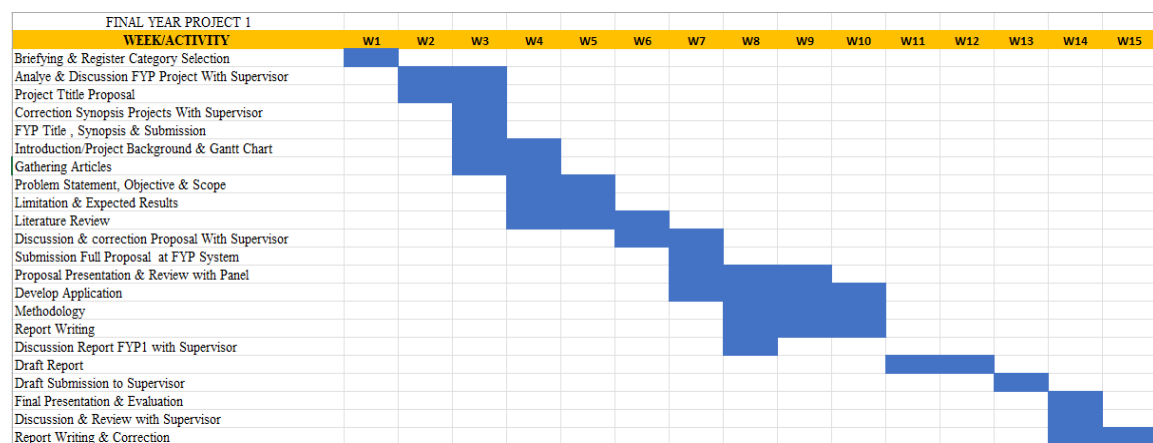


Figure 1.1 Gantt chart (Final Year Project 1)

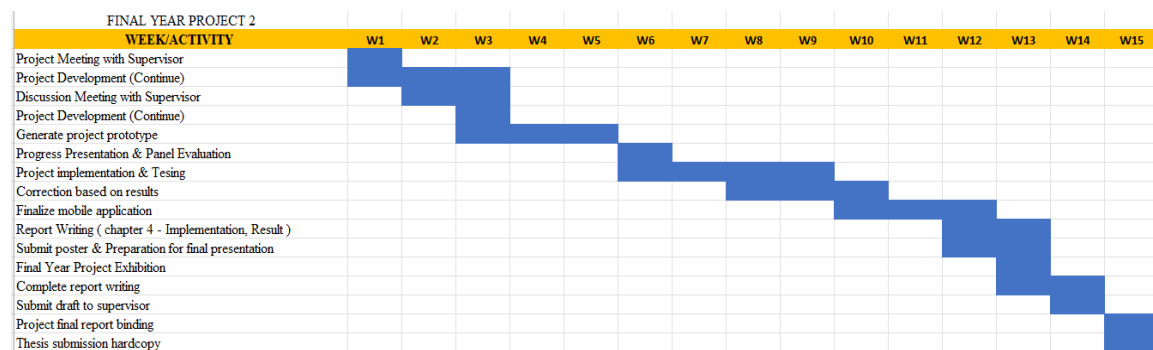


Figure 1.2 Gantt chart (Final Year Project 2)

1.9 Expected Outcome

In the end, this system was proposed to facilitate lecturers and students in taking attendance so the classes can be conducted smoothly without worrying about proxy attendance and attendance data loss. This project will also provide face recognition for a smart attendance system that can be easily accessed by all students and lecturers.

1.10 Limitation of work

Despite the successful implementation of the Face Recognition for Smart Attendance (FaceAtten), several limitations remain in the current version of the project.

Firstly, while the system is designed as a responsive web application and is accessible on any device with a modern web browser, it is not yet available as a dedicated standalone mobile or desktop application. As a result, users are still required to access the system through a browser, which may limit offline accessibility and integration with native device features.

Secondly, due to the use of facial recognition powered by TensorFlow.js, the application requires a secure HTTPS environment to access device camera functions. Modern browsers restrict camera access on unsecured (HTTP) connections, making HTTPS a mandatory requirement for full functionality.

Currently, the application uses local IP access with self-signed SSL certificates to simulate a secure connection during testing and development. While this solution avoids the need for third-party tunnelling tools like Ngrok, it still involves technical setup steps that may be challenging for non-technical users or institutions without access to secure hosting infrastructure.

These limitations indicate that while the system effectively meets its core objectives secure and accurate attendance tracking future improvements should focus on simplifying deployment, improving platform accessibility, and possibly developing native applications for better user experience and broader adoption.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter has provided a summary of the research conducted in developing a Smart Attendance System. It included a literature review of various articles and existing systems. This literature review aims to discover the different methods used to create a smart attendance system and to identify the best approach to create a smart attendance system that can be accessed and used by everyone.

2.2 Review on Similar Existing Systems

2.2.1 QR Code-Based Smart Attendance System (UNIMAS Student Attendance System)

The QR (Quick Response) code-based smart attendance system offers a simple and cost-effective solution for automating attendance tracking. This system uses quick response (QR) codes as unique identifiers for individuals, enabling seamless attendance registration through scanning devices such as smartphones or specialized scanners. As illustrated in Figure 1 (Wei, X., 2017), the process involves four key steps: discovering the QR code, scanning the code with a mobile device, accessing and verifying the information, and storing attendance data securely in a cloud-based database. This streamlined workflow enhances the system's usability and ensures efficient data management.

Evaluating this system based on the key measures of accuracy, recognition or matching time provides insight into its strengths and limitations. In terms of accuracy, the QR code-based system ensures reliable identification by associating each code with a unique user. However, the system's performance may be affected by physical damage to the QR codes, such as scratches, fading, or improper printing, which can lead to failed or inaccurate scans (Torgensen, 2023). Environmental conditions like poor lighting or dirty scanner lenses may also influence

accuracy. To enhance reliability, it is essential to use high-quality printed codes and regularly maintain the scanning devices. Despite these challenges, the system's straightforward design makes it highly adaptable and capable of achieving consistent results with proper handling (Hegde, 2020).

Recognition or matching time is another critical factor in the system's effectiveness. QR code-based systems typically achieve rapid scanning and identification, with the process often completed within seconds. This efficiency makes them suitable for scenarios with moderate attendance volumes. However, manual alignment of the QR code with the scanner can occasionally cause delays, especially in high-traffic environments or when users are unfamiliar with the process. Optimizing the scanning setup, such as using wide-angle or high-speed scanners, can help mitigate these delays and improve throughput (Mohammed & Zidan, 2023).

At Universiti Malaysia Sarawak (UNIMAS), a public university in Malaysia, the QR code-based smart attendance system has been implemented to track student attendance in a more efficient manner. The system allows students to easily scan their QR codes to register attendance for lectures and events. By streamlining the attendance process, UNIMAS has reduced administrative workload and ensured accurate attendance records. The cost-effectiveness and simplicity of the QR code system make it an excellent choice for large institutions like UNIMAS, where managing student attendance efficiently is essential.

In conclusion, the QR code-based smart attendance system provides a practical and efficient solution for attendance tracking, especially in settings with limited resources, such as UNIMAS. The integration of the four-step process outlined in Figure 2.1 enhances its efficiency and reliability. While issues like code damage and manual alignment may impact its performance, these challenges are manageable through regular maintenance and system

optimization. By balancing affordability, accuracy, and efficiency, this system continues to be a popular choice for organizations seeking straightforward attendance solutions.

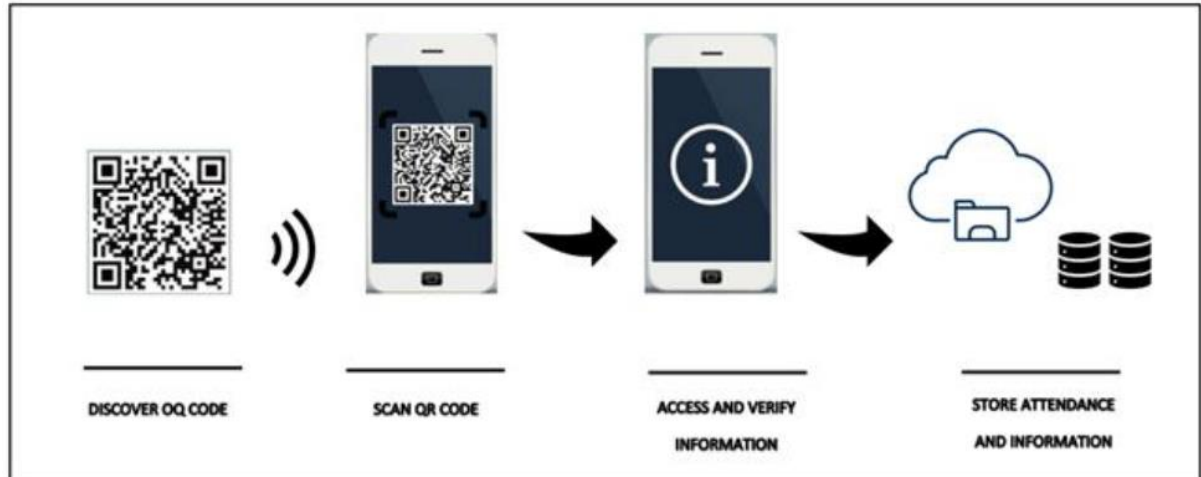


Figure 2.1 Working procedure of QR based Smart Attendance System

2.2.2 Fingerprint-Based Smart Attendance System (Hospital Staff Attendance)

Fingerprint-based smart attendance systems have emerged as a widely used biometric solution for reliable and efficient attendance tracking. This system relies on the uniqueness of human fingerprints to accurately identify individuals, offering a secure and automated alternative to traditional methods. As can be seen in Figure 2, a basic fingerprint-based smart attendance system consists of two main steps: enrollment and authentication. During enrollment, the user's fingerprint is scanned, and its distinctive features are extracted. The user's identity and fingerprint data are then stored in a database as a template for future authentication (C.O., A, 2013). During the authentication phase, the fingerprint is scanned again, and its features are matched against the stored template to verify the individual's identity.

By focusing on the critical performance measures of accuracy and recognition or matching time, the effectiveness of this system can be comprehensively evaluated. In terms of accuracy, fingerprint systems exhibit high precision by ensuring that only authorized individuals are identified and recorded. The system effectively minimizes errors such as False Match Rates (FMR), where an unauthorized individual is incorrectly recognized, and False Non-Match Rates (FNMR), where a legitimate user fails to be identified (Council et al., 2025). However, certain external factors, such as dirt, moisture, or physical damage to the skin, can hinder the sensor's ability to capture clear impressions, potentially impacting accuracy (Bécue & Christophe Champod, 2022). Maintenance of the system and user training can mitigate these issues to maintain reliable performance.

Recognition or matching time is another crucial aspect of the system's effectiveness. Fingerprint scanners typically process and match fingerprints within seconds, making them suitable for environments requiring rapid attendance marking (Akinduyite C.O et al., 2013). While the system performs efficiently under normal conditions, situations where fingerprints

are unclear or the sensor hardware is outdated may lead to repeated attempts, slightly increasing the overall time required for successful recognition (Yu et al., 2023). Despite these occasional delays, the system remains efficient, particularly when compared to manual or semi-automated methods.

In fact, the Penang General Hospital, a government hospital in Malaysia, has implemented a fingerprint-based attendance system for its staff (Hoo & Ibrahim, 2019). This system has streamlined the attendance process, enhanced operational efficiency, and reduced administrative burdens. By leveraging the reliability of fingerprint technology, the hospital ensures accurate staff attendance tracking, promoting a more secure and automated work environment. Such systems are especially beneficial in healthcare settings, where time efficiency and security are critical.

In conclusion, fingerprint-based smart attendance systems provide a robust balance between accuracy and recognition time, making them a reliable choice for various applications, including in healthcare institutions like Penang General Hospital. The integration of enrollment and authentication, as highlighted in Figure 2.2, forms the foundation of this system's effectiveness. While external factors and occasional processing delays may present minor challenges, the system's overall reliability and efficiency make it an effective solution for modern attendance tracking. With proper maintenance and user awareness, this biometric system can sustain its performance in diverse environments.

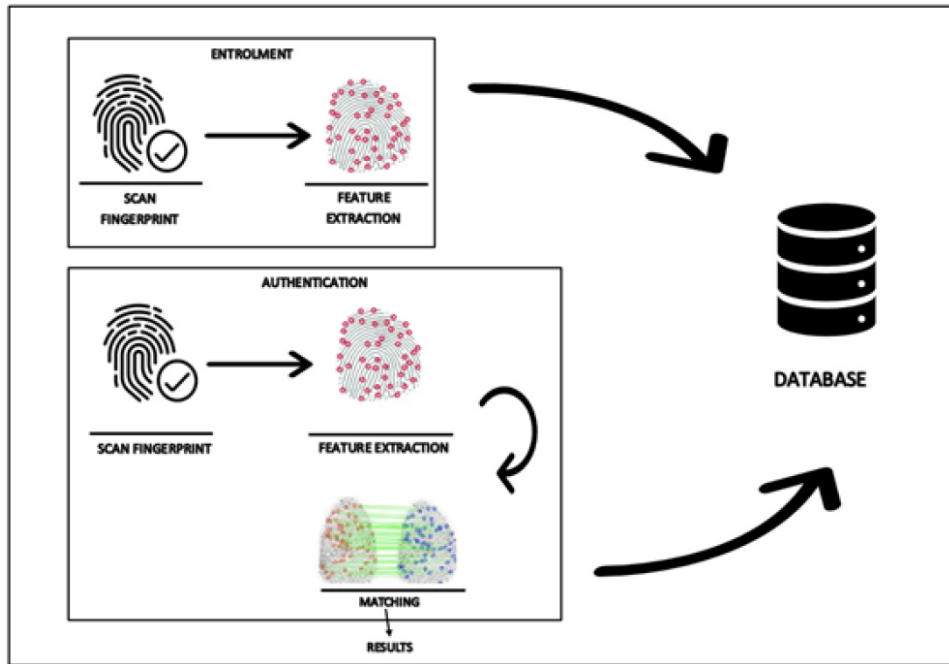


Figure 2.2 Working procedure of Fingerprint based Smart Attendance System

2.2.3 RFID -Based Smart Attendance System (KMS Autocount Sdn Bhd Staff Attendance)

RFID (Radio-Frequency Identification) based smart attendance systems have gained traction as an efficient and automated solution for attendance management in educational institutions and organizations. By utilizing RFID technology, which employs electromagnetic fields for communication between a reader and RFID tags, these systems provide a streamlined approach to logging attendance without the need for physical interaction. The core of an RFID attendance system is comprised of RFID tags assigned to individuals, RFID readers that capture the tag's signal, and a centralized database for storing attendance records.

The operational process of an RFID-based attendance system typically involves two main stages: tagging and tracking. During the tagging phase, each individual is issued an RFID tag, which may be embedded in an ID card or worn as a wristband. As students or employees enter the designated area, they approach an RFID reader that emits a radio frequency signal. This signal activates the RFID tag, prompting it to transmit its unique identification number back to the reader. The RFID reader records the information in real time and updates the central database with the individual's attendance status.

When evaluating the effectiveness of RFID-based attendance systems, two critical performance metrics come into focus: speed and accuracy (Nimith et al.,2024). Speed is particularly crucial in settings with large volumes of individuals, as RFID systems can record attendance within milliseconds. This rapid logging capability significantly reduces queuing times and improves overall efficiency during peak periods. In stark contrast to traditional manual roll-call methods, which can be time-consuming and prone to errors, RFID systems streamline the attendance process considerably.

Accuracy is another fundamental aspect of RFID attendance systems (Qureshi,2020). Due to the unique identification embedded in each tag, the system minimizes the likelihood of errors associated with misidentification or missed records. Studies have indicated low rates of False Acceptance Rates (FAR) and False Rejection Rates (FRR), making RFID systems highly reliable (El Beqqal et al., 2020). However, challenges such as tag loss or physical damage can affect system performance as missing tags can hinder accurate attendance tracking. Additionally, environmental factors, such as interference from electronic devices or obstructions, may impact the effectiveness of the RFID signal (De Azambuja et al., 2010).

From a practical perspective, organizations implementing RFID-based attendance systems can experience notable benefits. For example, educational institutions have adopted RFID technology to enhance their attendance recording efficiency, drastically reducing administrative burdens associated with manual attendance tracking. Such systems not only minimize the potential for human error but also provide valuable analytical data regarding attendance patterns, which can be advantageous for behavioral assessments and resource allocation.

In conclusion, RFID-based smart attendance systems offer a comprehensive solution that balances speed, accuracy, and user-friendliness, making them an attractive choice for applications in various sectors, including education and corporate environments (Kheiravar, 2008). While challenges such as tag management and environmental interference exist, the overall capabilities of RFID systems, when properly implemented and maintained, provide a robust framework for efficient attendance tracking. As organizations continue to seek modern solutions to optimize operational efficiencies, RFID technology stands out as a viable and future-forward option.

2.2.4 Face Recognition-Based Smart Attendance System (SOCSO, Penang)

Facial recognition-based attendance systems have increasingly been adopted across Malaysia's public sector for their ability to provide secure, contactless, and automated solutions. One notable implementation is by the Social Security Organization (SOCSO or PERKESO) in Penang, where a facial recognition system was deployed to enhance attendance tracking and reduce manual administrative workload. This system leverages Convolutional Neural Networks (CNN) to detect and authenticate employees' faces during check-in and check-out procedures.

According to Nabi et al. (2023), the system was designed not only for attendance purposes but also to support broader human resource and security operations within PERKESO. The face recognition process begins with facial image acquisition through a standard camera, followed by real-time feature extraction using CNN algorithms. Once a match is verified against the stored employee dataset, the attendance is logged automatically into the organization's internal record-keeping system. The system achieved high accuracy in real-world tests and effectively eliminated incidents of "buddy punching," where employees mark attendance on behalf of absent colleagues.

Compared to traditional QR code, fingerprint, or RFID-based systems, PERKESO's face recognition solution offers several advantages. It is fully contactless, reducing hygiene concerns, particularly in high-traffic office environments. Additionally, it automates attendance management, reducing the burden on administrative staff and enhancing the integrity of attendance data. However, as with many biometric systems, certain limitations were noted, such as variations in lighting conditions, camera angles, and facial occlusions like face masks or glasses, which can affect recognition accuracy. Moreover, the handling of sensitive biometric

data requires strict compliance with Malaysia's Personal Data Protection Act to ensure the security and confidentiality of employee information.

In conclusion, the adoption of face recognition technology by PERKESO in Penang demonstrates the practical effectiveness of biometric attendance systems in Malaysian government settings. This implementation showcases how such systems can enhance transparency, accuracy, and operational efficiency in managing daily attendance within large organizations.

2.2.4 Comparison of Features between existing system

Table 2.1 Comparison between existing system and proposed system

	QR Code Based System (UNIMAS)	Fingerprint Based System (Penang General Hospital)	RFID -Based Smart Attendance System (KMS Autocount Sdn Bhd Staff Attendance)	Face Recognition-Based System (PERKESO PENANG)
Accuracy	High accuracy if QR codes are intact and well-printed.	Very high accuracy under normal conditions. - May be affected by dirty, wet, or damaged fingerprints.	High accuracy with unique identification, performance may decline due to tag loss or signal interference,	Very high accuracy with quality camera input and proper lighting. – May be affected by low lighting, facial occlusions (e.g., masks, glasses), or poor angles.
Recognition Time	Fast recognition (typically a few seconds per scan). - May experience delays due to	Rapid identification (a few seconds). - Repeated attempts needed for poor-quality fingerprints.	Extremely fast recognition, typically in milliseconds, ideal for environments with high user volume.	Fast recognition (1–2 seconds per scan). – Real-time processing with minimal

	manual alignment or damaged codes.			user interaction.
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2.2.5 Critical Review

The selection of a Face Recognition-Based Smart Attendance System as the proposed solution is well justified when evaluated in terms of accuracy and recognition time, especially compared to QR Code-Based, Fingerprint-Based, and RFID-Based systems. These two metrics are fundamental in determining an attendance system's overall efficiency, and the Face Recognition approach generally outperforms other methods across both dimensions.

In terms of accuracy, Face Recognition systems offer significant advantages. QR Code-Based Systems, while functional, are susceptible to physical damage like scratches or smudges, which can lead to scan failures. They also depend on proper alignment and camera focus, introducing room for human error. Fingerprint-Based Systems, although generally accurate, are affected by conditions such as dirt, skin dryness, or moisture, which may cause false rejections or require multiple scans. RFID-Based Systems perform well in many cases, but they lack biometric verification. A student or employee could potentially pass the tag to someone else, compromising authenticity. In contrast, Face Recognition systems rely on unique biometric traits and modern AI algorithms that enhance accuracy even under variable lighting or partial facial occlusion. Real-world implementations, such as at PERKESO Penang, have demonstrated high accuracy rates in practical environments, further validating its robustness.

Recognition time is another key aspect, especially in environments with high user volumes like universities and government agencies. QR and Fingerprint systems both require some level of user interaction aligning a code or pressing a sensor which can slow down the

process, particularly if multiple attempts are needed. RFID systems are fast and contactless but do not verify identity. Face Recognition systems, on the other hand, are fully contactless and operate in real-time. They can detect and verify individuals in 1–2 seconds without manual input, making them highly suitable for streamlining attendance in high-traffic settings.

In conclusion, Face Recognition-Based Smart Attendance Systems offer superior performance in both accuracy and recognition time when compared to QR Code, Fingerprint, and RFID-based systems. Their ability to verify identity biometrically, operate in a contactless manner, and process users quickly makes them a highly efficient and secure option for modern attendance management, as demonstrated in practical implementations such as at PERKESO.

2.3 Review on Tools and Technology

2.3.1 Software

The Face Recognition for Smart Attendance System (FaceAtten) was developed using Visual Studio Code, a versatile source code editor that supports modern web development technologies. Backend development was handled using Node.js and Express.js, while MySQL served as the database engine for managing user, class, and attendance records. The database was managed locally through phpMyAdmin, bundled with XAMPP, which provided a local server environment for development and testing.

The system is implemented as a web-based application that mimics the behavior of a native mobile app when accessed through a modern web browser. This approach allows the application to run on multiple platforms both desktop and mobile without requiring installation from official app stores.

To enable secure access to device cameras for facial recognition, the application must be hosted over an HTTPS connection, as modern browsers restrict camera access on unsecured HTTP connections. During development, this requirement was addressed using local IP access, allowing secure, browser-based testing without relying on external tunneling tools like Ngrok.

All development and testing tasks were performed on an Asus Vivobook laptop, which provided sufficient performance for running local servers, facial recognition processes, and responsive UI testing.

2.3.2 Hardware

System development was carried out on an Asus Vivobook equipped with modern hardware specifications, suitable for handling local server execution and machine learning-

based facial recognition components. The machine was used to manage the full development stack, from backend processing to browser-based testing.

Since the system is web-based, end users are not required to install any specific hardware or software. The only hardware requirements for users are access to a smartphone with a built-in camera. During testing, both desktop and mobile browsers were used to validate the application's cross-platform compatibility, and the device's built-in camera was used for real-time face scanning.

2.3.3 Technology Stack

The development of the Face Recognition for Smart Attendance System utilizes a comprehensive technology stack that supports both the frontend and backend, as well as database management and facial recognition functionality. On the frontend, the application is built using a combination of HTML, CSS, JavaScript, Bootstrap, Element UI, Vue.js, Nuxt.js, and TypeScript. These technologies were selected to ensure a responsive, user-friendly interface that works seamlessly on both desktop and mobile devices. The use of Vue.js and Nuxt.js enables efficient rendering of components and navigation, mimicking the experience of a native application when accessed through modern web browsers.

For backend development, the system uses Node.js together with the Express.js framework. This setup is responsible for handling server-side logic, managing API endpoints, and processing attendance data. Backend operations also include communication with the MySQL database, which is managed through phpMyAdmin. MySQL was chosen for its performance, scalability, and suitability for structured data storage, making it ideal for managing user profiles, class data, and attendance records.

The facial recognition component is implemented using TensorFlow.js, a JavaScript-based machine learning library that enables real-time facial identification within the browser.

Unlike server-side machine learning models, TensorFlow.js processes image data directly on the client side, reducing server load and enhancing user privacy by avoiding the need to transmit biometric data externally.

To comply with browser security policies, especially for accessing device cameras, the system is served over a secure HTTPS connection. This approach eliminates reliance on third-party tools like Ngrok while ensuring that all testing is conducted in a secure environment. Overall, the chosen technology stack allows the system to operate efficiently, securely, and flexibly across multiple platforms.

2.4 Summary

This chapter has provided a comprehensive review of existing smart attendance systems, along with an evaluation of the tools and technologies used in the development of the proposed solution. The literature review examined widely implemented systems such as QR code-based, fingerprint-based, RFID-based, and face recognition-based attendance methods. These systems were analyzed based on their accuracy, recognition time, and vulnerability to proxy attendance. The review highlighted several limitations in traditional methods particularly in terms of security, physical contact, and the potential for misuse.

In contrast, face recognition-based systems, such as the one implemented by PERKESO in Penang, were shown to offer more secure and reliable attendance tracking. By leveraging facial biometrics, these systems reduce the risk of fraudulent check-ins and allow for contactless, automated verification. Literature supports the adoption of this approach, especially in high-traffic environments where speed and accuracy are essential.

This chapter also detailed the tools and technologies employed in the development of the proposed system. The system utilizes a modern technology stack, including Vue.js and Nuxt.js for the frontend, Node.js and Express.js for the backend, and MySQL for data storage. TensorFlow.js was used to enable real-time face recognition directly in the browser, providing efficient biometric verification. The development was conducted using Visual Studio Code on an Asus Vivobook, with XAMPP for local server and database management. To support browser-based camera access, the system was configured to run over HTTPS.

In conclusion, this chapter established the rationale for adopting a face recognition-based attendance system. It outlined the comparative advantages of this method over traditional

systems and described the technical foundation required for system design and implementation, which will be elaborated in the subsequent chapters.

CHAPTER 3: REQUIREMENT ANALYSIS AND DESIGN

3.1 Introduction

This chapter outlines the essential requirements, selected methodology, and system design considerations for the development of the Face Recognition for Smart Attendance System (FaceAtten). It includes an analysis of user and technical requirements, identification of appropriate development tools, and a detailed explanation of the development approach. The chapter also describes the overall structure of the system and how the modules interact with each other to meet the project objectives.

3.2 Requirements

3.2.1 Analysis on Proposed Application

The Face Recognition for Smart Attendance System aims to provide an accurate, secure, and efficient solution to manage class attendance using facial recognition. It eliminates common issues associated with traditional and QR-code-only methods, such as proxy attendance and manual errors.

The system supports three roles:

- Admin – Registers students and lecturers, uploads student facial data, and assigns students to class and monitors attendance lists.
- Lecturer – Logs in, creates class sessions, generates QR codes for attendance, assigns students to class and monitors attendance lists.

- Student – Logs in, scans a QR code provided by the lecturer, verifies their location, scans their face to mark attendance and view their attendance list.

The multi-factor verification process QR code + location verification + face recognition ensures that only students who are physically present and properly identified can record attendance.

The project methodology used to develop the system was examined in this chapter. A methodology was an all-encompassing collection of guidelines that comprised a structure for carrying out actions across the Software Life Cycle of Development (SDLC). It guaranteed the efficient use of all procedures, strategies, techniques, and system approaches. It was an important developmental stage because it led researchers through the entire system's development process.

3.2.2 Software Requirements

The table below lists the software required for system development, deployment and documentation.

Table 3.1 Software requirements that are used in this project

Software	Details
Windows 11 64-bit	Operating system for the development environment
Visual Studio Code	Source code editor
XAMPP + phpMyAdmin	Local server environment and MySQL database management
Node.js + Express.js	Backend framework for handling server logic and API communication
Vue.js + Nuxt.js	Frontend frameworks for building the user interface
Firebase Authentication	Provides secure login and user management
TensorFlow	Machine learning framework for implementing facial recognition
Ngrok	Tool for local HTTPS testing and mobile access
Microsoft Word 2021	Documentation and report writing

3.2.3 Hardware Requirements

The system was developed and tested on the following hardware specifications:

Table 3.2 Hardware requirements that are used in this project

Hardware	Specification
Operating System	Window 11 Home
Processor	12th Gen Intel(R) Core (TM) i5-12500H 2.50 GHz
Memory	16.0 GB (15.7 GB usable)
Hard disk	475GB
Mobile Device (for testing)	Android smartphone with built-in front camera, used for QR scanning and facial recognition testing

3.3 Methodology

The development process model or methodology that will be used in this project is the waterfall model. This model is suitable for projects that are concerned with planning and structure. Each phase must be completed before proceeding to the next phase as required by the project. The project cannot be carried out if the training model construction process is not complete. The project will begin with the requirements phase where the project requirements are defined and explained in detail. Then, the project moves to the design phase. This phase determines how the application will be designed for example using appropriate colors or text. Next, the implementation phase where the application will be tested whether it is able to be used smoothly. Finally, the maintenance phase for the repair of the application if there are new problems that occur.

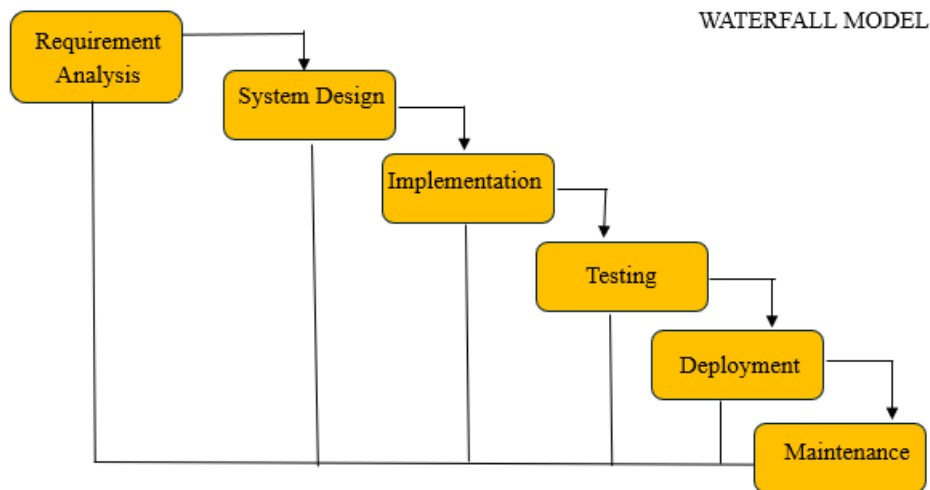


Figure 3.1 Waterfall methodology model

3.3.1 Requirement Analysis Phase

Referring to Figure 3.1, this phase is the first phase of the Waterfall methodology. It involves identifying and analyzing all necessary system requirements to serve as the foundation for development. This includes understanding user expectations, system objectives, and defining functional and non-functional specifications.

To support this phase, a survey was conducted involving 62 respondents, consisting of 51 students and 10 lecturers, to gather feedback on the current attendance processes and the feasibility of implementing a face recognition-based system. The survey was distributed and collected using Google Forms, which allowed for easy access and data compilation. The complete list of questions asked in the survey is provided in Appendix A for reference.

The key findings from the survey are as follows:

- 85.7% of respondents agreed that traditional attendance methods (e.g., manual signatures) are inefficient and time-consuming.
- 80.7% indicated that even digital methods such as QR codes or fingerprint scanners are still prone to proxy attendance issues.

- 92% expressed support for using face recognition technology to improve security and efficiency in attendance tracking.
- 59.99% stated that they would feel comfortable using a mobile app with face recognition features.

These findings reflect a strong demand for an automated and secure attendance solution. The responses provide a solid foundation for selecting facial recognition as the core technology of the proposed system. Furthermore, the clarity and stability of the requirements obtained from the survey justify the use of the Waterfall model, which supports a structured and phase-by-phase approach aligned with user expectations.

3.3.2 System Design Phase

The system design phase outlines how the Face Recognition for Smart Attendance System named FaceAtten is structured to meet user requirements collected during the analysis phase. This system is designed as a modular web application that incorporates role-based access control and integrated face recognition technology for accurate attendance validation. The design included system architecture, component flow, and user interactions.

3.3.2.1 System Architecture

The application follows a three-tier architecture:

- Front-End: Build using HTML, CSS, JavaScript, Vue.js, Bootstrap, Nuxt.js and Element UI for responsive UI on desktop and mobile.
- Back-End: Developed using Node.js and Express.js to handle server logic, data routing and QR generation.
- Database: MySQL, managed through phpMyAdmin, used to store user data, face encoding, attendance records, and class sessions.

- AI component: TensorFlow is used for processing and verifying face recognition results during attendance.

3.3.2.2 User Roles and System Permissions

a. Admin:

- Log in to the system using credentials.
- Register students and lecturers into the system.
- Add new classes and assign students to sessions.
- Upload and manage student facial images for recognition
- Manage user accounts and system settings.
- View attendance overview for the selected classes.

b. Lecturer:

- Log in to the system using credentials.
- Add new classes and assign students to sessions.
- Generate QR codes to create attendance sessions.
- View attendance overview for the selected classes.
- Edit their profile details (e.g., full name, password).
- Monitor attendance status.

c. Student:

- Log in to the system using credentials.
- Scan QR codes provided by the lecturer to initiate attendance.
- Verify attendance by scanning face after QR and location validation.
- Edit their profile details (e.g., full name, password).
- View attendance history.

3.3.2.3 System Workflow

The attendance process is structured as follows:

- a) The admin registers all students and lecturers in the system and assigns students to their respective classes.
- b) The admin also uploads each student's facial image, which is encoded and stored for face recognition.
- c) Before each class session, the lecturer generates a unique QR code to represent the attendance session.
- d) The student logs in, scans the QR code using their mobile device, and the system verifies the student's current location.
- e) If the location is approved, the student proceeds to scan their face using the device camera.
- f) The system compares the scanned face against stored data. If matched, attendance is recorded successfully for that session.
- g) Admin and lecturers can view and manage attendance records in their respective dashboards.
- h) Students can view their attendance records from their dashboards.

This multi-step verification (QR code + location + face) ensures secure, fraud-resistant attendance logging.

3.3.2.4 System Modules

The system is composed of the following core modules:

- a) Login Module:
Authenticates users securely using Firebase Authentication.

b) **Registration Module:**

Used by the admin to register new lecturers and students.

c) **Class Management Module:**

Allows admins and lecturers to create and manage class records and assign students.

d) **QR Code Module:**

Enables lecturers to generate session-specific QR codes for attendance validation.

e) **Location Verification Module:**

Confirms that the student is physically present at the correct location before face scan.

f) **Face Recognition Module:**

Uses TensorFlow to verify the student's identity through facial comparison.

g) **Attendance Module:**

Records attendance only when QR, location, and facial data are successfully verified.

h) **Profile Module:**

Allows students to view and update their full name and password.

3.3.2.5 Tools and Technologies Used

a) **Language & Frameworks:** HTML, CSS, JavaScript, TypeScript, Vue.js, Nuxt.js,

Bootstrap, Element UL.

b) **Back-End:** Node.js, Express.js

c) **Database:** MySQL (manage with phpMyAdmin via XAMPP)

d) **AI:** TensorFlow (for facial recognition model)

e) **Other Tools:**

- Firebase (for authentication)
- Ngrok (to expose local development environment for HTTPS testing)
- Visual Studio Code (as the development environment)

3.3.3 Implementation Phase

For the Face Recognition for Smart Attendance System (FaceAtten), each module was developed and tested incrementally to ensure functionality before system integration. The front end was built using Vue.js, Nuxt.js, and Element UI to create a responsive user interface. The back end was developed with Node.js and Express.js to manage API routes and application logic. MySQL was used to store data, including user credentials, class records, and attendance logs.

Facial recognition was implemented using TensorFlow, and facial images were encoded and stored in the system during student registration. Firebase was integrated for secure user authentication. The system was tested using both desktop browsers and mobile devices to ensure compatibility and responsiveness. XAMPP was used to manage the local database, and Ngrok was used to simulate HTTPS for secure local testing.

3.3.4 Testing Phase

The testing phase ensures the system works as intended and meets user requirements. The following types of testing were conducted:

a) **Unit Testing:**

Each module (login, QR scan, face recognition, attendance recording) was tested individually to confirm its functionality.

b) **Integration Testing:**

After individual modules were tested, they were integrated to ensure smooth data flow and interaction between components.

c) **Face Recognition Testing:**

Face matching accuracy was evaluated using real student images under varying lighting and angle conditions. Incorrect matches were handled with error prompts.

d) User Acceptance Testing (UAT):

A group of students and lecturers were asked to use the system and provide feedback.

The feedback was used to make minor adjustments to the UI and improve scanning reliability.

Overall, the system successfully passed all testing phases with only minor issues that were resolved during iterative development.

3.3.5 Deployment Phase

The system was deployed in a local development environment for testing. XAMPP was used to host the MySQL database, while the Node.js server handled application logic. Ngrok was used to expose the local server over HTTPS so it could be accessed from mobile devices during field testing.

Although not deployed to a live server in this phase, the system was structured in a way that allows for seamless deployment to platforms such as Heroku, Firebase Hosting, or institutional cloud infrastructure when required in the future. All environment variables and configuration settings were documented to facilitate easy migration.

3.3.6 Maintenance Phase

The maintenance phase involves updating the system to fix bugs, improve functionality, and adapt to new requirements. During initial usage, feedback was collected from test users to refine user experience. Minor issues such as text alignment, button placement, and session handling were corrected.

The system was built with modular code to ensure easy future upgrades for example, adding new attendance methods, multi-language support, or integrating with institutional

student information systems. Admin users are empowered to manage students, lecturers, and classes without developer involvement, reducing the need for frequent backend maintenance.

3.4 Specification of System Requirements

The specification of system requirements is divided into two, namely the functional requirements of the system and non-functional requirements. The functional requirements of the system are requirements in which the functions of the built system will satisfy the user's needs to achieve the objective. Non-functional requirements are things that involve external aspects of the system that are evaluated through the level of user satisfaction.

3.4.1 System Functional Requirements

The following functional requirements define the core operations that the Face Recognition for Smart Attendance System (FaceAtten) must support, based on its intended flow and user roles:

a) User Registration (Admin Only)

The system allows admins to register students and lecturers. During student registration, the admin enters personal information for students and lecturers. The admin also uploads the student's facial image, which is processed and stored for future facial recognition.

b) Login Functionality

All users (students, lecturers, and admin) must be able to log in using their email and password. The system authenticates users using Firebase Authentication and redirects them to role-specific home pages.

c) Class Management

Admin and lecturers can create new classes and assign students to their respective sessions. This enables a structured organization of attendance data by course and group.

d) Attendance Session Creation

Lecturers can create attendance sessions by generating a unique QR code tied to specific class and time. This QR code is presented to students during the class.

e) Attendance Verification (QR Code + Location + Face Recognition)

Students scan the QR code using their device, while validates the session. The system then verifies the student's current location. If the location is approved, the student scans their face. The system compares the scanned image with the stored facial data. If verified, the student's attendance is successfully recorded.

f) Attendance Record Display (Student, Lecturer, and Admin)

Students can view their personal attendance history through the system interface. The lecturers and admin can view real-time and historical attendance lists of students enrolled in their classes.

g) Profile Management (Student, Lecturer)

Students and admin can view and update their profile information, including full name and password. This ensures their data is up to date and accurate.

3.4.2 Non-Functional Requirements

Non-functional requirements are functional requirements that include the behavior and general characteristics of the system that affect users. The extent to which these non-functional requirements are obtained will determine the usefulness of the developed system and is used to evaluate the system's performance because it is the nature of the product and focuses on user expectations. Among the non-functional requirements of this smart attendance system are:

a) Efficiency

The system should perform operations such as login, QR scan, location validation, and face recognition quickly and smoothly. Server response time must be optimized to minimize delays, especially during attendance peak periods.

b) Security

Robust security measures are required to protect sensitive user data, including login credentials and facial recognition data. The system must use secure authentication (e.g., Firebase), encrypted storage, and restrict access based on user roles.

c) Accuracy and Reliability

Face recognition must match facial images accurately to avoid false acceptances or rejections. QR codes must be uniquely tied to sessions to prevent proxy attendance. Location verification must be accurate and consistent to ensure physical presence.

d) Usability

The system interface should be user-friendly and intuitive, especially for non-technical users like students and lecturers. Navigation, buttons, and instructions should be simple and self-explanatory.

e) Scalability

The system must support scalability to handle an increasing number of users, classes, and sessions. It should maintain stable performance regardless of growing data volume or user load.

3.5 System Model

The system model is one of the important aspects to be made before any development implementation is done. The system model that is done will describe the entire functionality of the system related to the user and the system. The developed model will also be used as a framework and guide to facilitate development work at the next stage.

3.5.1 Use Case Diagram

A use case diagram is the main form developed to identify system requirements. The specified use cases can be developed in the form of visual symbols and text that provide a concept to the developer about the user's relationship with the functionality of the system as well as its condition with the system's boundaries. The main concept of this modeling method is for developers to plan system development from the user's perspective. This is an effective technique for identifying system behavior in user terms by specifying all externally visible system behavior.

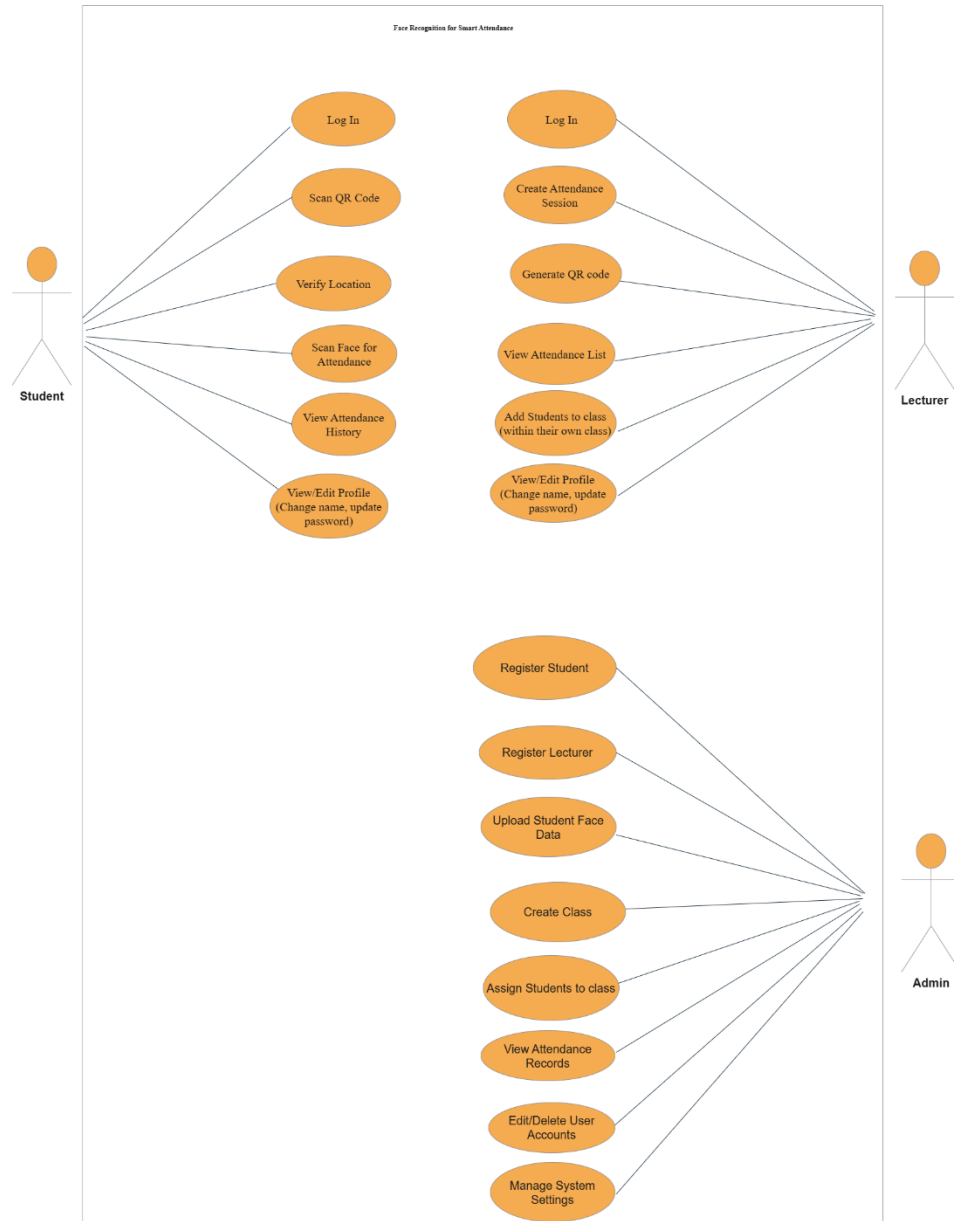


Figure 3.2 Use case diagram

3.5.2 Use Case Descriptions

Table 3.3 Use case diagram of register student

USE CASE	Register Account
Actor	Admin
Description	Admin registers a new student and inputs personal details along with uploading a face image.
Preconditions	Admin is logged into the system.
Postconditions	Student account is created and facial data is stored

Main flow	1. Admin navigates to the “Register Student” page. 2. Admin fills in student details. 3. Admin uploads the student’s facial image. 4. System validates and stores the information. 5. Confirmation message is displayed.
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Table 3.4 Use case diagram for upload face data

USE CASE	Register Account
Actor	Admin
Description	Admin uploads or updates a student’s face image for facial recognition.
Preconditions	Admin is logged into the system.
Postconditions	Face image is stored and linked to the student’s profile.
Main flow	1. Admin navigates to the “Face Recognition” page. 2. Admin have to select the class. 3. Admin upload or replaces the face image for the student. 4. System processes and stored the image. 5. Face data is saved in the database.

Table 3.5 Use case diagram for create attendance session

USE CASE	Register Account
Actor	lecturer
Description	Lecturer created a session and generates a QR code for attendance.
Preconditions	Lecturer is logged into the system.
Postconditions	QR code is generated
Main flow	1. Lecturer navigates to the “Manage Attendance” page. 2. Lecturer selects a class and inputs session details. 3. System generates a unique QR code. 4. QR code is displayed to students for scanning.

Table 3.6 Use case diagram for scan QR code and mark attendance

USE CASE	Register Account
Actor	Student
Description	Student scans QR code, verifies location, and completes face scan to mark.
Preconditions	Student is logged into the system and have to assign to the class.
Postconditions	Attendance is recorded if all verifications succeed.
Main flow	1. Students scan QR code shown by the lecturer. 2. System checks QR validity. 3. System prompts for location access and verifies GPS. 4. Student performs a face scan using the camera. 5. System matches scanned face with stored data. 6. Attendance is recorded and confirmation is shown.

Table 3.7 Use case diagram for View attendance history

USE CASE	Register Account
Actor	Student
Description	Student views their personal attendance records.
Preconditions	Student is logged into the system.
Postconditions	Attendance history is displayed.
Main flow	1. Student navigates to the “Dashboard” page. 2. System retrieves the student’s attendance records. 3. Records are displayed in a list.

Table 3.8 Use case diagram for view attendance list

USE CASE	Register Account
Actor	Lecturer
Description	Lecturer views attendance data for a specific session or class.
Preconditions	Lecturer is logged into the system.
Postconditions	Attendance records for selected session.
Main flow	1. Lecturer navigates to “Manage Attendance” page. 2. System displays a list of attendance session created by the lecturer. 3. Lecturer locates the desired session from the list. 4. Lecturer clicks the download icon. 5. System retrieves and displays the list of students and their attendance status for the selected sessions.

3.5.3 Context Diagram

A context diagram, also known as a Level 0 Data Flow Diagram (DFD), provides a high-level overview of the system by illustrating how it interacts with external entities. It represents the system as a single process and shows the flow of information between the system and users or other external systems.

For the Face Recognition for Smart Attendance System, the context diagram demonstrates the key interactions between the system and its three main actors: Admin, Lecturer, and Student. Each actor communicates with the system through specific inputs and receives corresponding outputs.

Admin Role:

1. The admin is responsible for the initial setup and ongoing management of user profiles and academic structures. This includes registering new students and lecturers into the system.
2. The admin also has the crucial function of creating new classes within the system.
3. Following class creation, the admin assigns students to their respective classes.
4. To enable facial recognition, the admin uploads student facial images to the system.
5. In return for these actions, the system provides confirmation of successful operations (e.g., registration, class creation, assignments) and allows the admin to manage and update user information.

Lecturer Role:

1. Lecturers initiate the attendance process by creating attendance sessions for their classes.

2. Upon session creation, the system automatically generates a unique QR code for that session and stores the associated session data.
3. Lecturers can also retrieve detailed attendance reports for their classes, providing insights into student presence.

Student Role:

1. Students engage with the system to record their attendance during sessions. This involves scanning the unique QR code provided by the lecturer.
2. Simultaneously, students must verify their current location through the system.
3. The final step for attendance verification requires students to submit a facial scan.
4. In response, the system records the student's attendance for the session and provides students with access to their personal attendance history.

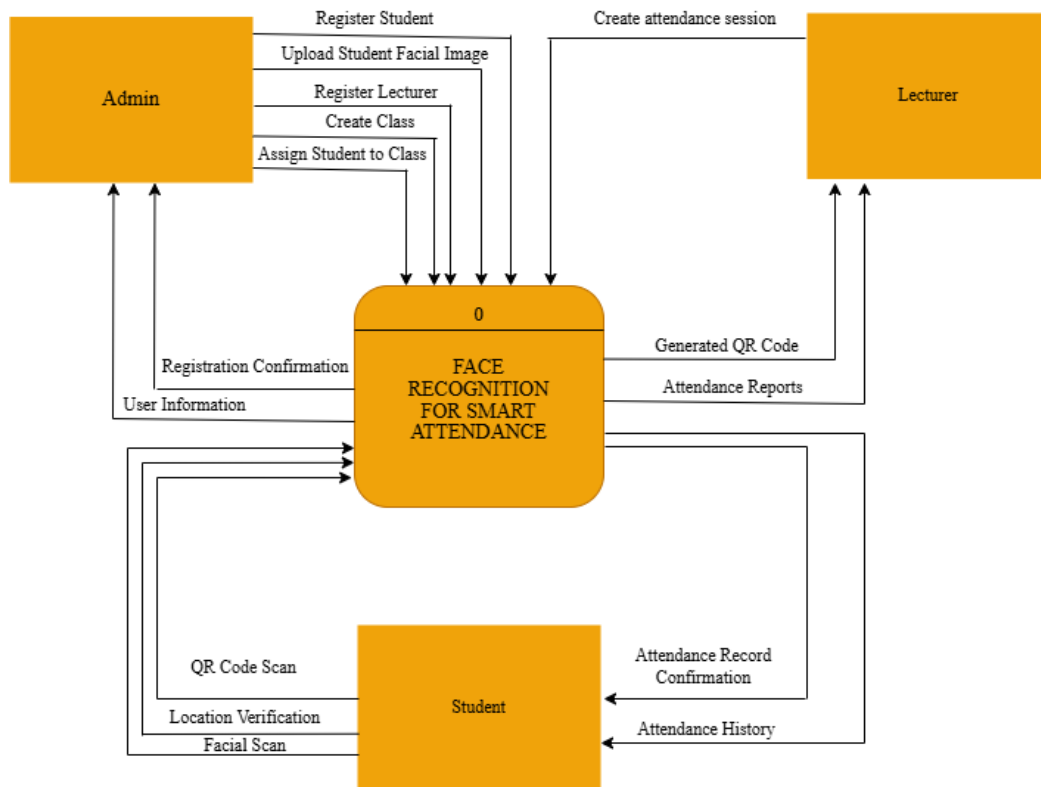


Figure 3.3 DFD of Face Recognition for Smart Attendance (Level 0)

Based on figure 3.3, helps clarify the overall structure of the system at a glance and sets the foundation for more detailed system design and data flow.

3.5.4 Entity Relationship Diagram

An entity relationship diagram is a structural diagram that shows the design of a database. This diagram is very important to identify the types of data that are required and stored in the correct entity and the relationship of the data with the entire system. The production of a perfect entity relationship diagram can simplify the work of building a database without facing data confusion. Figure 3.4 shows the entity relationship diagram of an intelligent attendance system.

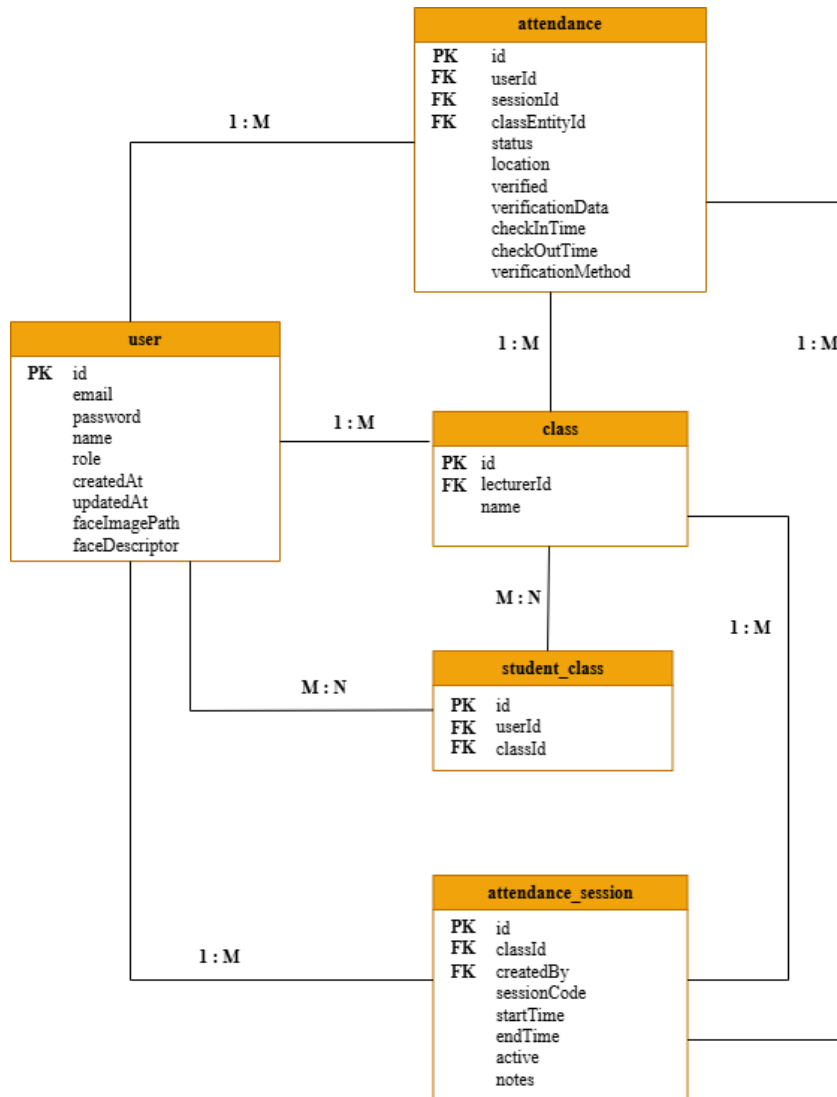


Figure 3.4 Intelligent Attendance System Entity Relationship

3.6 Interface Design

Interface design aims to create interaction between the user and the system. It is also designed to make it easier for users to use this system. The interface design developed is user-friendly by using easy-to-read writing and attractive design. The following is an initial overview of the FaceAtten system that will be developed. The figures below show the interface of the account registration function for normal users.

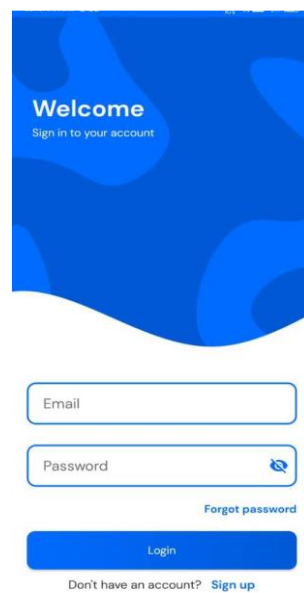


Figure 3.5 Login Interface

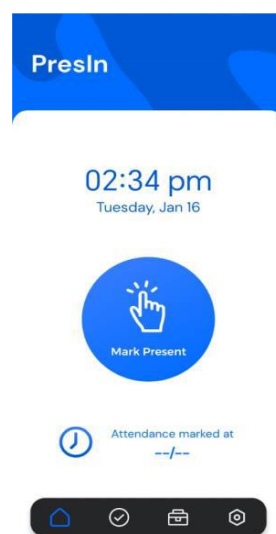


Figure 3.6 Homepage Student Interface

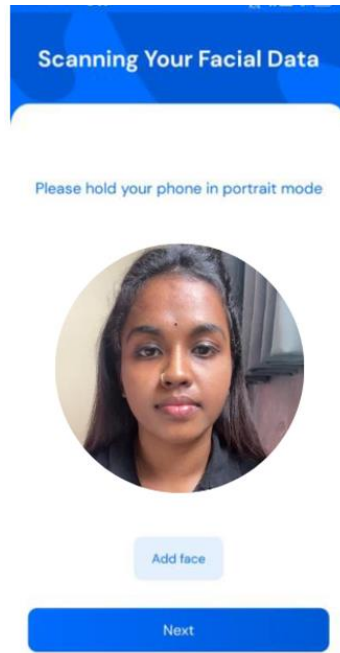


Figure 3.7 Attendance Taking Interface

3.7 Summary

This chapter has discussed the essential components involved in analyzing and designing the Face Recognition for Smart Attendance System (FaceAtten). It began by identifying both functional and non-functional requirements that the system must fulfill based on user roles, including students, lecturers, and administrators.

The chapter then introduced the Waterfall Model as the selected development methodology, suitable for this project due to its clear, structured phases. Following that, detailed system designs were presented through the use of diagram such as the use case diagram, content diagram, and entity relationship diagram, (ERD), all of which helped visualize the system's logic and data flow.

Finally, the chapter presented the proposed interface designs for the application. These designs aimed to ensure a user-friendly experience across different user types while maintaining functionality and clarity. Together, these components provide a strong foundation for the

implementation phase, ensuring the system will meet its goals in terms of usability, accuracy, and effectiveness.

Chapter 4: IMPLEMENTATION

4.1 Introduction

This chapter discusses the implementation of the Face Recognition for Smart Attendance covering system setup, module functions, user workflows, and interface behavior. The system was developed using modern web technologies such as Vue.js, Node.js, MySQL, and TensorFlow for the facial recognition feature, with development carried out in Visual Studio Code and managed using XAMPP and phpMyAdmin.

4.2 Installation

This section explains the installation process and the tools and technologies used during the development of the Face Recognition for Smart Attendance. The system was developed and tested in a local environment using various modern web and AI technologies.

4.2.1 Tools Used

Table 4.1 Table of Tools Used

Tool	Description
Asus Vivobook	Used as the main development machine.
Visual Studio Code	Source code editor used for writing and managing the project files.
XAMPP	Local server environment to run Apache and MYSQL.
PhpMyAdmin	Used to manage and interact with the MySQL database.
Ngrok	Used to expose the local development server over the internet via HTTPS.

4.2.2 Technologies Used

Table 4.2 Table of Technologies Used

Category	Technologies
Frontend	HTML, CSS, JavaScript, Bootstrap, Element UL, Vue.js, Nuxt.js,
Backend	Node.js, Express.js
Database	MySQL
Artificial intelligence	TensorFlow (face recognition functionality)

4.3 User of the System

The Face Recognition for Smart Attendance System (FaceAtten) is designed to support three main types of users Students, Lecturers, and Admins. Each user role is assigned specific responsibilities and access privileges to ensure a secure, organized, and role-based attendance process.

4.3.1 Student

Students are the primary users of the system and are responsible for marking their attendance during class sessions. Each student must first log in using their registered credentials. At the start of a session, the student scans a QR code displayed by the lecturer. This initiates a location verification step, where the system checks the student's GPS position to confirm they are physically present in the correct location. If the location is verified, the student proceeds to perform facial recognition using their device's camera. The scanned facial data is then matched against pre-uploaded facial descriptors in the system. Upon successful verification, attendance is recorded automatically. In addition to marking attendance, students can view their attendance history and update personal profile details such as their name and password. Students can only mark attendance for classes they have been assigned to by the admin or lecturer.

4.3.2 Lecturer

Lecturers are responsible for managing class attendance sessions. After logging in, a lecturer can create an attendance session for a specific class, which automatically generates a unique QR code. This QR code is shared with students at the beginning of the session. Lecturers are also able to assign students to their respective classes, monitor real-time attendance activity, and review past attendance records. Profile management features are also available, allowing lecturers to update their account information. However, lecturers do not have administrative privileges such as uploading facial image data for students.

This multi-role structure ensures that every user interacts with the system according to their level of responsibility, while the combination of QR codes, location verification, and facial recognition enhances security, accuracy, and efficiency across the attendance process.

4.3.3 Admin

Admins have the highest level of control within the system. Their primary responsibilities include registering users (students and lecturers), uploading facial image data for students, and assigning users to specific classes. Admins also have the ability to create attendance sessions and class records, although this is typically handled by lecturers. They oversee the entire system's operations, including managing the database, monitoring system usage, and resolving technical issues. Admins ensure that the system remains secure, organized, and up-to-date for all users.

4.4 Workflow for FaceAtten

The workflow for the Face Recognition for Smart Attendance System (FaceAtten) outlines how the system functions based on the responsibilities of its three main user roles: Student, Lecturer, and Admin. Each role performs specific tasks in the system to ensure a

secure, structured, and fraud-resistant attendance process. The workflow integrates key technologies such as QR code scanning, GPS location verification, and facial recognition.

4.4.1 Student Workflow

1. The student logs into the system using their registered credentials.
2. At the start of class, the student scans a QR code generated by the lecturer for that specific session.
3. Upon scanning the QR code, the system verifies the student's GPS location to ensure they are physically within the approved range (e.g., in or near the classroom).
4. If the location verification is successful, the student proceeds to scan their face using their device's camera.
5. The system compares the scanned image with the stored facial data using TensorFlow.js.
6. If the facial recognition is successful, the system records the student's attendance for the session.
7. The student can view their attendance history and update their profile details, such as name and password.

4.4.2 Lecturer Workflow

1. The lecturer logs into the system.
2. The lecturer assigns students to the classes they are teaching, based on their enrolled course list.
3. The lecturer creates a new attendance session for a selected class and time.
4. The system generates a unique QR code for that session.
5. The lecturer displays the QR code to students in class.
6. The lecturer can monitor student check-ins in real time and view attendance records for each session.

7. The lecturer may update their personal profile as needed.

4.4.3 Admin Workflow

1. The admin logs into the system with full administrative access.
2. The admin registers new users both students and lecturers and manages their credentials.
3. The admin uploads facial image data for each registered student to enable facial recognition.
4. The admin assigns students to their respective classes and links lecturers to the appropriate courses.
5. The admin can also create class records and attendance sessions if needed.
6. The admin oversees all system operations, manages the user database, handles technical issues, and ensures that data is secure and up to date.

4.5 Modules for Student

This section describes the modules that are accessible to students in the FaceAtten system. These modules support the end-to-end attendance process, from login attendance tracking. The student is required to log in, scan the QR code generated by the lecturer, verify their location, and perform facial recognition to complete the attendance process. Additional students allow to view their attendance history and manage their personal profile.

4.5.1 Login Module

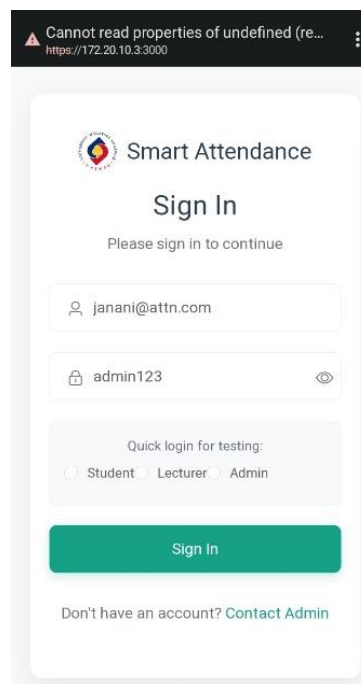


Figure 4.1 Interface Login

The figure 4.1 shows the login page for students in the FaceAttn. Students are required to enter their registered username and password to access to the application.

4.5.2 Home Module

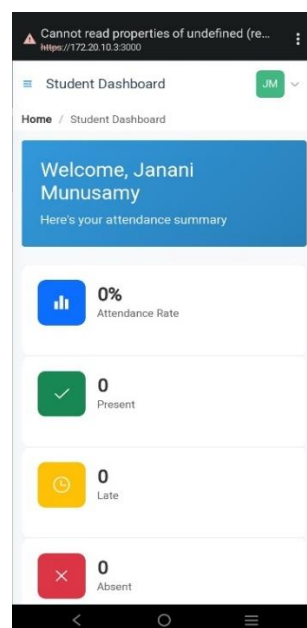


Figure 4.2 Student Dashboard

Once authenticated, the student is redirected to their personalized dashboard, as shown in Figure 4.2, where they can view their attendance history.

4.5.3 Reset Password Module

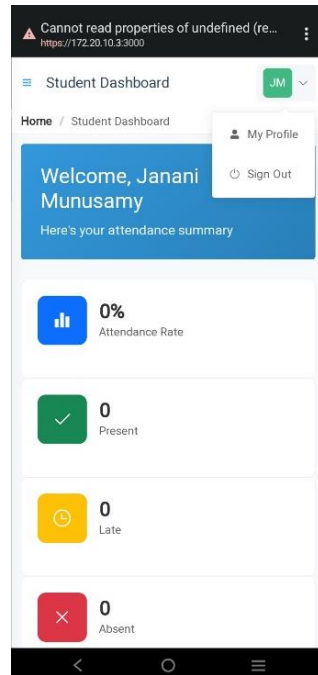


Figure 4.3 Interface Student Dashboard

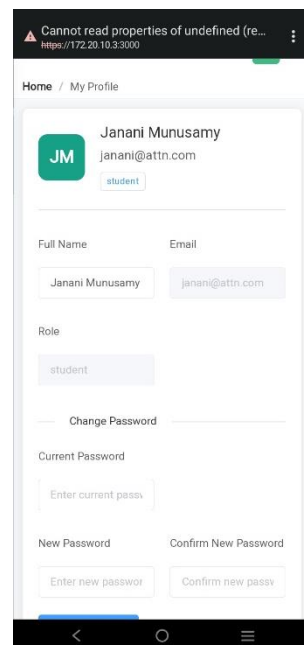


Figure 4.4 Interface My Profile

For the password reset process, in the figure 4.3, where the student has to select ‘My Profile’. The figure 4.4 shows the interface where the user can reset their password or update their full name.

4.5.4 QR Code Scan Module

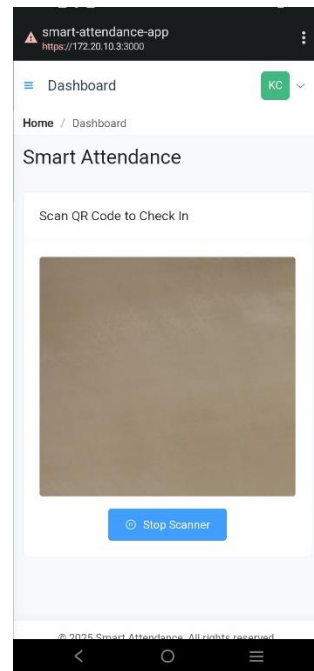


Figure 4.5 Interface for QR Code Scan

The figure 4.5 illustrates the QR code scanning interface, where student can scan the generated QR code to mark their attendance.

4.5.5 Location Verification Module

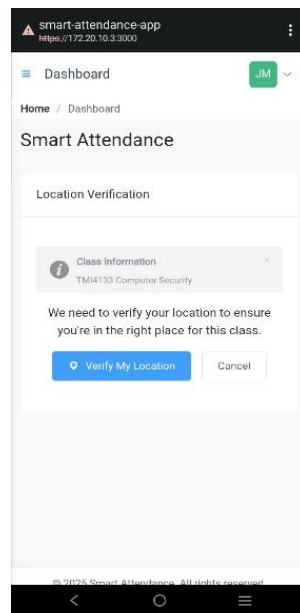


Figure 4.6 Interface to verify location

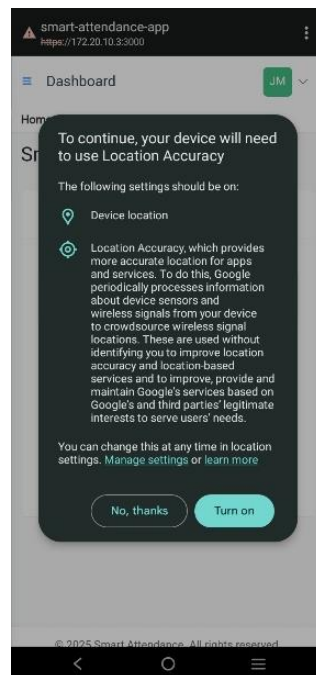
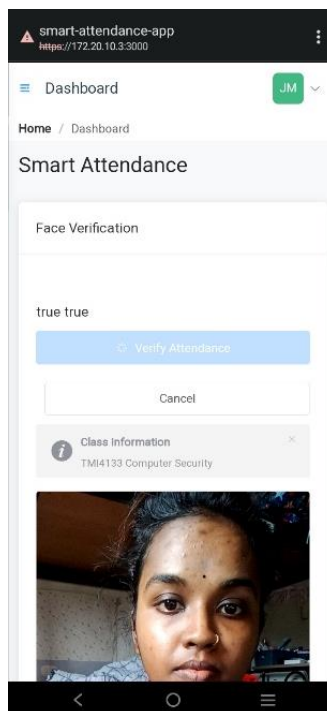
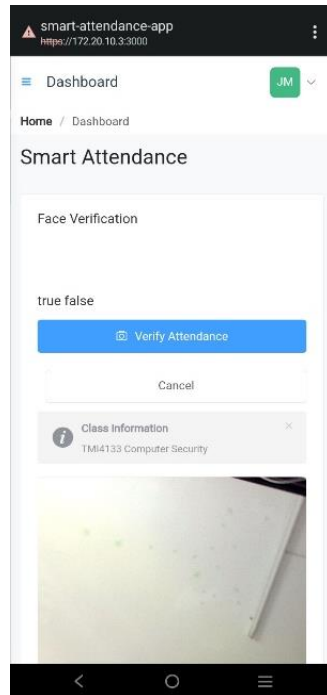


Figure 4.7 Interface for Location Verification

The figure 4.6 shows the location verification feature. Which ensures that the student is physically present at the designates location before attendance is recorded. Students must

enable their device location. Otherwise, they will receive a notification prompting them to do so, as show in figure 4.7.

4.5.6 Face Recognition Module



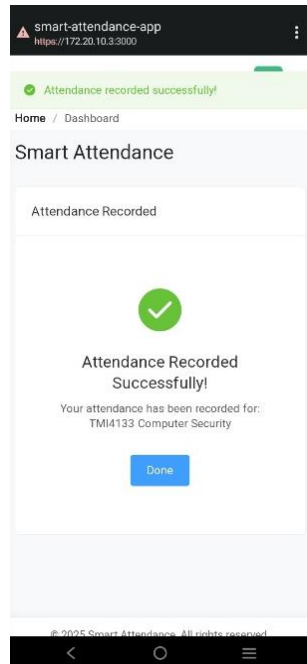
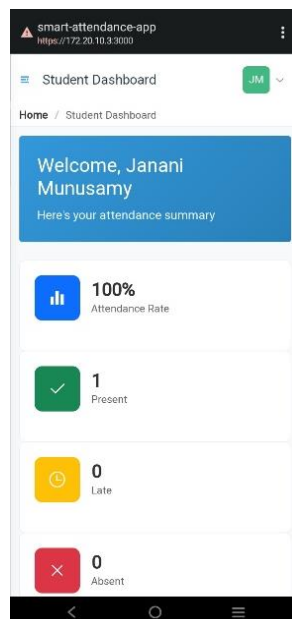


Figure 4.8 Interface for Face Verification

The figure 4.8 displays the face recognition feature, where the system captures the student's facial image in real time and verifies it against the registered data to ensure accurate identity verification before marking attendance.

4.5.7 Attendance History Module



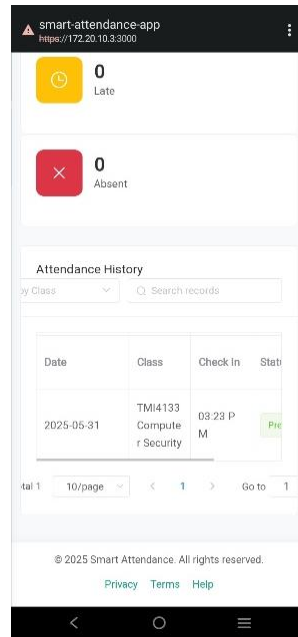


Figure 4.9 Interface for View Attendance History

The figure 4.9 shows that attendance history interface, where students can view summary of their past attendance records, including date, class, check in time and attendance status for each class.

4.6 Modules for Lecturer

This section outlines the modules available to lecturers in the FaceAtten system. Lecturers are responsible for managing class attendance sessions. The system enables lecturers to log in, create attendance sessions, generate QR codes for students, and view real-time attendance records. Lecturers can also manage class assignments and update their personal profile. These modules are designed to simplify classroom attendance management while maintaining integrity and traceability.

4.6.1 Lecturer Login Module

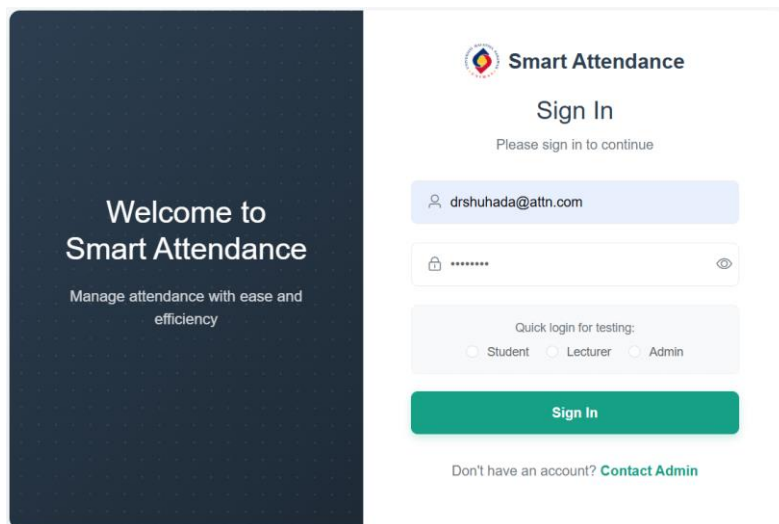


Figure 4.10 Login Interface

The figure 4.10 shows the login site for lecturer in the FaceAtten. Lecturers are required to enter their registered username and password to access to the system.

4.6.2 Lecturer Home Module

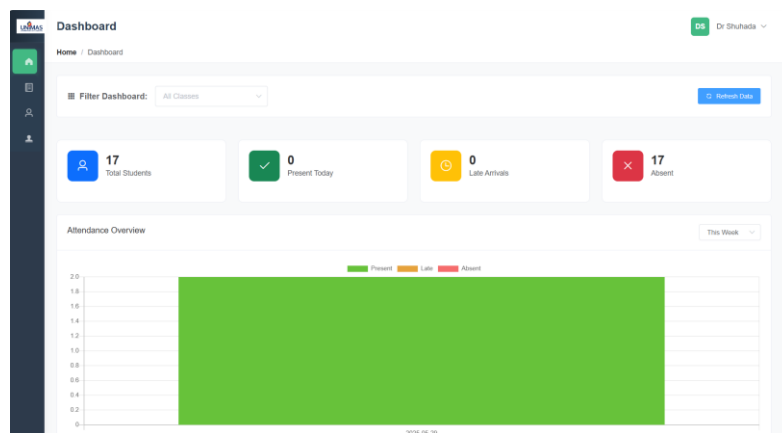


Figure 4.11 Dashboard View

Once authenticated, the lecturer is redirected to their personalized dashboard, as shown figure 4.11, where they can view classes attendance history.

4.6.3 Lecturer Reset Password Module

The screenshot shows the 'My Profile' page for Dr. Shuhada. The page includes a sidebar with navigation icons. The main content area displays the user's profile information: 'Dr Shuhada' with email 'drshuhada@qatn.com'. Below this are fields for 'Full Name' (containing 'Dr Shuhada') and 'Email' (containing 'drshuhada@qatn.com'). The 'Role' field is set to 'Lecturer'. There is a 'Change Password' section with fields for 'Current Password', 'New Password', and 'Confirm New Password'. A 'Save Changes' button is at the bottom.

Figure 4.12 Interface of reset password

For the password reset process, in the figure 21 where the lecturer has to select ‘My Profile’. The figure 4.12 shows the interface where the lecturer can reset their password or update their full name.

4.6.4 Create Attendance Session Module

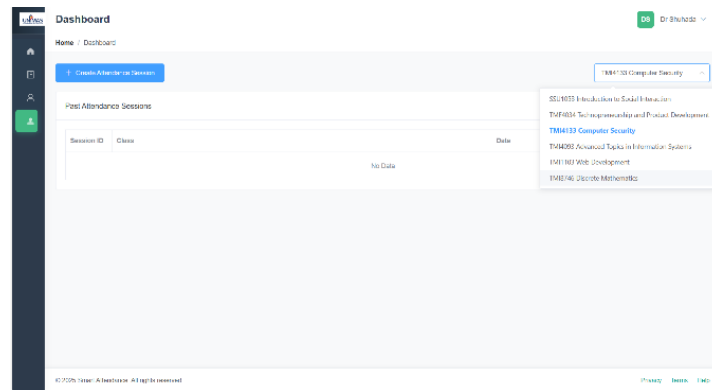


Figure 4.13 Interface select class

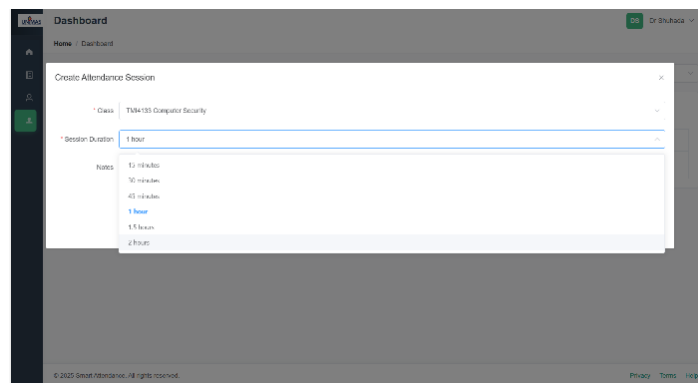


Figure 4.14 Interface of Create Attendance Session

The figure 4.13 illustrates the interface for creating attendance session, where the lecturer has to choose the class first then only get to click create attendance session. At the figure 4.14, where the lecturer needs to choose the duration of the class.

4.6.5 QR Code Generation Module

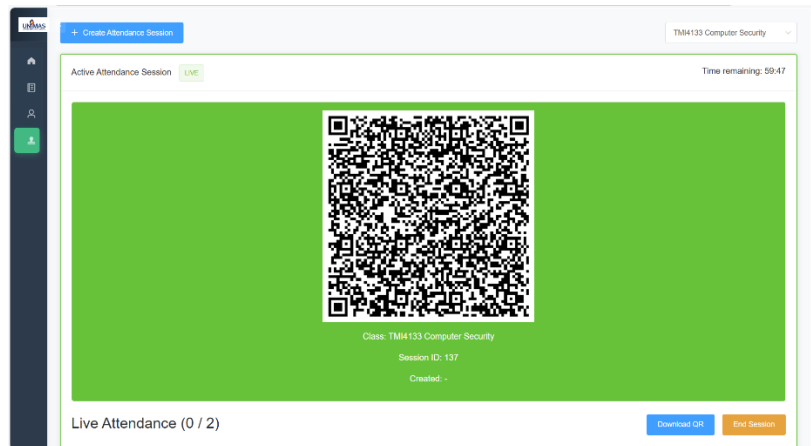


Figure 4.15 Interface QR code generation

The figure 4.15 shows, the QR code generation interface, where the system automatically created a unique QR code for attendance session.

4.6.6 Attendance Monitoring Module

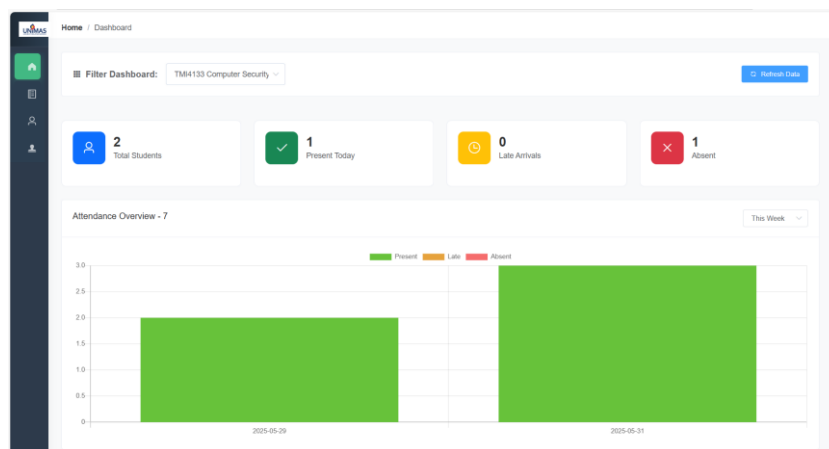
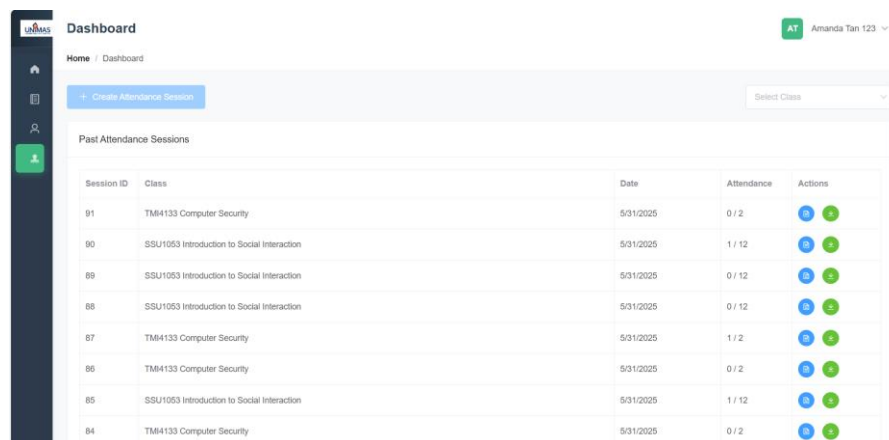


Figure 4.16 Interface of Attendance Monitoring

The figure 4.16 shows the attendance monitoring interface, where the lecturer can view the attendance records of their classes based on the selected session.

4.6.7 View Attendance List Module



Session ID	Class	Date	Attendance	Actions
91	TMB4133 Computer Security	5/31/2025	0 / 2	View Download
90	SSU1053 Introduction to Social Interaction	5/31/2025	1 / 12	View Download
89	SSU1053 Introduction to Social Interaction	5/31/2025	0 / 12	View Download
88	SSU1053 Introduction to Social Interaction	5/31/2025	0 / 12	View Download
87	TMB4133 Computer Security	5/31/2025	1 / 2	View Download
86	TMB4133 Computer Security	5/31/2025	0 / 2	View Download
85	SSU1053 Introduction to Social Interaction	5/31/2025	1 / 12	View Download
84	TMB4133 Computer Security	5/31/2025	0 / 2	View Download

Figure 4.17 Interface of View Attendance

The figure 4.17 displays the attendance list interface, where the lecturer can view all attendance sessions. From this interface, the lecturer can download the list of students in excel format and can view the attendance report.

4.7 Modules for Admin

This section details the administrative modules used by system administrators in FaceAtten. Admins hold the highest access level and are responsible for registering users, assigning students to classes, uploading face data, and maintaining the overall system. The modules in this section allow admins to manage user accounts, configure attendance settings, and ensure the security and accuracy of system data.

4.7.1 Admin Login Module

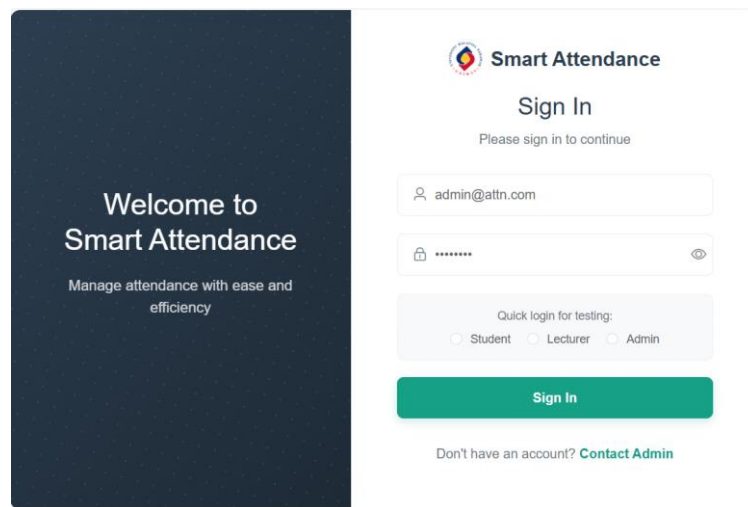


Figure 4.18 Login Interface

The figure 4.18 shows the login site for admin in the FaceAtten. Admin are required to enter their registered username and password to access to the system.

4.7.2 Admin User Registration (Student and Lecturer) Module

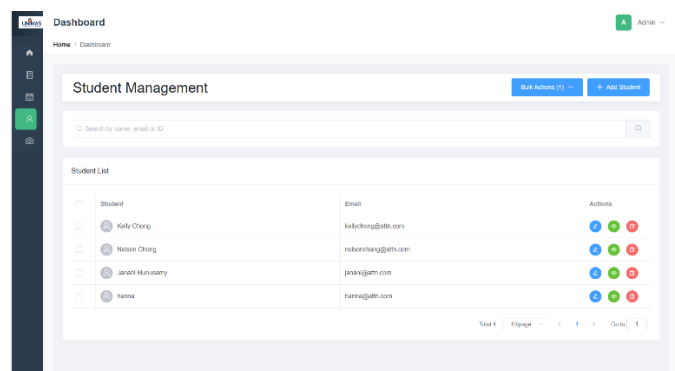


Figure 4.19 Interface of Add Student

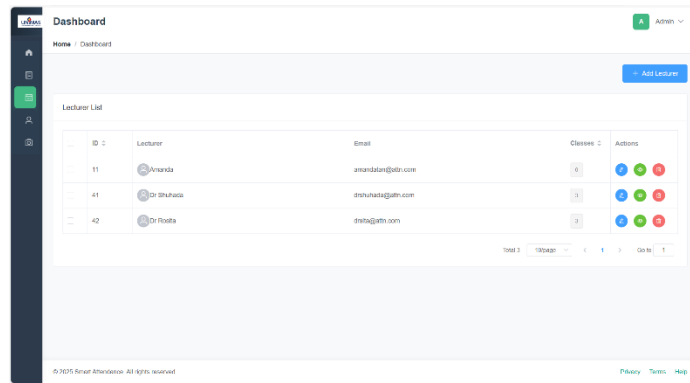


Figure 4.20 Interface of Add Lecturer

The figure 4.19 and 4.20 shows the user registration interface for student and lecturer, where the admin is responsible for registering new users by entering their personal details.

4.7.3 Upload Face Data Module

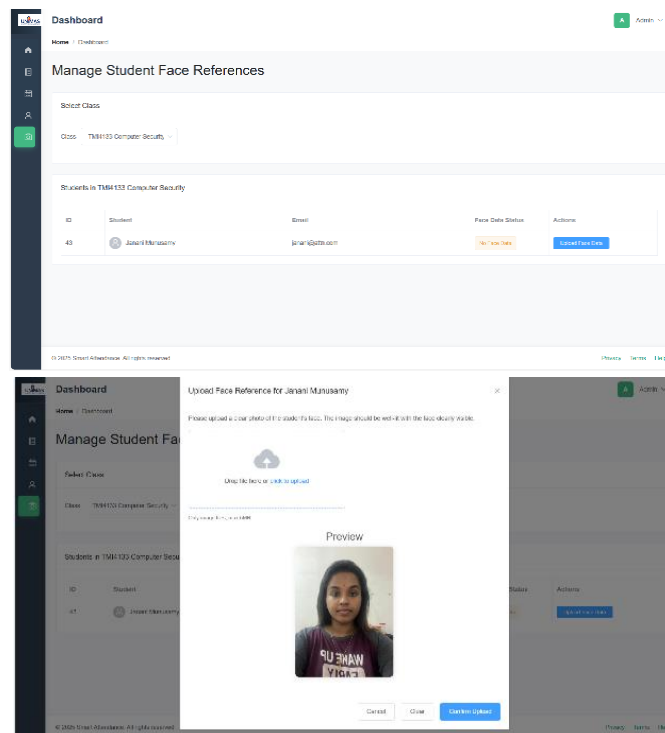


Figure 4.21 Interface of Upload Picture

The figure 4.21 illustrates the face data upload interface, where the admin uploads a clear image of the student's face to be used for identify verification in the face recognition.

4.7.4 Class Management Module

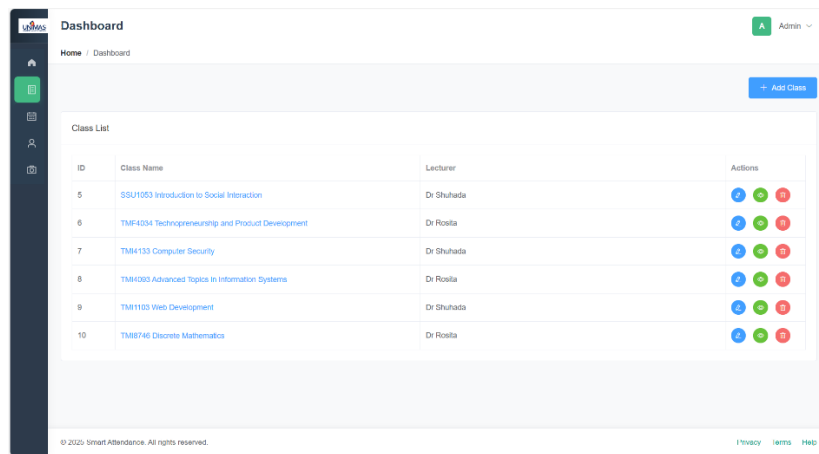


Figure 4.22 Interface of class management

The figure 4.22 shows the class management interface, where the admin can create new classes and assign lecturer to each class accordingly.

4.7.5 Assign students to Class Module

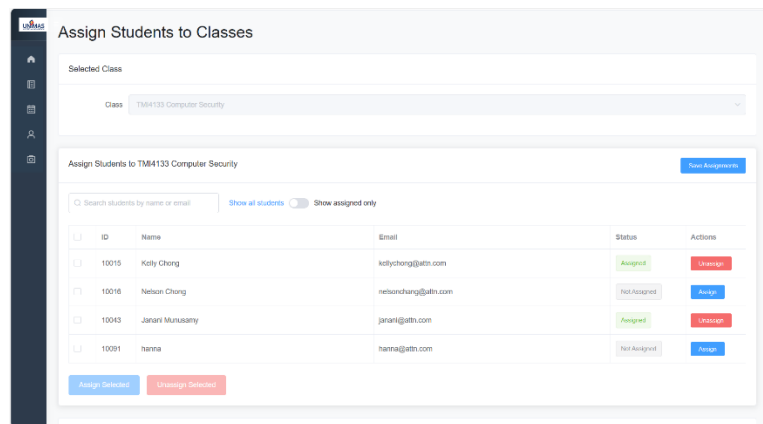


Figure 4.23 Interface of Assign student to class

The figure 4.23 displays the student assignment interface, where the admin can assign students to their respective classes.

4.8 Summary

This chapter has presented the implementation of the Face Recognition for Smart Attendance System (FaceAtten), covering the installation environment, user roles, system

workflows, and detailed module descriptions. The system was developed as a web-based application using modern web technologies such as Vue.js, Node.js, MySQL, and TensorFlow.js, allowing cross-platform access with secure, real-time facial recognition capabilities.

Each of the three main user roles Students, Lecturers, and Admins, was defined along with their specific system interactions and permissions. Detailed workflows illustrated the sequential steps each user type performs to complete tasks such as registering users, managing classes, generating QR codes, and recording attendance. The system employs a multi-layered verification process including QR code scanning, GPS location verification, and facial recognition to ensure secure and accurate attendance logging.

Furthermore, the chapter documented all key modules by user role, accompanied by relevant interface screenshots and explanations. These modules represent the core functionalities implemented in the system and support its overall objectives of minimizing attendance fraud and improving attendance management efficiency.

In conclusion, the implementation phase successfully translated the system design into a working application that fulfills the project's functional requirements and lays the foundation for future enhancements.

CHAPTER 5: TESTING

5.1 Introduction

This chapter describes the testing phase conducted for the Face Recognition for Smart Attendance System (FaceAtten). Testing is essential to verify that all system functionalities operate correctly and meet the specified requirements. The testing includes both functional testing, which validates individual modules such as QR generation and facial recognition, and non-functional testing, which evaluates the system's usability and user experience. The goal of this phase is to identify and fix any defects, ensure the reliability of the system, and gather real user feedback for refinement.

5.2 Functional Testing

Functional testing was conducted to verify that each feature of the Face Recognition for Smart Attendance System (FaceAtten) functions correctly based on the role of the user. The testing focused on exercising key actions available to Students, Lecturers, and Admin, ensuring that each module performs as expected under normal operating conditions.

1. Student

- **Login and Logout of the System**
 - Student logs in with registered credentials
 - System redirects to student dashboard
 - Logout returns to login screen
- **Scan QR code for Attendance**
 - Student scans valid QR code provided by lecturer
 - System verifies QR and links to session
- **Location Verification**
 - System detects current GPS location
 - Access to next step only if within valid

- Invalid location results in access denied
- **Face Recognition and Attendance**
 - System activates device camera
 - Live face scan is compared with stored face data
 - If matched, attendance is marked successfully
 - If not matched, error message is displayed
- **View Attendance History**
 - Student views past session records
 - Displays attendance status (Present, Absent, etc.)
- **Profile Management**
 - Student can view personal profile
 - Update name and change password

2. Lecturer

- **Login and Logout of the System**
 - Lecturer logs in with registered credentials
 - System redirects to student dashboard
 - Logout returns to login screen
- **Create Attendance Session**
 - Lecturer selects class and creates session
 - System generates unique QR code
- **Share QR Code with Students**
 - QR code id displayed for student scanning
- **Monitor Attendance**

- View real-time student check-ins
- Attendance list updates automatically
- **View Past Attendance Records**
 - Lecturer accesses list of previous sessions
- **Class Management**
 - Lecturer assigns students to classes
 - Can assign/unassign students from their classes
- **Profile Management**
 - View and update personal details
 - Change password if needed

3. Admin

- **Login and Logout of the System**
 - Admin logs in using secure credentials
 - Access to full admin dashboard
 - Logout terminates session
- **User Registration**
 - Register new students and lecturers
 - System stores login credentials and role type
- **Upload Facial Image data**
 - Upload student face images for recognition
- **Class and User Assignment**
 - Assign student to specific classes
 - Assign lecturer to their teaching classes
- **Manage Attendance and Class Records**

- Admin can view all sessions and attendance data
- **System Management and Maintenance**
 - View and edit user details
 - Provide technical support

Table 5.1 User FaceAttn

User Name	Password	Role
janani@attn.com	password123	student
praveen@attn.com	praveen456	student
audi@attn.com	audi789	student
kirthana@attn.com	kirthana321	student
vee@attn.com	shree234	student
hanna@attn.com	joseph897	student
thas@attn.com	thas973	student
ayu@attn.com	Ayu435	student
drshuhada@attn.com	Shu1150	Lecturer
caroline@attn.com	Line7898	Lecturer
admin@attn.com	admin123	Admin

Table 5.2 Test Case of Login Module

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Login Module		Functional Requirement	FR1: Multi-role login (Student, Lecturer, Admin)	
Test Scenario Description	Testing login using valid and invalid credentials for different user roles				
Test Title	Multi role login validation				
Objective	To confirm correct handling of user login for all roles (student, lecturer, admin)				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-1	Login with valid student credentials	Use janani@attn.com and password123 then click Sign in	Redirect to Student Dashboard	As expected	Pass
TC-2	Login with valid lecturer credentials	Use drshuhada@attn.com and Shu1150 then Click Sign in	Redirect to Lecturer Dashboard	As expected	Pass
TC-3	Login with valid admin credentials	Use admin@attn.com and admin123 → Click Sign in	Redirect to Admin Dashboard	As expected	Pass

TC-4	Login with wrong password	Use vee@attn.com and wrongpass → Click Sign in	Show “Invalid username or password” message	As expected	Pass
TC-5	Attempt login with blank fields	Leave both fields empty → Click Sign in	Show "Login failed. Please try again" validation	As expected	Pass

Table 5.3 Test Case QR Code Scan Module

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	QR Code Scan Module		Functional Requirement	FR2: Student scans QR code for session verification	
Test Scenario Description	Student scans a valid/invalid QR code				
Test Title	QR Code Scan for Attendance				
Objective	To verify that students can scan QR codes and trigger the attendance process correctly				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-7	Scan valid QR	Login as audi@attn.com →	Proceed to location verification	As expected	Pass

		Scan QR displayed by lecturer			
TC-8	Scan expired/invalid QR code	Login as thas@attn.com → Scan expired or reused QR	Show error “Invalid or expired QR code”	As expected	Pass

Table 5.4 Test Case Location Verification Module (student)

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Location Verification Module		Functional Requirement	FR3: Verify student GPS location	
Test Scenario Description	Student's location is verified after QR scan				
Test Title	GPS Location Verification				
Objective	To confirm that attendance proceeds only when the student is within the allowed GPS radius				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-9	Location verified within valid radius	Login as hanna@attn.com → Scan QR → Allow	Proceed to face recognition	As expected	Pass

		location access in class area			
TC-10	Location is off at device	Login as ayu@attn.com → Scan QR → Access system from remote area	Show error “You are XX meters away from the class location”	As expected	Pass

Table 5.5 Test Case for Face Recognition Module

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Face Recognition Module		Functional Requirement	FR4: Match scanned face with stored data	
Test Scenario Description	Student scans face after location is verified				
Test Title	Facial Recognition for Attendance				
Objective	To verify the accuracy and response of the facial recognition process using TensorFlow.js				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-11	Valid face match	Login as praveen@attn.com → Scan QR → Location	Attendance marked	As expected	Pass

		verified → Face matches stored image			
TC-12	Face does not match	Login as janani@attn.com → Scan QR → Location OK → Face is blocked or mismatched	Show error “Face verification failed”	As expected	Pass

Table 5.6 Test Case Attendance History Viewing (student)

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Attendance History Viewing		Functional Requirement	FR5: Student views past attendance records	
Test Scenario Description	Student accesses attendance records from previous sessions				
Test Title	View Attendance History				
Objective	To verify that students can successfully view and retrieve accurate attendance history data from the system				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-13	Student views attendance history	Login as janani@attn.com →	Display a list of attended sessions	As expected	Pass

		view to “student dashboard” page			
TC-14	Student with no attendance records	Login as new student → view to “student dashboard” page	Show message like “No attendance records found”	As expected	Pass

Table 5.7 Test Case Admin User Registration

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Admin user registration		Functional Requirement	FR6: Register students and lecturers	
Test Scenario Description	Admin registers new users into the system				
Test Title	Admin Registers Users				
Objective	To verify that admin can register new users and assign roles correctly				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-15	Register new student	Login as admin@attn.com → Navigate to "Student	Student added successfully	As expected	Pass

		Management" page → Add student			
TC-16	Register new lecturer	Login as admin@attn.com → Navigate to "Lecturer List" page → Add lecturer	Lecturer created successfully”	As expected	Pass
TC-17	Submit registration with empty fields	Leave full name or email blank → Click “Register”	Show validation warning	As expected	Pass

Table 5.8 Test Case Admin Upload Face Data

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Admin Face Data Upload Module		Functional Requirement	FR7: Upload student facial data	
Test Scenario Description	Admin uploads image files for students				
Test Title	Upload Facial Recognition Data				
Objective	To verify that the system accepts valid image formats and links them to the correct user profile				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-18	Upload student face image successfully	Login as admin@attn.com → Select Face Recognition → select class → Upload a valid image file to the selected user	Face image linked to user	As expected	Pass
TC-19	Upload unsupported file format	Upload a .pdf file instead of an image	Show error “Please select image file”	As expected	Pass

Table 5.9 Test Case Lecturer create attendance session

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Lecturer create attendance session		Functional Requirement	FR8: Create attendance sessions with QR generation	
Test Scenario Description	Lecturer creates a session and shares the QR code				
Test Title	Lecturer Creates Attendance Session				
Objective	To confirm that a lecturer can successfully create sessions and generate usable QR codes				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-20	Lecturer creates session for a class	Login as drshuhada@attn.com → Click “Manage attendance” → Select class → create session	QR code generated for session	As expected	Pass
TC-21	Session creation with no class selected	Try to create session without selecting a class	Button is disable	As expected	Pass

Table 5.10 Test Case Assign Student to Class

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAtten)		Designed By	Janani Munusamy	
Module Name	Class Management Module		Functional Requirement	FR9: Assign Student to class	
Test Scenario Description	Tester is Admin or Lecturer assigning students to existing classes				
Test Title	Assign Student to Class				
Objective	To verify that students can be assigned to the correct class and are reflected in attendance sessions.				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-22	Assign student to existing class	Login as admin@attn.com → Go to Classes → Select class name → (ayu@attn.com) → Click "Assign" → Save assignments	Student is added to class; appears in class student list	As expected	Pass

Table 5.11 Test Case Logout

Part A: Project Information					
Project Name	Face Recognition for Smart Attendance System (FaceAttn)		Designed By	Janani Munusamy	
Module Name	Logout Functionality		Functional Requirement	FR10: End user session and return to login	
Test Scenario Description	Student, Lecturer, or Admin logs out from the system				
Test Title	User Logout				
Objective	To verify that the system ends the session and redirects user to the login page properly				
Part B: Test Case					
Test Case ID	Test Case Description	Test Procedure	Expected Result	Actual Result	Pass/Fail
TC-	Student logout	Login as praveen@attn.com → Click “Logout”	Redirect to login page and session cleared	As expected	Pass
TC-	Lecturer logout	Login as caroline@attn.com → Click “Logout”	Redirect to login page and session cleared	As expected	Pass
TC-	Admin logout	Login as admin@attn.com → Click “Logout”	Redirect to login page and session cleared	As expected	Pass

5.3 Non-Functional Testing

The non-functional testing conducted in this chapter demonstrates that the Face Recognition for Smart Attendance System (FaceAtten) meets the key quality attributes defined in Chapter 1, including performance, usability, security, reliability, and maintainability.

Performance testing under conditions simulating multiple concurrent users confirmed that the system remains responsive during core operations such as login, QR code scanning, location verification, and facial recognition. Even when accessed simultaneously by students using various devices, the system maintained a consistent response time, ensuring that attendance could be taken quickly without delays or bottlenecks.

Usability testing, conducted with both students and lecturers, yielded highly positive results. The majority of participants found the interface to be clean, intuitive, and easy to navigate, even without prior training. Students were able to complete the attendance process from login to face scan with minimal guidance, and lecturers were able to create attendance sessions and view attendance records efficiently.

Security testing verified that sensitive operations, such as login and facial data processing, are secured via HTTPS. User data is protected with authentication controls, and facial recognition is only accessible through secure channels. Since the system uses TensorFlow.js for on-device facial processing, no facial data is transmitted to external servers, which further enhances privacy and security.

Reliability tests, including repeated check-ins, logout/login cycles, and location/GPS tests, showed that the system remains stable during prolonged use. The system consistently handles attendance checks without data loss or unexpected errors. Even in cases of invalid QR

scans or failed facial recognition, the system produced appropriate warnings and preserved system integrity.

Maintainability checks confirmed that the codebase is modular and organized, allowing future improvements (such as adding new modules or upgrading the face recognition model) to be implemented with minimal disruption. Admin-level control over user assignments and facial image uploads also makes the system flexible and scalable.

Lastly, compatibility testing across multiple browsers like Chrome or Edge to ensure that the application works seamlessly in different environments. Students were able to complete attendance from both smartphones, provided they had camera and location access enabled.

In conclusion, the non-functional tests validate that FaceAtten not only performs its intended functions, but also does so reliably, securely, and with a user-friendly experience that meets the expectations of both students and academic staff.

5.3 User Acceptance Testing

5.3.1 Overview

The purpose of this User Acceptance Testing (UAT) is to confirm that the Face Recognition for Smart Attendance System (FaceAtten) effectively supports real user's students and lecturers in a typical classroom scenario. A total of 10 users, consisting of 8 students and 2 lecturers, participated in this testing session.

Each participant interacted with the functional prototype of FaceAtten in a simulated attendance-taking environment. They completed a standard attendance flow, which included logging in, scanning a QR code, verifying their location, and submitting their attendance through the facial recognition feature.

After completing the process, each participant filled out a structured Google Form questionnaire. The questionnaire included seven (7) questions designed to assess system usability, process flow accuracy, and overall user experience. The questions also collected both quantitative feedback (via multiple choice and Likert scale) and qualitative input (open-ended suggestions).

The sections evaluated in the questionnaire included:

1. User role identification
2. Login success
3. QR scan responsiveness
4. Location verification
5. Facial recognition accuracy
6. Ease of use rating (on a 5-point Likert scale)
7. User feedback or suggestions

This test was essential in determining whether the system meets its intended usability and functional expectations. The results and analysis of the responses are illustrated and summarized in the following section of this chapter.

5.3.2 User Acceptance Test Result

A. Demographic Information

what is your role in the system ?

10 responses

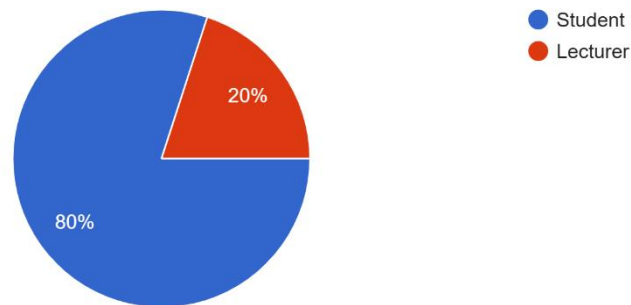


Figure 5.1 Demographic Questions

Figure 5.1 shows that 80% of the participants were students, while the remaining 20% were lecturers. A total of 10 users were involved in the testing process, consisting 8 students and 2 lecturers.

B. Usability Testing

How would you rate the ease of use of the attendance process (from login to final attendance submission)?

10 responses

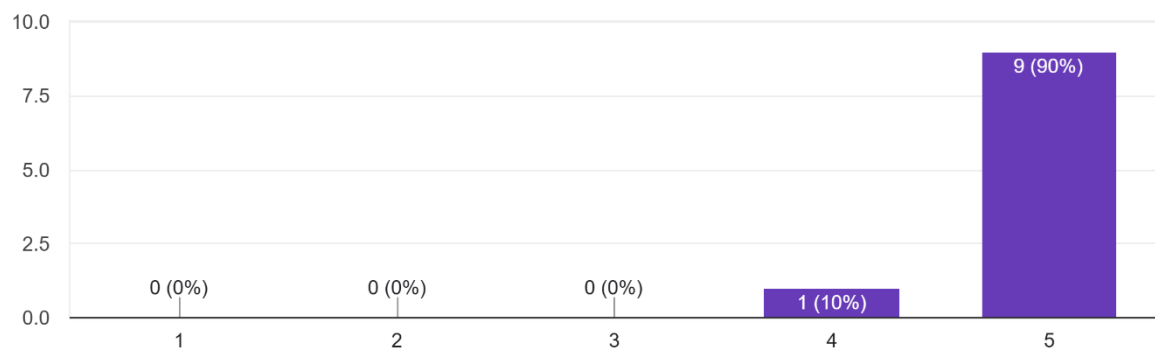


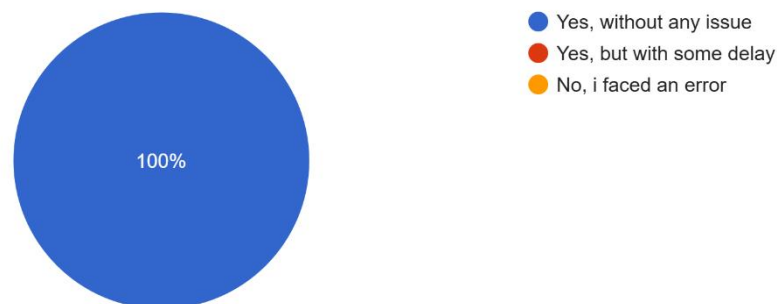
Figure 5.2 Usability Testing Questions

Figure 5.2 illustrates that 90% of users (9 out of 10) rather the attendance process as “Very Easy” (5/5), while 10% rated it as “Easy” (4/5). These results indicate a high level of user satisfaction with the system’s usability.

C. Performance Testing

Were you able to successfully log in to the system using your credentials ?

10 responses



Did the QR code scan respond correctly and guide you to the next step (location verification)?

10 responses

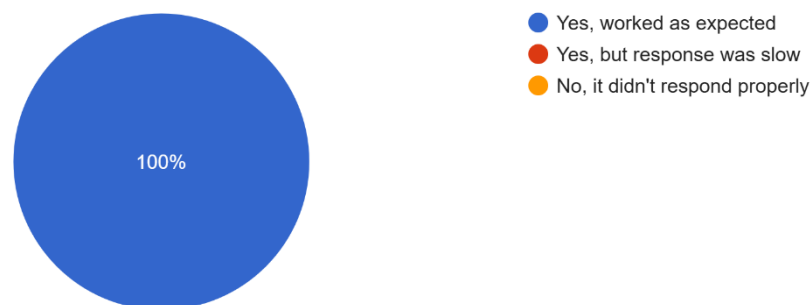


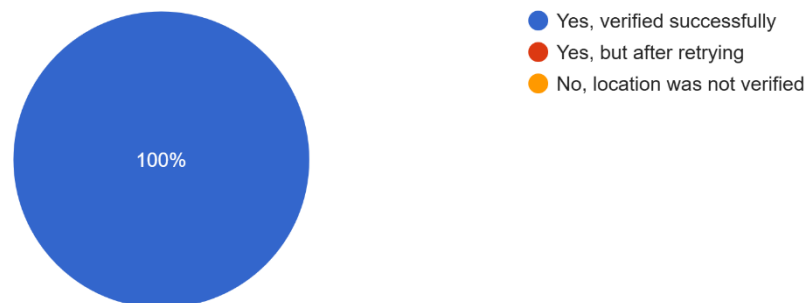
Figure 5.3 Performance Testing Question

Figure 5.3 shows, all 10 users (100%) responded “Yes, worked as expected” for both login process and QR code scanning functionality. This indicates that the system consistently performed well during initial user interactions.

D. Reliability Testing

Was your location verified successfully, and did it allow you to proceed to facial recognition ?

10 responses



Did the facial recognition feature work correctly and mark your attendance ?

10 responses

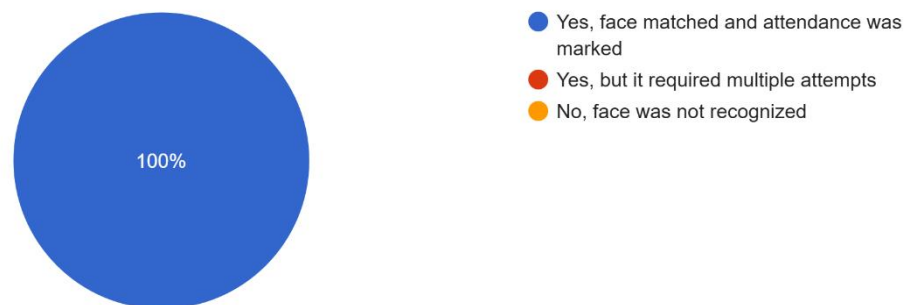


Figure 5.4 Reliability Testing Question

The figure 5.4 shows all 10 users (100%) responded “Yes, verified successfully” for both the location verification and facial recognition steps. This confirms that the system’s core verification mechanisms functioned reliably throughout the testing process.

E. Feedback

Did you experience any specific issues or have suggestions for improvement ?

10 responses

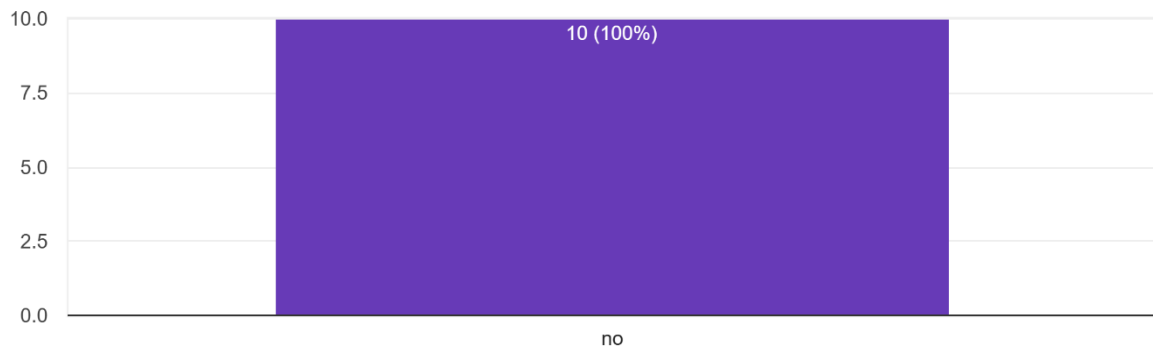


Figure 5.5 Feedback Question

Based on the figure 5.5, all 10 participants responded “No” to the question regarding issues or suggestions for improvement. This indicates that the users were generally satisfied with the system’s performance and usability, and did not encounter any significant problems during their interaction with the system.

5.4 Summary

This chapter has documented the testing strategies and results of the FaceAtten system. Functional testing validated key modules such as login, QR scanning, location verification, and facial recognition, all of which passed successfully. Non-functional testing through usability feedback helped refine the user interface and overall experience. Test outcomes indicate that the system meets its core objectives of accuracy, usability, and secure attendance tracking. Minor user suggestions have been considered for future updates to enhance system performance and accessibility.

CHAPTER 6: CONCLUSION AND FUTURE WORKS

6.1 Introduction

This chapter presents the conclusion of the Face Recognition for Smart Attendance (FaceAtten) project by summarizing the achievements, highlighting the limitations encountered during development, and proposing potential directions for future work. The system was developed to address common challenges in attendance management, particularly issues related to proxy attendance and inefficiencies in traditional methods.

6.2 Objectives Achievements

The FaceAtten system successfully fulfilled the two main objectives outlined at the beginning of the project. Firstly, the system was designed and developed as a mobile-accessible web application that incorporates facial recognition technology for accurate and contactless student attendance tracking. The implementation of the system involved integrating three layers of verification QR code scanning, GPS-based location verification, and facial recognition into a unified attendance process accessible to students, lecturers, and administrators. Secondly, the effectiveness of the system in minimizing attendance fraud was evaluated through functional and user acceptance testing. These tests demonstrated that the system performed reliably in authenticating student presence and effectively reduced the possibility of proxy attendance, which is a common issue in traditional and QR-code-only systems.

6.3 Project Limitations

Despite achieving its core objectives, the FaceAtten system has several limitations in its current version. One major limitation is that it is only available as a web-based application, which restricts its functionality in environments where internet access or browser compatibility is limited. The system cannot be used offline, and it lacks some advantages of native mobile or desktop applications, such as smoother camera integration and push notifications. In addition,

since the application utilizes TensorFlow.js for facial recognition, it requires a secure HTTPS connection to access the user's camera due to modern browser security policies. During the development phase, a self-signed SSL certificate was used in a local environment, but this method may not be suitable for deployment in production, particularly for non-technical users who may find SSL configuration challenging. Furthermore, while Ngrok and local SSL helped simulate a secure environment, the system was not fully deployed on a live hosting platform, limiting its current accessibility and scalability.

6.4 Conclusion

In conclusion, the Face Recognition for Smart Attendance system represents a practical and innovative solution for improving attendance tracking in academic settings. By combining QR code verification, GPS location tracking, and facial recognition in a single workflow, the system enhances both security and efficiency. It eliminates the need for manual attendance taking and reduces the potential for fraud, providing a more accurate method for monitoring student participation. The use of modern web technologies, a role-based interface, and client-side machine learning ensures that the system is user-friendly, secure, and adaptable to various educational environments. Although the system has not yet been deployed in a live institutional context, its successful testing and modular architecture suggest strong potential for real-world application and further enhancement.

6.5 Future Works

There are several opportunities to improve and expand the FaceAtten system in the future. One of the key recommendations is the development of dedicated mobile applications for both Android and iOS platforms. This would allow better integration with device hardware, enable offline features, and provide a smoother user experience overall. Additionally, deploying the system on a cloud-based platform with HTTPS support such as Firebase Hosting or Heroku

would enhance accessibility, eliminate local hosting constraints, and allow for scalability across institutions. The facial recognition functionality could also be improved by incorporating more advanced or custom-trained deep learning models that can handle a wider variety of facial angles, lighting conditions, and user appearances, leading to greater accuracy. Moreover, adding data analytics and reporting features for lecturers and administrators could provide valuable insights into attendance trends, enabling better classroom management. Finally, integrating the FaceAtten system with existing university infrastructure such as Learning Management Systems (LMS) or student information databases would facilitate seamless user registration and class scheduling, making the system even more practical for institutional adoption.

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Appendices

Appendix A: Survey Questions Used for Requirement Analysis

The following questions were distributed using Google Forms to gather feedback from 62 respondents (students and lecturers) regarding attendance systems and implementation of face recognition technology.

Table A.1 Table of Survey Question

Section	Question	Response Type	Source / Notes
A: Participant Background	1. Gender	Multiple Choice	Self-developed
	2. Role	Multiple Choice	Self-developed
	3. How often have you encountered issues with attendance marking?	Single Choice	Self-developed
	4. Do you have a smartphone with camera?	Single Choice	Self-developed
B: Experience with current Attendance system	5. The current attendance method used in my classes is efficient.	Likert Scale	Adapted from Kumar et al., 2023
	6. The current method is time-consuming.	Likert Scale	Self-developed
	7. I have experienced or noticed proxy attendance.	Likert Scale	Self-developed
	8. I am satisfied with the accuracy of the current attendance system.	Likert Scale	Self-developed
	9. I believe that traditional attendance methods are easy to manipulate.	Likert Scale	Adapted from Majeed et al., 2022
C: Perception of QR Code + Face Recognition	10. QR code + face recognition will improve attendance security.	Likert Scale	Self-developed, based on review
	11. A dual-authentication system (QR + Face) is more reliable than QR alone.	Likert Scale	Self-developed

	12. I am comfortable using face recognition technology for attendance.	Likert Scale	Adapted from Sundar et al., 2024
	13. Face recognition helps prevent cheating attendance.	Likert Scale	Adapted from Sundar et al., 2024
	14. This system will save time compared to manual methods.	Likert Scale	Adapted from Sundar et al., 2024
D: Concerns About Privacy and Security	15. I am concerned about how my face data will be stored and used.	Likert Scale	Adapted from Council et al., 2025
	16. I believe face recognition can protect personal data securely.	Likert Scale	Adapted from Bécue & Champod, 2022
	17. I am willing to use face scanning if privacy is guaranteed.	Likert Scale	Self-developed
	18. I trust this system will not be misused.	Likert Scale	Self-developed