IMPLEMENTATION OF A WEB-BASED FACIAL RECOGNITION ATTENDANCE SYSTEM

BY

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A PROJECT REPORT SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE, FACULTY OF PHYSICAL SCIENCE, UNIVERSITY OF BENIN, BENIN CITY, EDO STATE.

IN PARTIAL FUFILMENT OF THE REQUIREMENT FOR THE AWARD OF A BACHELOR OF SCIENCE (B.Sc.) DEGREE IN COMPUTER SCIENCE

NOVEMBER 2025

CERTIFICATION

This is to certify that this project work was carried out by IYAWE OSAGIE GREGORY with Matriculation Number PSC2105347 under my supervision. It is adequate and satisfactory, both in scope and content, for the award of a Bachelor of Science (B.sc) Degree in Computer Science of the University of Benin.

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PROF. F.O. CHIETE **DATE**

Project Supervisor

APPROVAL

This project work is hereby approved in partial fulfilment of the requirements for the award of Bachelor of Science (B.Sc.) Degree in Computer Science from the University of Benin.

______________________________ ______________________________

DR. (MRS.) ROSEMARY USIOBAIFO **DATE**

Head of Department

DEDICATION

This project is dedicated to God Almighty for giving me the strength and guidance to see it through to completion, and throughout my stay in the University of Benin. It is also dedicated to my parents; Arch and Mrs Iyawe and to my siblings; for their love, support and guidance throughout my academic journey.

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ABSTRACT

Attendance management in academic tertiary institutions is a critical administrative task that directly impacts the credibility of academic records. Traditional methods such as manual roster calls, paper-based attendance sheets, and ID card verification have proven inefficient, time-consuming, and vulnerable to impersonation attendance fraud.

This project highlights the necessity for automated attendance systems using modern technologies such as biometric verification, Radio Frequency Identification (RFID) tracking, and facial recognition. Considering the operational constraints and specific requirements of the University of Benin, Department of Computer Science, this project proposes a Web-Based Facial Recognition Attendance System as an optimal solution.

The project focuses on implementing a functional prototype of the facial recognition attendance system, where students register their facial biometrics during enrollment and subsequently mark attendance by scanning their faces via a web-based application. The system follows an object-oriented approach to system analysis and design, utilizing use case diagrams, class diagrams, and sequence diagrams to model the system architecture. These designs form the foundation for a system capable of handling the complete attendance process from student authentication to generating real-time attendance reports for courses offered by the Department of Computer Science.

The key features of this attendance system include real-time face detection, liveness verification to prevent bypass attempts, and geolocation validation to ensure attendance is marked within authorized locations. The system also provides administrative dashboards for attendance monitoring and analytics. By implementing this solution, the University of Benin would probably have achieved a more secure, efficient, and fraud-resistant attendance management system compared to conventional methods

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Facial recognition technology has emerged as a transformative solution in attendance management systems, offering contactless, efficient, and secure alternatives to traditional methods like manual roll calls or fingerprint scanning (Scribd, n.d.). The global shift toward digital transformation in educational and corporate environments has accelerated the adoption of biometric systems, with facial recognition standing out due to its non-intrusive nature and ability to leverage existing hardware (Lu Chen, 2025). Recent advancements in computer vision algorithms, particularly those based on artificial intelligence and machine learning, have significantly improved recognition accuracy under varying conditions.

Web-based implementations of these systems provide added advantages of portability, real-time processing, and seamless integration with cloud-based attendance records. The COVID-19 pandemic further highlighted the need for touchless attendance solutions, prompting innovations that combine facial recognition with mask detection capabilities (WHO, 2020). This study builds upon existing work in facial recognition systems while focusing specifically on optimizing the implementation for web-based platforms to enhance usability and accessibility.

In academic tertiary institutions worldwide, attendance tracking remains a critical administrative task that directly impacts the integrity of academic records. Traditional methods such as manual roster calls, paper-based attendance sheets, and ID card verification have been widely used in universities, including the University of Benin. These methods require students to physically sign or present identification, which is time-consuming, labour-intensive, and vulnerable to impersonation attendance fraud (InfoPlus Commerce, 2022).

With technological advancements, institutions have adopted digital solutions like barcode scanners, RFID cards, and biometric systems (fingerprint recognition). However, these methods face limitations: barcodes can be damaged or forged (Adaptalift, 2012), fingerprint scanners raise hygiene concerns, and RFID cards are prone to loss or misuse.

Facial recognition technology (FRT) has emerged as a contactless, efficient alternative. Powered by artificial intelligence and deep learning, FRT can identify individuals in real-time with high accuracy (Vasundhara, et al., 2022). Web-based FRT systems are particularly advantageous as they leverage smartphone cameras, eliminating the need for specialized hardware. At the University of Benin, where large class sizes make manual attendance cumbersome, a web-based facial recognition system could streamline the process while maintaining security.

1.2 Statement of the Problem

The current attendance system at the University of Benin faces significant challenges that compromise its effectiveness. Manual methods require substantial time investment from both staff and students, often disrupting the flow of lectures and examinations. These traditional approaches lack robust mechanisms to prevent proxy attendance, where students may falsify their presence in class. Environmental factors such as poor lighting or camera angles further complicate biometric verification processes. Existing digital solutions either prove too costly for widespread implementation or fail to provide real-time attendance monitoring capabilities. The absence of a reliable, automated system has created administrative bottlenecks and raised concerns about the accuracy of attendance records. These issues collectively highlight the need for an innovative solution that can overcome these limitations while remaining accessible and user-friendly.

1.3 Aim and Objectives of the Study

The primary goal of this research is to develop a web-based facial recognition system that revolutionizes attendance tracking at the University of Benin. This system aims to achieve the following objectives:

i. Develop an intuitive web interface for face registration and attendance marking.
ii. Integrate OpenCV/Dlib for real-time face detection with $\geq$95% accuracy.
iii. Implement liveness verification to prevent impersonation attendance fraud.
iv. Ensure compatibility with the University of Benin's existing systems.
v. Provide real-time attendance reports for lecturers.

1.4 Significance of the Study

The implementation of this facial recognition attendance system carries substantial importance for academic institutions. Beyond the immediate benefits of automated attendance tracking, the project represents a significant step toward digital transformation in education administration. For the University of Benin specifically, this system offers a solution to longstanding challenges in managing large student populations while maintaining accurate records. This system will help the University of Benin to realize the following:

1. Saving Time: the system will reduce the time and resources currently devoted to manual attendance methods.
2. Enhancing Security: Liveness detection curbs impersonation.
3. Improving Hygiene: Eliminates contact-based biometrics.
4. Providing Analytics: The creation of digital attendance records also facilitates better data analysis and reporting capabilities, enabling more informed decision-making by faculty and administrators.

1.5 Scope of the Study

This research focuses specifically on the implementation of a web-based facial recognition attendance system tailored for the University of Benin's Department of Computer Science. The development will concentrate on creating user-friendly interfaces for both Android and iOS platforms, ensuring broad accessibility for students and staff. While the project encompasses the complete user experience design, it acknowledges certain limitations regarding backend processing and hardware dependencies. The scope includes testing the system's performance under typical classroom conditions but excludes extensive modifications to existing university infrastructure. Special consideration is given to maintaining compliance with regulations while delivering a practical solution that can be readily adopted within the academic environment.

1.6 Limitations of the Study

This research is constrained by several important limitations. Primarily, the project focuses on implementation and relies on established facial recognition methods rather than attempting to improve the underlying facial recognition algorithms. Furthermore, while testing was conducted in controlled educational environments, real-world classroom settings might present unforeseen challenges. The system's performance also remains subject to the hardware limitations of devices, particularly older models with lower-quality cameras. Although ethical and privacy considerations are acknowledged, they are not the primary focus of this work, unlike specialized studies on biometric data protection. The project does not address advanced challenges like sophisticated bypass attacks that commercial systems encounter, as its scope is instead focused on basic liveness detection.

CHAPTER TWO

LITERATURE REVIEW

This chapter reviews existing literature relevant to the development of a web-based facial recognition attendance system. It examines traditional attendance systems, biometric technologies, face recognition methods, and recent innovations addressing previous limitations. The review also highlights the theoretical and conceptual foundations upon which the current project is based.

2.1 Theoretical Background

Face recognition is a subfield of computer vision and artificial intelligence concerned with identifying or verifying individuals based on their facial features. It integrates principles from image processing, pattern recognition, and machine learning to develop systems capable of interpreting human faces in digital images or video frames. The fundamental theory of facial recognition relies on representing of facial features as numerical data that can be analyzed by algorithms for classification and comparison purposes (Zhao, et al., 2003). The process generally involves three main stages: face detection, feature extraction, and classification or matching. Detection locates a face within an image; feature extraction encodes unique patterns such as eye spacing, nose length, or jaw shape; and classification matches these encodings to known identities in a database (Goodfellow, et al., 2016).

Theoretical developments in face recognition can be traced to early statistical approaches. The Eigenfaces method, introduced by Turk and Pentland (1991), was among the first successful implementations using Principal Component Analysis (PCA) to represent facial images in a reduced-dimension feature space. This approach demonstrated that key facial patterns could be captured through mathematical decomposition, but it was sensitive to variations in illumination and head pose. Later, Linear Discriminant Analysis (LDA) improved upon PCA by maximizing the separation between individuals' classes (Belhumeur, et al., 1997). Other dimensionality-reduction techniques, such as Independent Component Analysis (ICA), further refined the extraction of statistically independent facial features.

However, classical linear models struggled to generalize across diverse lighting, occlusion, and age variations. The shift toward machine learning and, later, deep learning frameworks marked a significant theoretical advancement. Convolutional Neural Networks (CNNs) revolutionized face recognition by learning hierarchical feature representations directly from raw images (Goodfellow, et al., 2016). CNN-based models like DeepFace, FaceNet, and VGGFace achieved human-level accuracy through end-to-end training on large-scale datasets (Schroff, et al., 2015). These architectures combine convolutional filters, pooling layers, and embedding spaces to automatically capture both local and global facial patterns, providing robustness against rotation, pose, and illumination changes.

The use of face recognition in attendance systems builds upon biometric authentication theory, which asserts that physiological or behavioral characteristics provide reliable identity verification (Jain, et al., 2004). Among all biometric traits, facial recognition offers non-contact and passive identification, making it more user-friendly and hygienic than fingerprints or iris scans. Theoretically, deep learning models enhance biometric reliability by mapping facial images into multidimensional embedding spaces, where faces of the same person cluster closely while different individuals remain separated (Schroff, et al., 2015).

Recent works demonstrate that CNN-based embeddings outperform earlier handcrafted features. Essien and Ansa (2023) applied a Multi-Task Convolutional Neural Network (MTCNN) for face detection, combined with the FaceNet-512 embedding model for recognition. Their theoretical framework highlights how deep feature learning captures complex nonlinear relationships within facial structures. Similarly, Thalor and Gaikwad (2023) developed an end-to-end attendance monitoring model using CNNs, illustrating the capability of neural networks to learn discriminative features automatically without manual preprocessing. These models are grounded in the principle of representation learning, where hierarchical features become progressively more abstract and invariant to noise.

The theoretical underpinnings of web-based face recognition systems are based on client–server architecture and real-time data streaming principles. A typical system employs a webcam as an input device that captures facial images, transmits them to a server for preprocessing, and receives recognition results through an API interface. Ismail, et al. (2022) designed a web-based university classroom attendance system utilizing deep learning for face recognition, integrating front-end interfaces with a cloud-hosted model. Their study emphasized the feasibility of deploying advanced CNNs within browsers using frameworks such as TensorFlow.js and Face API, aligning with this project's use of Face.js and PHP.

Furthermore, Naveen Raj and Vadivel (2023) incorporated geolocation features within their attendance framework, adding a layer of contextual authentication. This theoretical extension merges biometric verification with spatial validation, mitigating impersonation and proxy attendance. In such systems, face recognition is not an isolated module but a component within a distributed network of web technologies, database management systems, and security protocols.

Recent theoretical advancements also address scalability and real-time performance. Traditional algorithms typically process one face per frame, but in environments such as classrooms or offices, multiple faces must be recognized simultaneously. Krishna, et al. (2023) proposed a multiple face recognition attendance system based on deep learning, employing region-based detectors to extract several facial embeddings concurrently. This work builds on the theoretical premise of parallelized detection pipelines, in which feature extraction layers process multiple sub-regions simultaneously to minimize latency.

The challenge of illumination, mask-wearing, and partial occlusion (highlighted during and after the COVID-19 pandemic) has also influenced modern theory. The 2025 AIP Conference paper on "Automatic Student Attendance System Based on Face Recognition" proposed convolutional attention modules that enhance feature representation under variable conditions. This aligns with the principle that adaptive weighting within neural layers can simulate human visual focus, improving recognition in unconstrained environments.

From a theoretical perspective, system performance depends on the accuracy, precision, and recall of the recognition module, as well as computational efficiency. Lateef (2023) emphasized that practical deployments require balancing recognition accuracy with processing time, memory, and bandwidth. Theoretical evaluation metrics such as false acceptance rate (FAR) and false rejection rate (FRR) quantify system reliability, while ROC curves illustrate the trade-off between sensitivity and specificity.

In web-based implementations, latency is influenced by model size and browser computation limits. Essien and Ansa (2023) and Ismail, et al. (2022) both noted that lightweight CNN architectures and compressed embeddings are essential for maintaining responsiveness. These insights align with theoretical considerations of algorithmic complexity and resource optimization.

2.2 Conceptual Review

Attendance management systems are designed to record, monitor, and manage the presence of individuals in an organization, school, or workplace. Traditionally, attendance has been tracked manually using paper sheets or roster calls, but this method is prone to human error, manipulation, and inefficiency (Kaur & Kaur, 2020). The evolution of technology has led to the development of automated systems using RFID, biometric, and facial recognition technologies to ensure accuracy and reliability in attendance records. These systems not only streamline data collection but also integrate with databases for automated processing and reporting (Patil & Kolekar, 2021).

Biometric systems rely on measurable physical or behavioral characteristics that uniquely identify individuals. Common modalities include fingerprints, iris scans, voice recognition, and facial recognition. Biometric-based attendance systems are more secure than manual or RFID systems because they directly verify an individual's identity based on biological traits (Singh & Agarwal, 2019). However, different biometric methods vary in accuracy, cost, and usability. Facial recognition, in particular, has gained attention due to its non-intrusive nature and the ease of capturing images without physical contact (Nguyen, et al., 2020).

Face recognition is a subset of computer vision and artificial intelligence that involves identifying or verifying individuals using their facial features. The process generally involves three key stages: face detection, feature extraction, and face matching (Jain & Li, 2011). Recent advancements in deep learning, particularly convolutional neural networks (CNNs), have significantly improved the accuracy of face recognition systems (Schroff, et al., 2015). This technology has found applications in security, surveillance, authentication, and attendance systems. Compared to other biometric methods, facial recognition is contactless, fast, and user-friendly, making it suitable for institutions and organizations (Zhao, et al., 2020).

Artificial Intelligence (AI) and Machine Learning (ML) form the backbone of modern face recognition systems. AI enables machines to simulate human intelligence, while ML allows them to learn from data and improve their performance over time (Russell & Norvig, 2020). Deep learning, a subset of ML, utilizes neural networks to analyze large datasets of facial images, allowing systems to detect complex patterns and features that distinguish one individual from another (Parkhi, et al., 2015). AI-powered facial recognition systems such as FaceNet and DeepFace have demonstrated near-human accuracy in recognition tasks (Taigman, et al., 2014).

Web-based attendance systems utilize internet technologies to allow remote access, data storage, and management through browsers. This approach provides flexibility, real-time synchronization, and integration with other enterprise applications such as payroll or academic management systems (Gupta & Chauhan, 2018). By combining web technologies with facial recognition, organizations can automate attendance tracking, store data securely in the cloud, and generate analytical reports. Moreover, PHP and JavaScript libraries such as face-api.js make it easier to build real-time browser-based face recognition applications (Abiola, et al., 2021).

While face recognition technology enhances security and convenience, it also raises privacy and ethical concerns. Collecting and processing biometric data involves handling sensitive personal information, which must comply with data protection laws such as the General Data Protection Regulation (GDPR) (Raji & Buolamwini, 2019). Ethical implementation requires transparency, user consent, and secure data handling to prevent misuse and bias. Developers must ensure that their systems are designed with fairness, accountability, and accuracy to avoid discrimination or data breaches (Whittaker, et al., 2021).

The conceptual framework of a face recognition attendance system integrates computer vision, machine learning, and web technologies to automate attendance marking. The camera captures facial images, which are processed through a recognition model to identify registered users. The recognized faces are matched with database records, and attendance logs are updated automatically. The system operates on three core concepts: automation, accuracy, and security to ensure reliability and efficiency in attendance management (Kumar, et al., 2020).

2.3 Review of Traditional and Modern Attendance Systems

Attendance management has long been an essential component of organizational efficiency, particularly in educational institutions and workplaces. Different attendance systems have evolved over time, from traditional manual methods to advanced biometric and facial recognition-based systems. This section reviews the major categories of attendance systems, outlining their features, limitations, and contributions to the field of automated attendance management.

2.3.1 Manual Attendance Systems

Manual attendance systems involve the traditional recording of attendance through physical registers, sign-in sheets, or verbal roll calls. This method, though simple and low-cost, has been criticized for being time-consuming and prone to human errors such as proxy attendance, loss of records, and difficulty in data retrieval (Okafor & Eze, 2019). Teachers or supervisors typically record the presence of individuals by marking names, which creates challenges in large groups due to inefficiency and lack of accuracy.

According to Singh and Sharma (2020), the manual approach limits the reliability of attendance data, particularly in institutions where punctuality and performance tracking are critical. Additionally, the manual method lacks real-time monitoring and integration with other administrative systems, making it unsuitable for modern digital environments. While it remains in use in some developing regions due to limited infrastructure, the need for automation has driven institutions toward adopting digital and biometric solutions (Afolayan, et al., 2021). As shown in Figure 2.1, manual attendance is recorded on paper, which is prone to transcription errors and time delays.

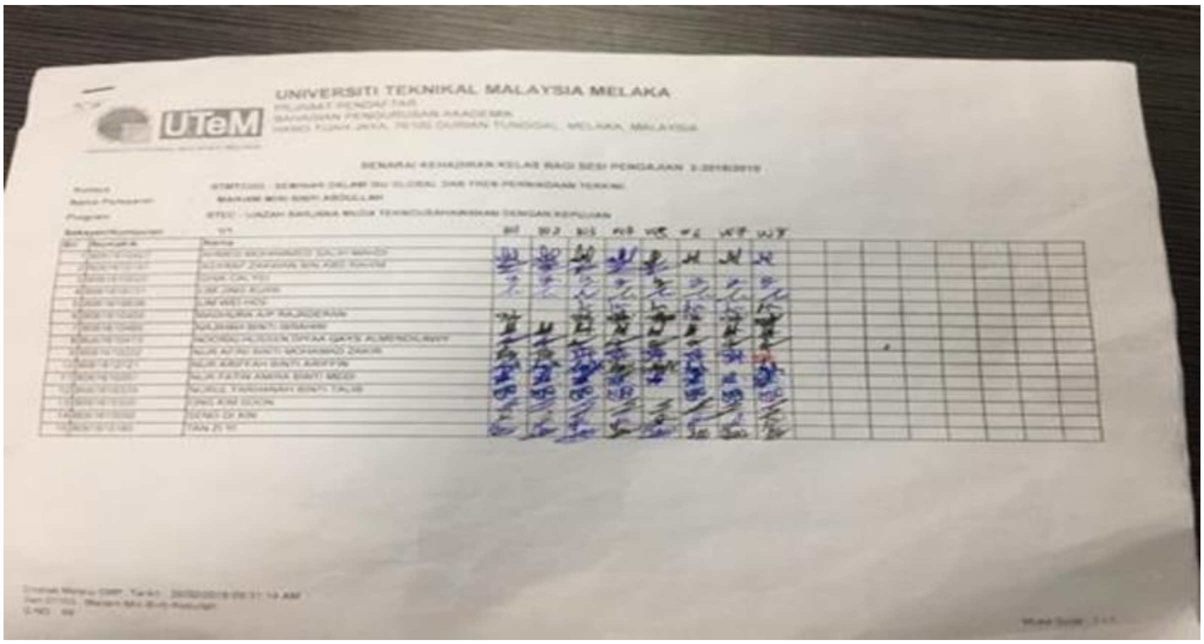
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Figure 2.1: Manual attendance register used for roll calls.

2.3.2 Biometric Attendance Systems

Biometric attendance systems represent a technological advancement over manual systems by using physiological or behavioral characteristics such as fingerprints, iris patterns, or voice recognition to authenticate individuals (Kumar & Kaur, 2020). These systems enhance accuracy, security, and efficiency by minimizing the chances of impersonation or attendance manipulation. Fingerprint-based systems, for instance, have been widely deployed in schools and offices due to their cost-effectiveness and reliability (Nair, et al., 2021).

However, despite their advantages, biometric systems are not without drawbacks. Hygiene concerns have been raised with contact-based systems, particularly after the COVID-19 pandemic, which discouraged physical contact with shared surfaces (Patil & Deshmukh, 2021). Moreover, fingerprint and iris recognition systems can suffer from poor performance when sensors are exposed to dirt, moisture, or lighting issues (Oladipo & Adeyemi, 2022). The cost of implementation and maintenance is also a barrier for small organizations. These challenges have led to the growing adoption of contactless systems, such as facial recognition, which offers greater convenience and automation. Figure 2.2 illustrates a typical fingerprint scanner used to authenticate users for attendance capture.

Figure 2.2: Fingerprint scanner (biometric device) used for automated attendance logging.

2.3.3 Facial Recognition Attendance Systems

Facial recognition attendance systems (FRAS) represent the latest evolution in automated attendance management. They utilize computer vision and artificial intelligence (AI) techniques to identify and verify individuals based on facial features captured through cameras (Zhang, et al., 2020). Unlike biometric systems that require physical contact, facial recognition operates passively, enabling seamless and non-intrusive attendance capture.

According to Li and Zhao (2021), facial recognition systems use deep learning algorithms and convolutional neural networks (CNNs) to detect and match faces in real time. This technology significantly reduces fraud, as it can identify unique facial landmarks even under varying lighting or pose conditions. Moreover, the integration of facial recognition with web-based platforms has enabled remote attendance monitoring, which is beneficial for hybrid learning or work environments (Rahman, et al., 2022).

Nonetheless, challenges such as data privacy, facial occlusion, and algorithmic bias remain concerns in deploying facial recognition systems. Ethical considerations regarding surveillance and data protection have also been raised (Suresh & Thomas, 2022). Despite these issues, facial recognition systems continue to gain traction due to their accuracy, automation capabilities, and ability to interface with modern cloud-based systems for analytics and reporting. Figure 2.3 shows the facial recognition interface, where detected faces are tracked and attendance is automatically logged.

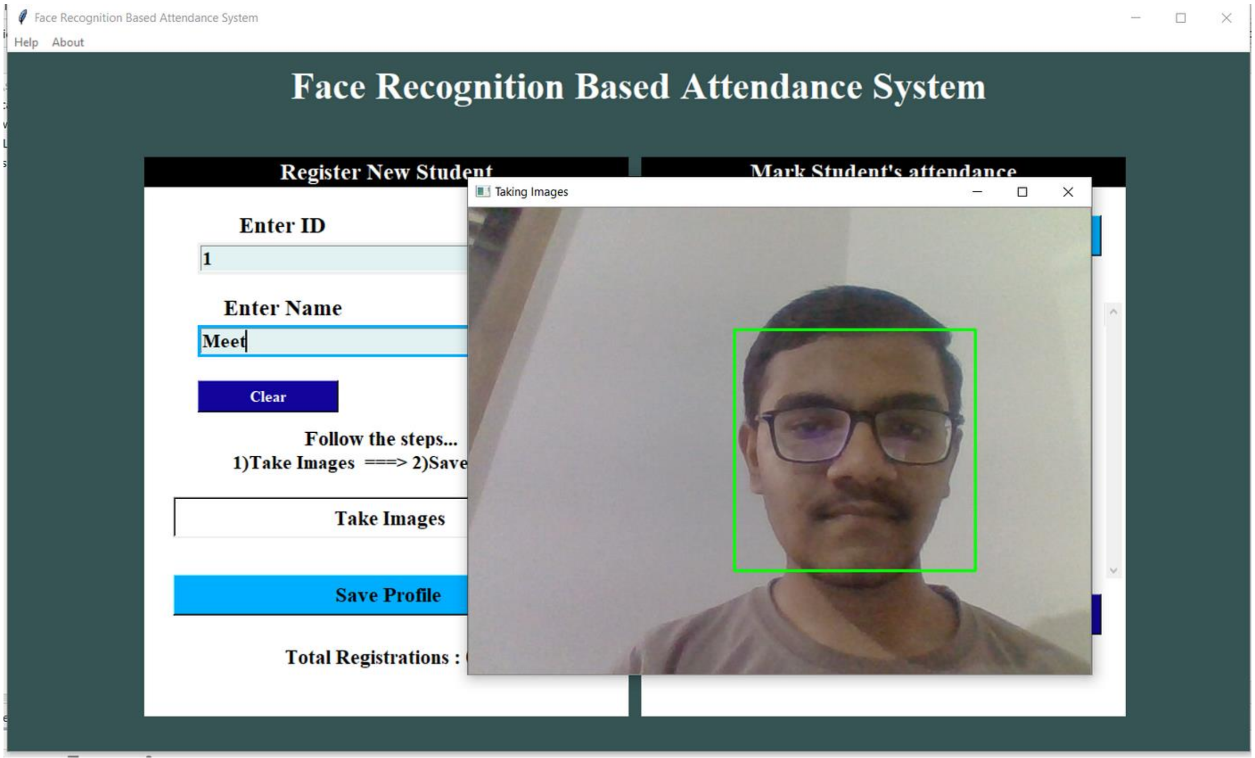


Figure 2.3: Facial recognition attendance interface showing detected faces and attendance confirmation.

2.4 Related Research Studies

The development of facial recognition technology has evolved through decades of research, progressing from traditional image-processing methods to advanced deep-learning techniques. A review of related studies provides insight into how different researchers have approached the automation of attendance systems using facial recognition. These studies highlight the evolution of algorithms, tools, and system architectures that have improved accuracy, speed, and user convenience. Examining prior works helps to establish the theoretical foundation for this project and identifies gaps in existing systems, such as limitations in scalability, liveness detection, and platform integration that the present study aims to address. The following subsections discuss early studies on face recognition, recent developments in deep learning, implementations on web and mobile platforms, and a comparative analysis of related works.

2.4.1 Early Studies on Face Recognition

Early work in face recognition laid the foundation for subsequent attendance tracking applications. In the domain of generic face recognition tasks (rather than attendance specifically), large deep-network architectures such as DeepID3 demonstrated high performance: for example, Sun, et al. (2015) proposed two very deep networks for identification-verification tasks and achieved 99.53 % on LFW verification using ensembles of "very deep" convolutional and inception-style architectures (Yi Sun, et al., 2015). These early efforts emphasized the capability of deep convolutional nets to learn highly discriminative facial embeddings, paving the way for biometric applications beyond research labs.

In more applied settings, simpler machine-learning methods and classical image-processing techniques were used. For example, studies implementing attendance systems using algorithms such as Local Binary Patterns (LBP), Haar Cascades for detection and simpler classifiers were common. One exploratory study noted the use of LBPH (Local Binary Pattern Histogram) and LBPN (Local Binary Pattern Network) in attendance systems, pointing out their limitations in handling illumination, occlusion and pose variation (Mochamad, et al., 2022). These early systems often operated on desktop/PC platforms, lacked mobile or web integration, and had limited real-time performance, but they provided useful insight into core challenges (face detection, feature extraction, recognition accuracy) for attendance tracking systems.

2.4.2 Recent Research Using Deep Learning

More recent research leverages deep learning more fully for face recognition in attendance systems. For instance, a study titled "Deep Learning in Face Recognition for Attendance System: An Exploratory Study" examined the transition from conventional methods to deep architectures (CNNs) and found promising results in terms of accuracy and robustness (Mochamad, et al., 2022). Another work, "Implementation of Face Recognition for Lecturer Attendance Using Deep

Learning CNN Algorithm," applied a CNN-based approach for lecturers at an Indonesian university and demonstrated that it improved reliability of attendance marking compared to manual or less-automated methods (Fajhar, et al., 2024). These systems often integrate convolutional neural networks for feature extraction, sometimes combined with face-embedding techniques, and report higher accuracy under controlled environments.

In addition to improving recognition performance, there has been work on optimizing models for speed and resource-efficiency. For example, the lightweight network MobiFace was proposed for mobile face recognition: it achieved 99.73 % on LFW and 91.3 % on the MegaFace challenge, while using fewer weights and lower computational cost than large networks (Chi Nhan Duong, et al., 2018). This kind of model is directly relevant when considering mobile or edge-device deployment of attendance systems where hardware constraints matter.

2.4.3 Web and Mobile-Based Implementations

As attendance systems move beyond desktop labs into classrooms and workplaces, web and mobile platforms have become important. A study titled "Enhancing Attendance Management with Facial Recognition: A Web and Mobile-Based System" describes an Android-based front end for students, uses image-processing libraries (e.g., OpenCV, Python Face Recognition) on the backend and integrates a web dashboard for administration (Adebimpe, et al., 2025) Another work, "Implementation of Face Recognition, Attendance Detection, and Geolocation using TensorFlow Lite and Google ML Kit in a Mobile Attendance Application" incorporated face recognition, liveness detection and geolocation to improve the validity of attendance, that is, confirming the device is at a valid location (Fajar & Nunik, 2025). Similarly, Fadillah and Jalil (2023) in "Design of an Attendance Application System Using Face Recognition and Location Based on Android" employed both face recognition and GPS location for an Android app aimed at improving accuracy of employee attendance. These studies reflect the trend towards mobile/web hybrid systems and highlight additional challenges: device performance, network latency, user interface design, liveness detection, and integration with backend systems.

2.4.4 Comparative Analysis of Related Works

Comparing across the related studies cited in this literature review chapter some key dimensions:

Recognition algorithm/complexity: Early systems often used classical techniques (LBPH, Haar cascade) that performed acceptably but struggled under pose/lighting variation. Recent deep-learning systems (CNNs, lightweight nets) achieve higher accuracy but may require more compute and data. For example, the exploratory study on deep learning for attendance systems highlights this trade-off (Mochamad, et al., 2022).

Platform/Deployment context: Some systems remain desktop-based; others move to mobile or web. The mobile/web implementations bring convenience and scalability but also new issues such as device heterogeneity, network connectivity, and geolocation verification.

Attendance specific features: Systems designed for attendance incorporate domain-specific features such as multiple snapshots over time (to confirm presence), integration with course/unit/roll-call databases, anti-spoofing/liveness detection, and sometimes geolocation. An example is the “AttenFace: A Real Time Attendance System using Face Recognition” which uses snapshots and a threshold over time for attendance rather than a single moment capture (Ashwin Rao, 2022).

Challenges and limitations: Across studies, recurring challenges are posed by lighting, pose variation, occlusion, spoofing (e.g., using photographs), the need for high-quality cameras or hardware. The hardware-based attendance system study remarks on processing large amounts of facial data requiring robust hardware and the limitation of camera resolution/processing power (Oluyemi, et al., 2024).

Scope and scalability: Many research systems are prototypical with limited user populations (students, lecturers) and controlled settings. As systems scale (hundreds or thousands of users, multiple concurrent classes), issues of database size, recognition time, concurrency, and latency become more significant. The survey "A Survey on Face Recognition Based Attendance System" synthesizes multiple works, highlighting future directions (scalability, mobile deployment, robustness) for the field (Anuj, et al., 2024).

2.5 Limitations of Existing Systems

Traditional attendance systems, such as manual paper-based registers and sign-in sheets, have long been used in academic and organizational settings. However, these systems suffer from several limitations that undermine their reliability, accuracy, and efficiency. Manual attendance recording is prone to human errors, such as incorrect entries, illegible handwriting, and omissions, which compromise the accuracy of attendance data (Kumar & Singh, 2019). Additionally, this method is time-consuming, particularly in large classes or organizations where verifying each individual's presence can take several minutes (Sharma, et al., 2020).

Another significant limitation of manual systems is susceptibility to manipulation and fraud, including proxy attendance fraud, where one person signs for another, making it difficult to ensure the authenticity of attendance records (Ojo & Adeniran, 2021). Maintaining and retrieving records over time is also cumbersome since paper-based records require physical storage and manual searching, leading to inefficiency in data management (Nandhini & Balasubramanian, 2020).

Moreover, manual systems do not provide real-time monitoring or analytics, making it challenging for administrators to track attendance trends or detect irregularities quickly. As educational institutions and workplaces continue to digitize, these shortcomings have created a strong need for automated and intelligent systems that enhance accuracy, security, and efficiency in attendance management (Mishra, et al., 2021).

2.6 Current Innovations and Solutions

To address the limitations of traditional and biometric attendance systems, facial recognition technology has emerged as an innovative solution that leverages artificial intelligence (AI) and computer vision. Modern systems integrate deep learning algorithms such as Convolutional Neural Networks (CNNs) to automatically detect, extract, and recognize faces with high accuracy (Zhao, et al., 2021). These systems minimize human intervention, making attendance tracking faster, more secure, and less prone to errors.

Recent innovations have seen the integration of web-based and mobile applications that allow real-time facial recognition using cameras embedded in smartphones or computers (Alvi, et al., 2022). Such systems store attendance data in cloud databases, enabling remote monitoring and automated report generation. The proposed system in this project adopts a face recognition-based attendance mechanism that utilizes Face.js models in combination with PHP for web integration, providing a low-cost, accessible, and scalable solution compared to proprietary commercial systems.

Furthermore, facial recognition systems overcome the limitations of other biometric methods such as fingerprint or iris recognition, which require physical contact or specialized sensors (Bhattacharya & Ghosh, 2020). This contactless nature improves hygiene and usability, especially in post-pandemic environments. In addition, facial recognition systems can be integrated with other technologies, such as Internet of Things (IoT) and cloud computing, for improved scalability, real-time monitoring, and data analytics (Jain, et al., 2021).

The continued improvement of deep learning frameworks, open-source libraries (e.g., OpenCV, TensorFlow, and Dlib) and hardware acceleration (via GPUs) has made facial recognition systems more reliable and efficient. Consequently, this technology provides a modern, intelligent, and user-friendly solution for attendance management, aligning with digital transformation trends in education and corporate sectors (Chowdhury, et al., 2023).

2.7 Related Literature

Face-recognition-based attendance systems have become a central research area in computer vision, pattern recognition, and artificial intelligence. Over the past decade, numerous studies have sought to improve the efficiency, reliability, and accuracy of such systems, particularly for academic institutions and corporate environments. The development of deep learning has been a major turning point, replacing the traditional methods that relied heavily on handcrafted feature extraction. The following section reviews notable works that have influenced current designs and implementations of intelligent attendance systems.

Early studies focused on the use of principal component analysis (PCA) and linear discriminant analysis (LDA) to identify distinguishing facial features. While these approaches offered acceptable results in controlled environments, they lacked robustness under real-world conditions involving occlusion, variable lighting, and diverse head poses. As Dixit (2024) explains, such conventional algorithms often led to misclassifications when environmental constraints changed, thereby limiting their applicability for large-scale attendance tracking. The introduction of deep convolutional neural networks (CNNs) addressed many of these deficiencies by learning hierarchical representations of facial structures directly from raw image data. Consequently, CNN-based systems have achieved significantly higher recognition rates compared to classical methods, especially when trained on large-scale datasets such as LFW and VGGFace2.

According to Lateef (2023), integrating CNNs into attendance management platforms not only enhanced facial-matching accuracy but also reduced administrative burdens in academic settings. His research emphasized the importance of a user-friendly interface and language localization, proposing an attendance interface that maintained full functionality even in low-resource computational settings. This adaptation highlighted the growing need for inclusivity and accessibility in smart attendance systems, ensuring that technological solutions are culturally and linguistically relevant.

Further advancements have focused on mitigating security vulnerabilities such as spoofing and replay attacks. Ming, et al. (2020) presented a comprehensive survey on face anti-spoofing methods and concluded that systems using only RGB images were highly susceptible to photo or video forgeries. They recommended the use of multi-spectral imaging or depth estimation to ensure liveness detection. Yu, et al. (2021) expanded upon this by analyzing deep-learning-based liveness detection approaches, introducing architectures that can detect micro-expressions, eye blinks, and subtle skin movements that are difficult to replicate with static media. Their study demonstrated that combining temporal and spatial cues significantly improves the robustness of face-recognition systems in practical deployments.

At the same time, ethical and privacy issues surrounding biometric data have gained attention in both academic and regulatory discussions. As noted by Sharma, et al. (2023), while face recognition has proven to be convenient for automation, it introduces considerable privacy risks if data handling is not properly managed. Their survey of presentation-attack detection mechanisms also highlighted the necessity of implementing data-protection measures, user consent, and secure storage protocols when collecting biometric information. These insights have encouraged developers and institutions to adopt privacy-preserving frameworks such as federated learning and differential privacy, which train models collaboratively without transmitting raw facial images to centralized servers. Such approaches not only comply with international data-protection regulations but also enhance user trust.

The evolution of research in this field has also emphasized the need for scalability and deployment efficiency. Several recent implementations, such as those reviewed by Huang, et al. (2024), have shown that lightweight deep-learning architectures can run on edge devices, eliminating the need for expensive centralized servers. Edge-based recognition reduces latency and bandwidth requirements, making these systems suitable for real-time attendance tracking in schools and offices with limited infrastructure. Moreover, combining face recognition with complementary technologies such as RFID cards, QR codes, or fingerprint verification has emerged as a practical solution to overcome single-modality failures. These hybrid systems provide a fallback mechanism whenever facial matching confidence is low or environmental conditions degrade image quality.

From a governance standpoint, the legal landscape around facial recognition is evolving rapidly. Regulatory bodies such as the UK Information Commissioner's Office (ICO) have taken enforcement action against organizations that deployed biometric attendance systems without adequate justification or consent. Such precedents underscore the necessity for institutions to conduct Data-Protection Impact Assessments (DPIAs) before implementing automated recognition technologies. Academic authors now stress that future research must consider both technical optimization and ethical compliance, positioning privacy and fairness as integral design goals rather than afterthoughts.

Table 2.1 summarizes selected related studies, highlighting their objectives, methods, and major contributions. This tabular representation provides a concise comparison of existing systems and research efforts, offering insight into how current innovations build upon or differ from earlier works. Together, these references form the theoretical and conceptual foundation upon which this project is developed.

Table 2.1: Summary Table of Related Works

Author(s)	Year	Objectives	Major Features
Manas Juneja, Snehal Moghe	2023	Survey face-recognition attendance research; highlight privacy & accuracy issues.	Reviews accuracy, bias, privacy concerns and gaps in deployed systems; recommends liveness detection and privacy controls.
Sravan Chandaka, Avinash Rao Thandra	2024	Propose a CNN-based real-time attendance system using deep learning backbones.	Real-time pipeline, CNN feature extractor, database matching, improved accuracy vs classical methods.
R. Rajkumar, Harshitha, Priyadarshini, Yamini	2024	Propose a smart attendance system for educational institutions using CNNs.	Uses CNN for detection/recognition; claims reduced manual rollcalls and higher throughput.

Yalavarthi Bharat Chandra, Gouru Karthikeya Reddy	2020	Compare VGGFace, FaceNet, OpenFace, DeepFace on masked faces.	Benchmarks model performance on masked-face datasets; shows accuracy drops and ranking of models.
Zitong Yu, Yunxiao Qin, Xiaobai Li, Chenxu Zhao, Zhen Lei, Guoying Zhao	2021	Review face anti-spoofing (liveness detection) methods and datasets.	Catalogues texture, motion, depth, learning-based liveness detection techniques and recommends combined liveness detection pipelines.
Yashaswini Sri	2025	Government rollouts of AI facial attendance for students and staff.	Large-scale enrollment efforts; central database updates, claims of real-time marking; shows adoption trend but also need for governance.

CHAPTER THREE

METHODOLOGY AND SYSTEM ANALYSIS

This chapter outlines the methodology adopted for the development of the Web-Based Facial Recognition Attendance System, as well as a detailed analysis of both the existing and proposed systems. The methodology provides the framework that guided the project's design, development, and implementation. Furthermore, this chapter highlights the limitations of the current attendance systems in use and demonstrates how the proposed system improves efficiency, reliability, and accuracy.

3.1 Research Methodology

Several methodologies are available for system development, including the Structured Systems Analysis and Design Methodology (SSADM), Object-Oriented Analysis and Design Methodology (OOADM), and the Prototyping Methodology.

SSADM is a highly structured, documentation-driven methodology, most suitable for large-scale, government or enterprise projects. However, it is often rigid and time-consuming.

OOADM focuses on modeling systems as interacting objects, making it ideal for complex systems requiring modularity, but it requires significant upfront analysis and modeling effort.

Prototyping Methodology emphasizes building working models quickly, testing them with users, and iteratively refining the system until it meets requirements. This is highly suitable for systems involving new technologies (e.g., face recognition) where user feedback and experimental testing are critical.

Given the experimental and data-dependent nature of facial recognition, this project adopts the **Prototyping Methodology**. This approach allows for rapid development of a functional model, which is tested and refined through multiple iterations. Feedback loops ensure that performance issues (such as recognition accuracy under varying lighting conditions) are identified and resolved early in the development lifecycle.

Key Phases of the Prototyping Methodology applied in this project include:

i. **Requirement Gathering:** Interviews and observations of lecturers and students to understand challenges with existing attendance methods.
ii. **Quick Design:** Development of an initial system outline, including student registration, image capture, and attendance marking.
iii. **Prototype Construction:** Building a working version of the system using face detection and recognition libraries, a relational database, and a web-based interface.
iv. **User Evaluation:** Testing the prototype with stakeholders to identify gaps in usability, accuracy, or functionality.
v. **Refinement:** Iteratively improving the prototype until it meets performance and usability requirements.
vi. **Final System Implementation:** Deploying the refined system for full use with complete features such as reporting, role-based access, and data export.

3.1.1 Requirement Gathering

To ensure the design of an effective and user-friendly Web-Based Facial Recognition Attendance System, relevant data were collected from university students who are the primary users of the system. The main instrument for data collection was a structured questionnaire created using

Google Forms. The questionnaire was distributed online to students across various departments and levels within the university.

A total of 24 responses were received from students across various departments and levels. The questionnaire included sections on demographic information, current attendance systems, awareness of facial recognition technology, and opinions about adopting it for attendance tracking. The responses are shown in Figure 3.1, Figure 3.2, Figure 3.3 and Figure 3.4

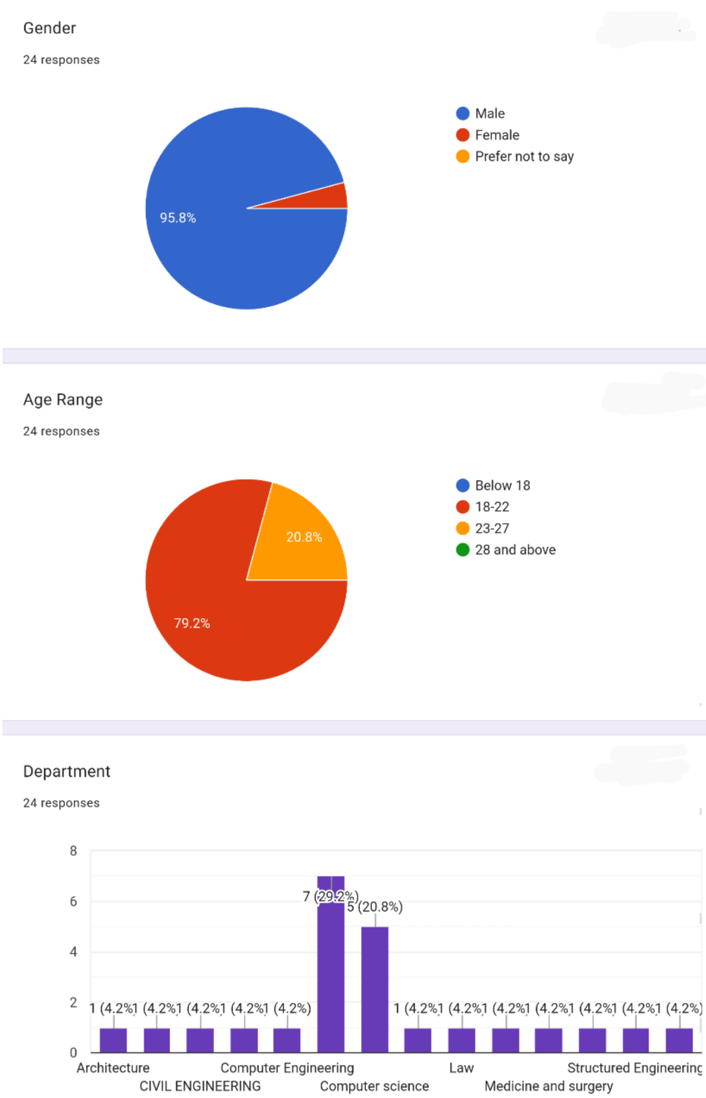


Figure 3.1: Demographic Data of Students (Gender, Age, Department)

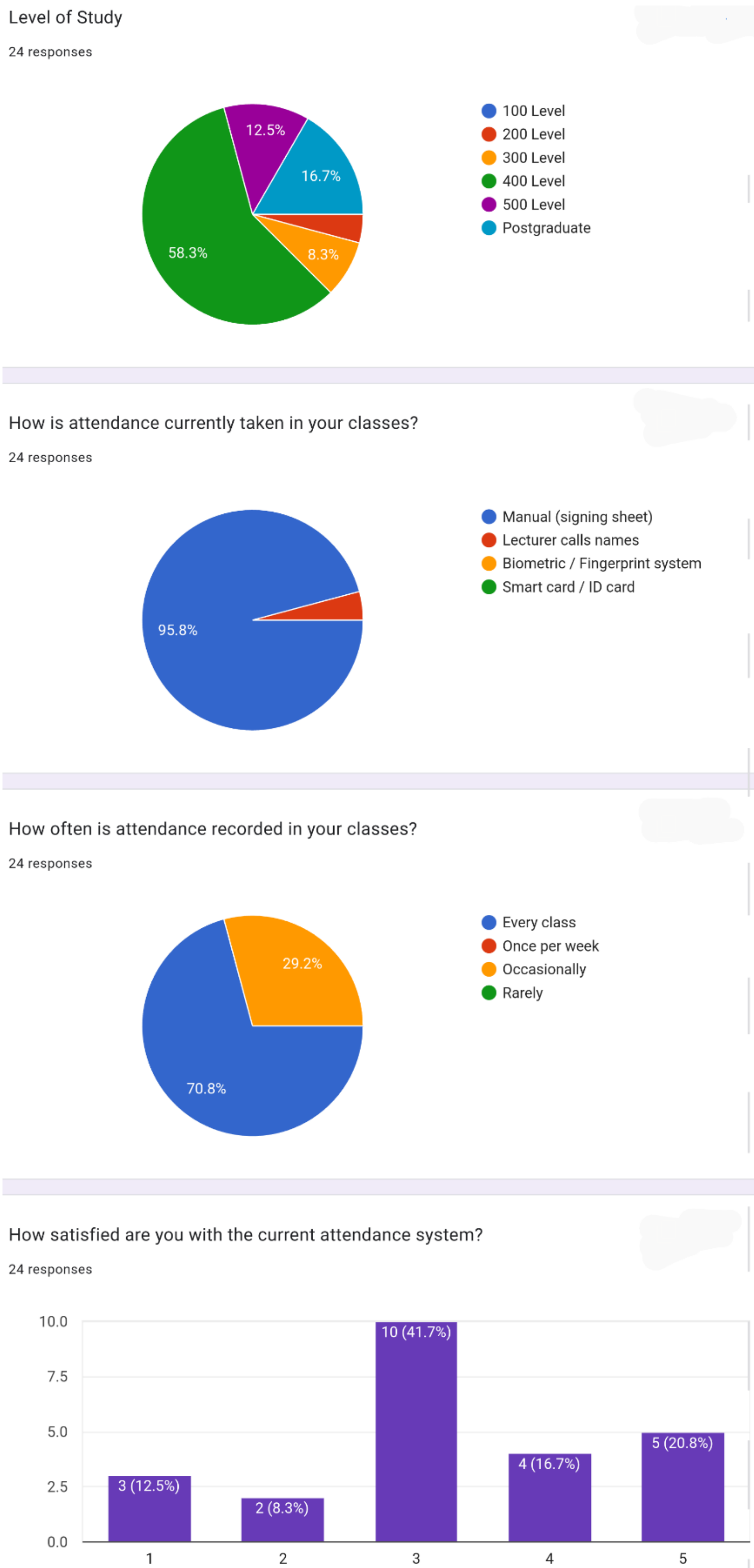
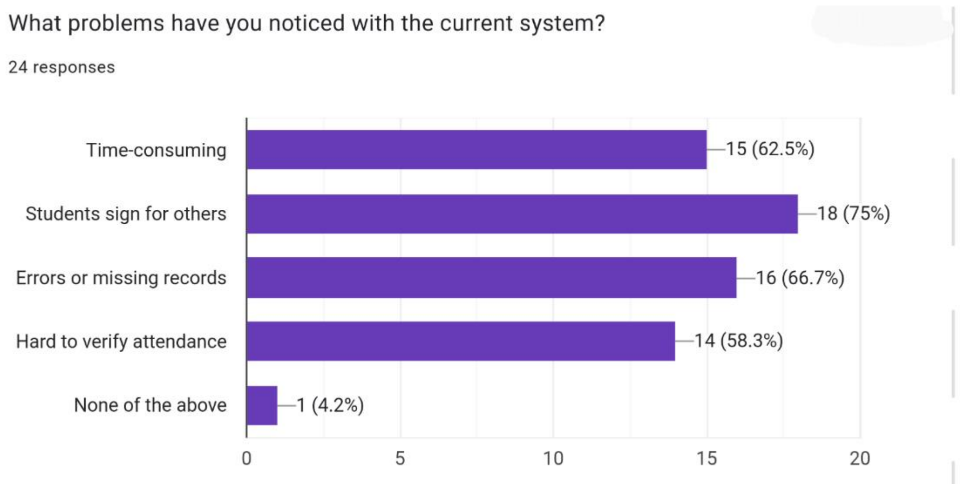
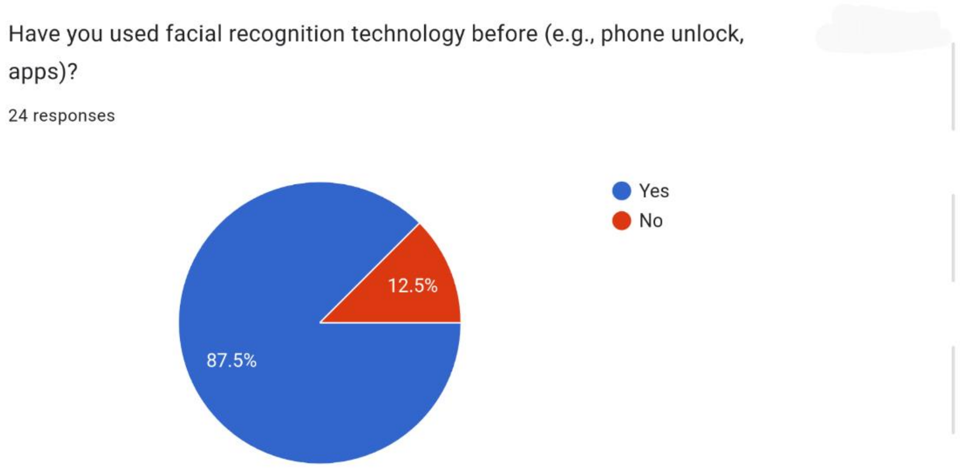


Figure 3.2: Students' Responses on Existing Attendance System





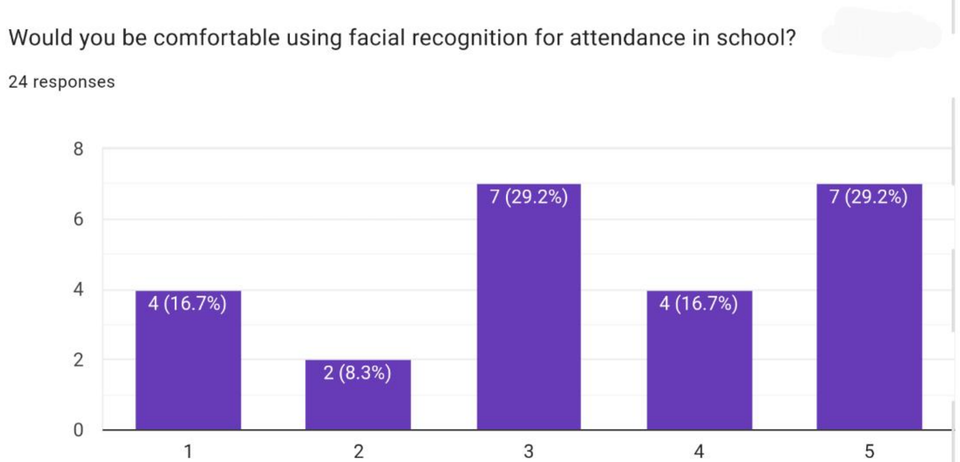


Figure 3.3: Students' Responses on Awareness and Comfortability of Face Recognition System

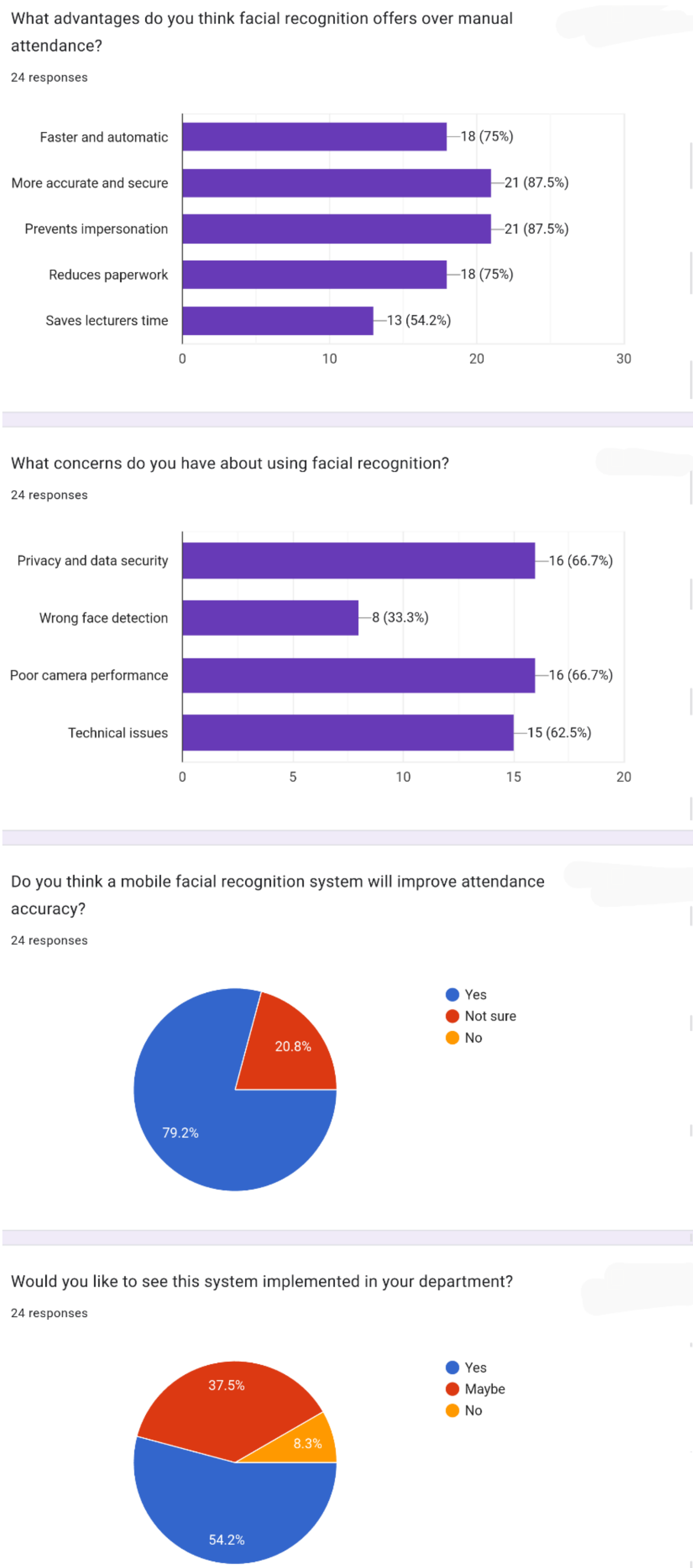


Figure 3.4: Students' Responses on Interest in Adoption of Face Recognition System

3.2 Existing System: Manual Attendance System

The "existing system" refers to the traditional, manual methods of recording attendance that this project aims to replace, typically involving paper-based sign-in sheets or manual roll calls.

Existing attendance systems are primarily designed to ensure accurate record-keeping of student participation, support academic monitoring, and meet institutional requirements. They serve as tools for accountability, compliance, and performance evaluation.

In most institutions, existing attendance systems operate as follows:

i. Manual Roll Call: Lecturers call out student names, and responses are marked on paper-based registers.
ii. Attendance Sheets: Students sign attendance sheets circulated during lectures.
iii. Card or ID-Based Scanning: Some institutions provide identity cards that are scanned or swiped.
iv. Biometric Systems (Fingerprint): A few advanced systems use fingerprint scanners, though these are not widely deployed due to cost and hygiene concerns.

The typical workflow/procedure is as follows:

i. Lecturer initiates attendance taking at the beginning of class.
ii. Students respond to name calls, sign sheets, or swipe ID cards.
iii. Attendance records are manually stored in registers or exported from scanning devices.
iv. Data is later processed for reporting or analysis.

The existing system has several limitations that hinder its efficiency and reliability. It is time-consuming, as roll calls often reduce the actual lecture time available for teaching. It is also prone to fraudulent practices such as attendance fraud, where students sign in or respond on behalf of absent peers. Additionally, the system suffers from data inaccuracy caused by human errors in transcription or the loss of paper-based records. The manual processes further contribute to inefficiency, requiring extra effort for analysis and reporting. Also, existing systems typically lack integration with academic databases, limiting their usefulness and effectiveness in supporting broader institutional needs.

3.3 Proposed System: Face Recognition Attendance System

The proposed Face Recognition Attendance System is designed to address the inefficiencies and limitations of existing systems by using facial recognition via images, together with a web interface (for administrator and lecturer roles) and database support for record-keeping.

The proposed Face Recognition Attendance System aims to automate attendance management, eliminate fraudulent practices, improve record accuracy, and reduce administrative overhead. By leveraging facial recognition, the system ensures that only physically present students are recorded as attending.

The system will operate as follows:

i. **Registration:** Students are enrolled by capturing multiple facial images, stored alongside personal identifiers in the database.
   The images serve as training data for recognition algorithms.

ii. **Lecture Session Setup:** Lecturer logs into the system and selects the relevant course, unit, and venue.
   The attendance session is initiated.

iii. **Face Detection and Recognition:** Live camera feed captures student faces in real time.

The system detects faces, matches them against registered images, and marks attendance automatically.

iv. **Record Storage:** Attendance is stored in a structured database, along with session details (time, date, course, venue).

v. **Reporting and Export:** Attendance reports can be generated instantly and exported (e.g., to Excel) for academic use.

vi. **Role-Based Access:**

Administrators: Manage student records, courses, venues, and lecturer accounts.

Lecturers: Conduct attendance sessions and generate reports.

3.3.1 Advantages of the Proposed System

The proposed system offers several advantages that make it more effective and reliable compared to the existing methods. It enhances efficiency by significantly reducing the time required for recording attendance, while ensuring greater accuracy by eliminating attendance fraud and minimizing transcription errors. Through automation, attendance data is captured and stored in real time thereby reducing manual effort. The system is also designed for integration, supporting course and venue management alongside attendance tracking. Its scalability allows it to handle large numbers of students and the web-based access provides flexibility and convenience for both administrators and lecturers.

While existing attendance systems are functional, they remain inefficient, error-prone, and vulnerable to fraudulent practices. The proposed Face Recognition Attendance System developed using the Prototyping Methodology overcomes these limitations by automating the process, improving accuracy, integrating with institutional databases and adopting an iterative prototyping approach so that the system evolves with user feedback ensuring a robust and user-centered solution that is well-suited to the academic environment.

CHAPTER FOUR

SYSTEMS DESIGN AND IMPLEMENTATION

This chapter presents the design and implementation of the proposed Web-Based Face Recognition Attendance System. The system design is divided into two key parts; logical design and physical design. Logical design describes the abstract representation of system processes and data flows, while Physical design translates the logical components into technical specifications, including hardware, software, and network configurations. This chapter also details the system implementation strategy, highlighting the process of converting design into a working system that meets quality standards and user requirements.

4.1 Logical Design

Logical design represents the blueprint of the system showing how data flows through processes and how entities interact. It does not depend on specific technologies but models the functional requirements of the system.

4.1.1 Context Diagram

A Context Diagram shows the system as a single process with its interaction with external entities (users, devices or systems). It highlights the main data inputs, data outputs, and the system’s boundaries. At the highest level, the system can be represented as a Context Diagram where the Face Recognition Attendance System is the central process interacting with external entities (such as students, lecturers, administrators or databases). The Context Diagram is shown in Figure 4.1.

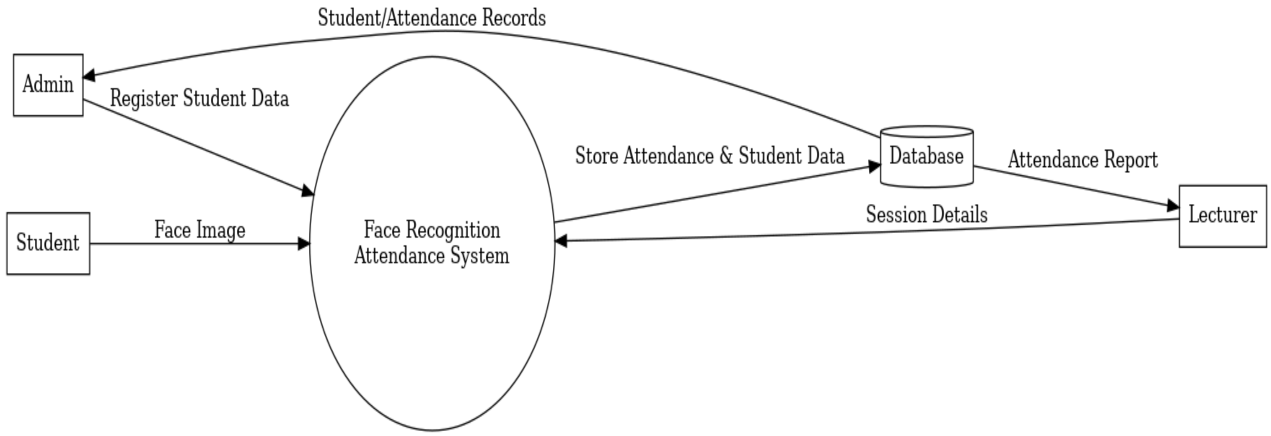


Figure 4.1: Context Diagram of the Face Recognition Attendance System

4.1.2 Data Flow Diagram (DFD)

A DFD expands the main process into sub-processes or modules. It provides a more detailed view of how data moves between processes, entities, and the database, showing the internal structure of the system's operations.

The DFD illustrates major processes such as Student Registration, Lecture Session Setup, Face Recognition and Attendance Marking, Report Generation. Each process is linked to data stores (student database, attendance database) and external entities (students, lecturers, administrators). The Data Flow Diagram is shown in Figure 4.2.

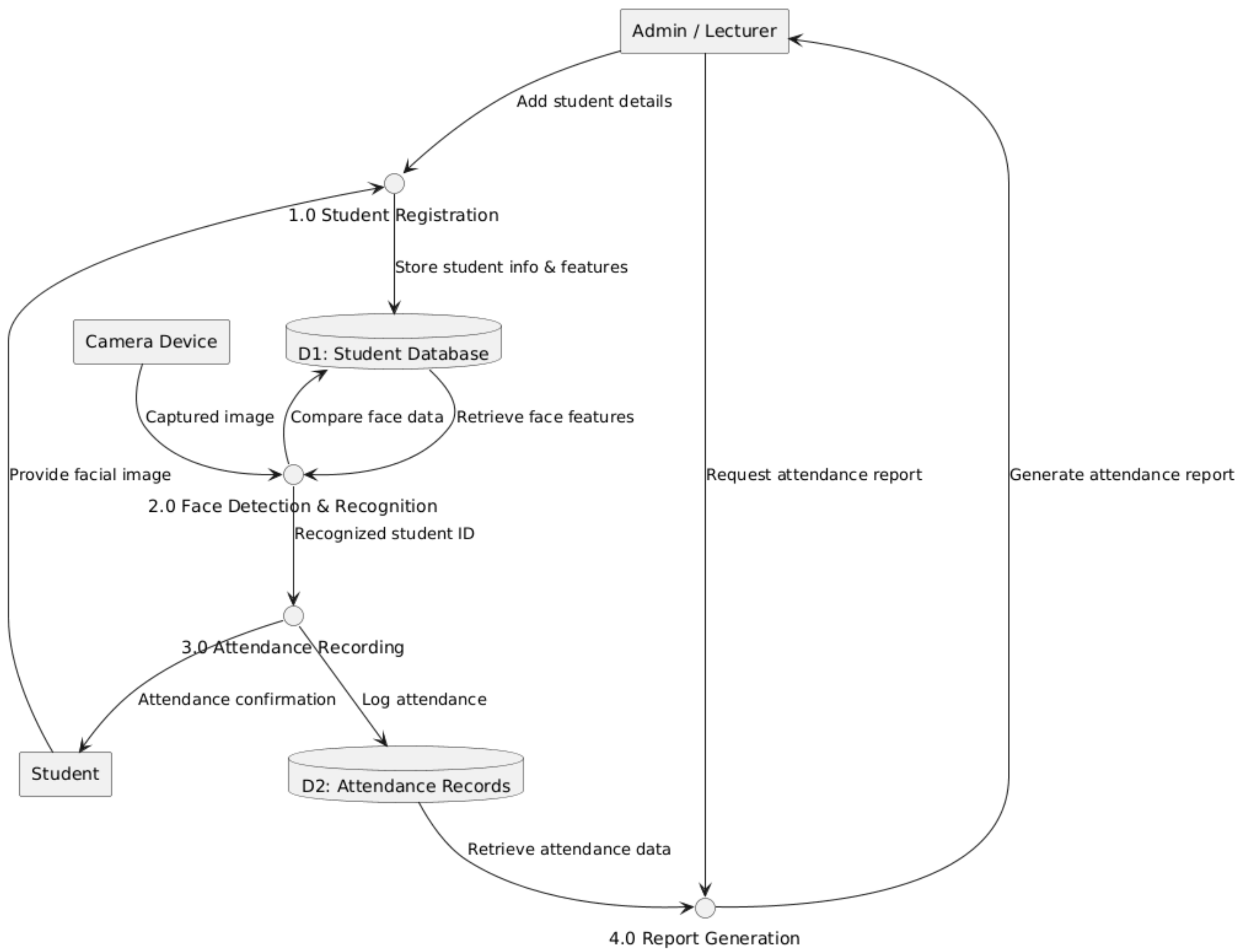


Figure 4.2: Data Flow Diagram of the Face Recognition Attendance System

4.1.3 Entity–Relationship (ER) Diagram

The ER diagram models the relationships among major system entities, their attributes and relationships between them; Student (StudentID, Name, Department, Images), Lecturer (LecturerID, Name, CourseAssigned), Course (CourseID, CourseName, CourseCode), Venue (VenueID, VenueName), Attendance (AttendanceID, Date, Status). The ER Diagram is shown in Figure 4.3.

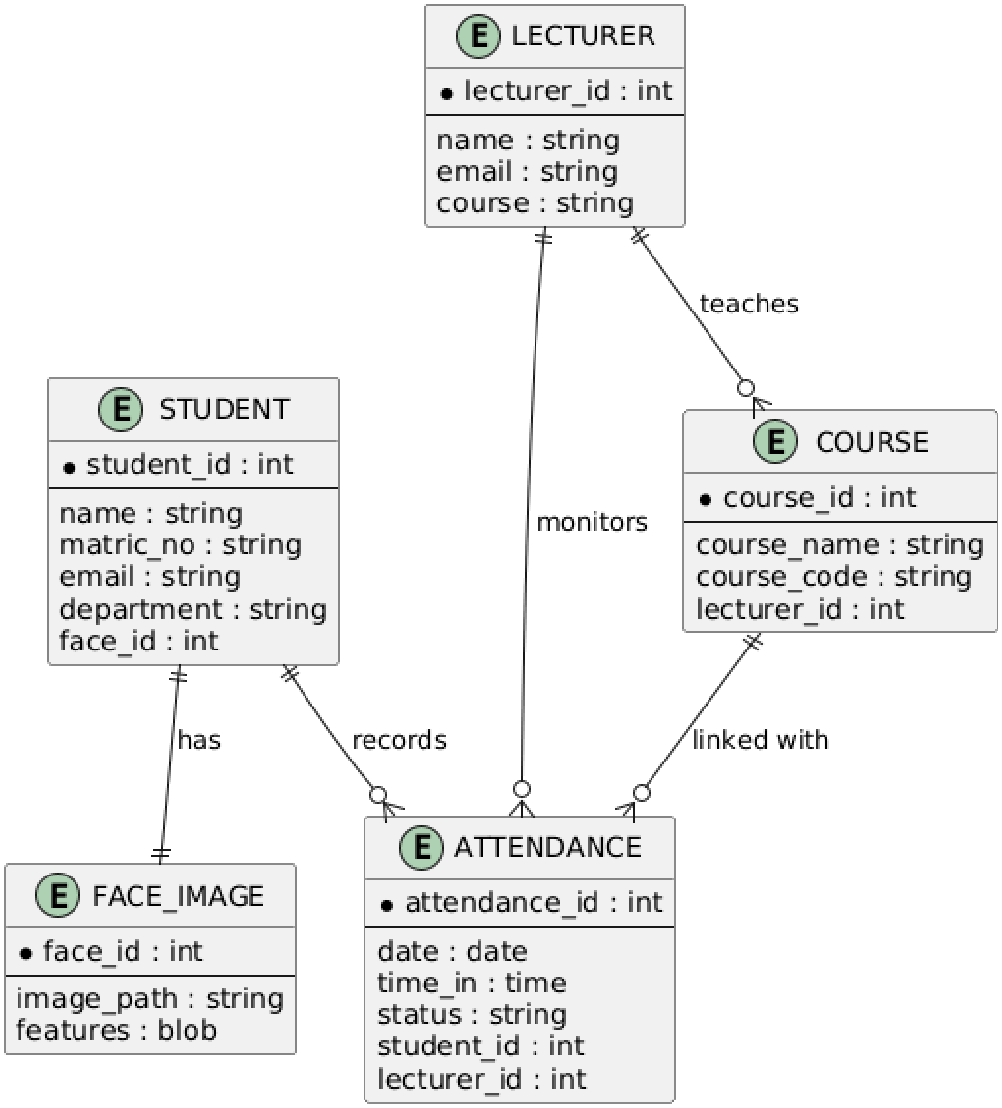


Figure 4.3: ER Diagram of the Face Recognition Attendance System

4.1.4 Flowchart

A flowchart shows the procedural flow of operations of the proposed system. The flowchart diagram is depicted in Figure 4.4.

Table 4.1: Flowchart Notations and Descriptions

Diagram	Notation	Symbol Representation	Description
Flowchart	Process	▭ (rectangle)	Represents an action, task, or operation.

	Decision	◇ (diamond)	Represents a condition or branching logic (Yes/No).
	Input/Output	☐ (parallelogram)	Represents data entry or result output.
	Flow Line	→ (arrow)	Indicates the direction of process flow.
	Database	▯ (cylinder)	Represents the system's database.
	Start/End	⭕ (ellipse)	Indicate the start or end of a process.

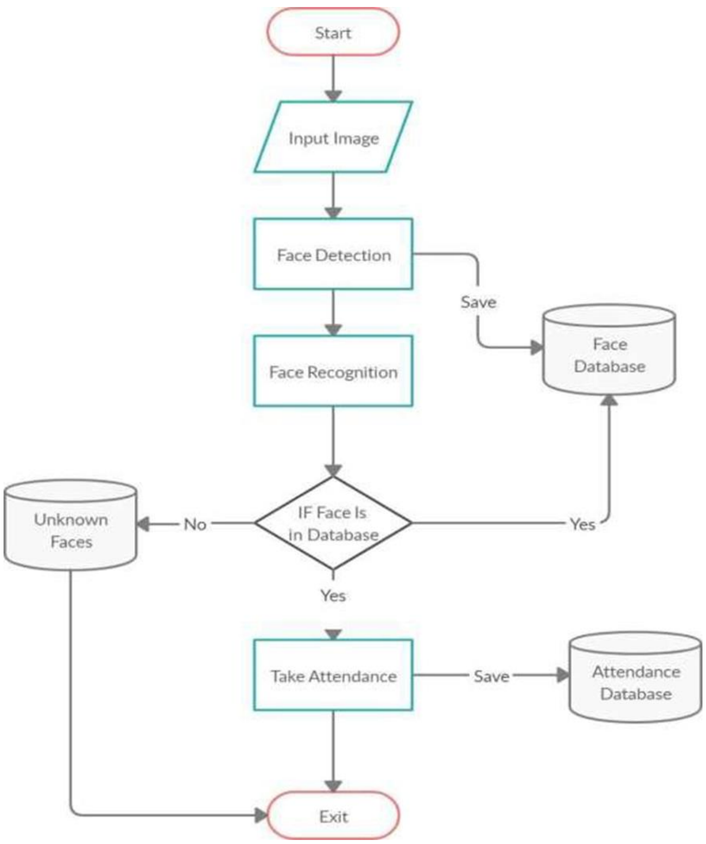


Figure 4.4: Flowchart of Face Recognition Attendance Process

4.2 Physical Design

Physical design translates the logical design into actual technologies, hardware, and software used to implement the system.

4.2.1 System Architecture Diagram

A System Architecture Diagram illustrates the overall structure of the system, including hardware, software, and communication layers. It shows how components such as the user interface, recognition engine, database, and external actors interact to form the complete system. The System Architecture diagram is depicted in Figure 4.5

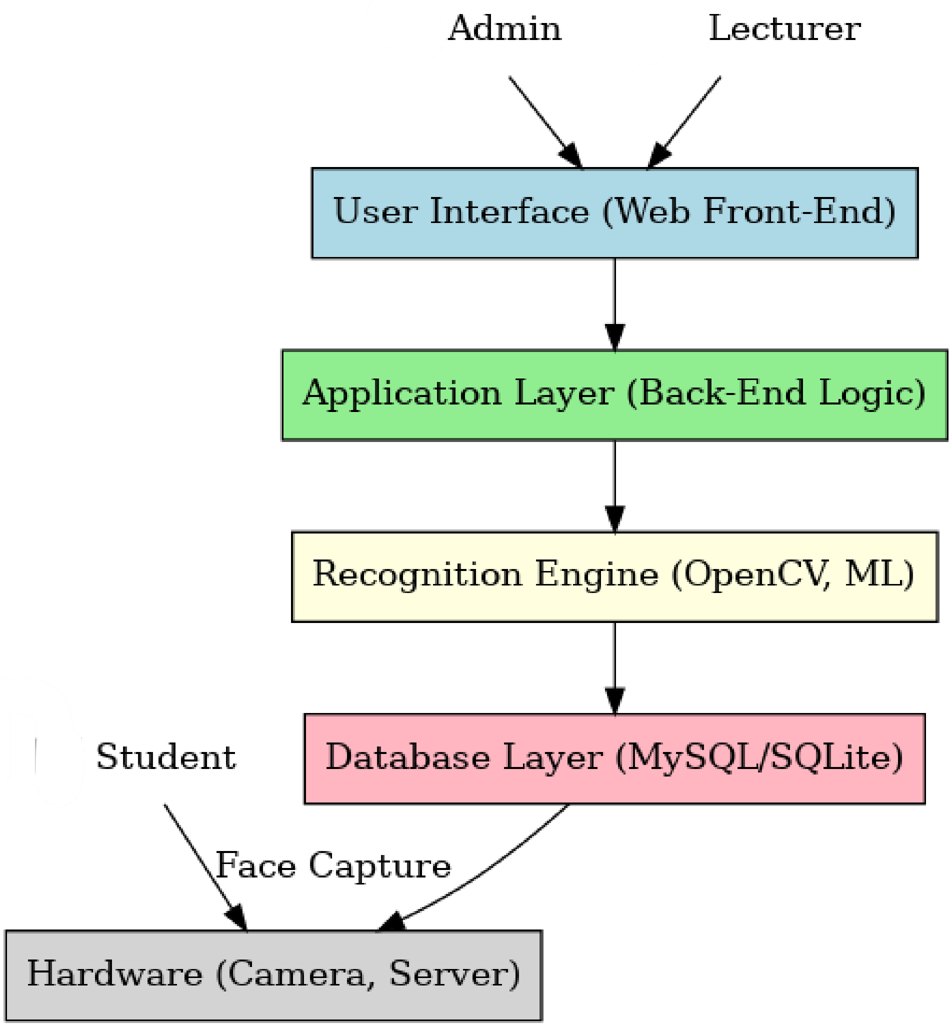


Figure 4.5: System Architecture of the Face Recognition Attendance System

4.2.2. Hardware Requirements of The System

Server: PC with 64-bit processor.

Camera: HD webcam or integrated camera with at least 720p resolution for accurate face detection.

Network: Stable Local Area Network/Wide Area Network for multi-user access.

4.2.3 Software Requirements of The System

Programming Languages: JavaScript, PHP (for face recognition model and backend logic).

Libraries/Frameworks: face-api.js, XAMPP, PHP Extensions to support development.

Database: MySQL for managing student, lecturer, and attendance records.

Front-End: HTML, CSS, JavaScript for the user interface.

Operating System: Windows

4.2.4 Database Design

A Database Schema is the **logical structure of a database** that defines how data is stored, organized, and related. It shows **tables, fields, keys, and relationships**, serving as a blueprint for database implementation. The database schema includes tables such as:

Students (StudentID, Name, Department, ImagePath).

Lecturers (LecturerID, Name, AssignedCourses).

Courses (CourseID, CourseName, UnitCode).

Venues (VenueID, VenueName).

Attendance (AttendanceID, StudentID, CourseID, Date, Status).

This design ensures normalization, data integrity, and efficient query execution.

4.3 System Implementation

System implementation involves transforming the system design into a functional web application ensuring that it is operational and meets required quality standards. The implementation includes creating the user interface, database connectivity, and integrating the face recognition model. To provide a visual understanding of the system's interface and operation, several screenshots of the web-based application are presented in 4.3.1.

4.3.1 System Interface Screenshots

The system interface screenshots provide a visual representation of the developed Facial Recognition Attendance System. They illustrate the key components of the web application, including the login page, dashboard, face registration module, attendance capture interface, and report generation page. Each screenshot demonstrates how users interact with the system to perform various tasks such as registering faces, marking attendance automatically through facial recognition, and viewing attendance reports.

System Login Page: The login page allows administrators or authorized users to sign in before accessing the attendance dashboard. The screenshots of the System Login Page is shown in Figure 4.6.

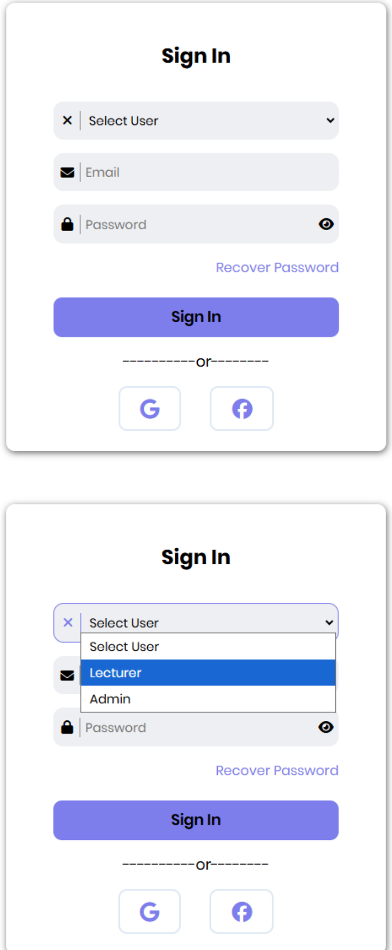


Figure 4.6: System Login Page

Dashboard Interface: The dashboard provides quick access to system functionalities such as user registration, attendance monitoring, and report generation. The screenshots of the Dashboard Interface is shown in Figure 4.7 and Figure 4.8.

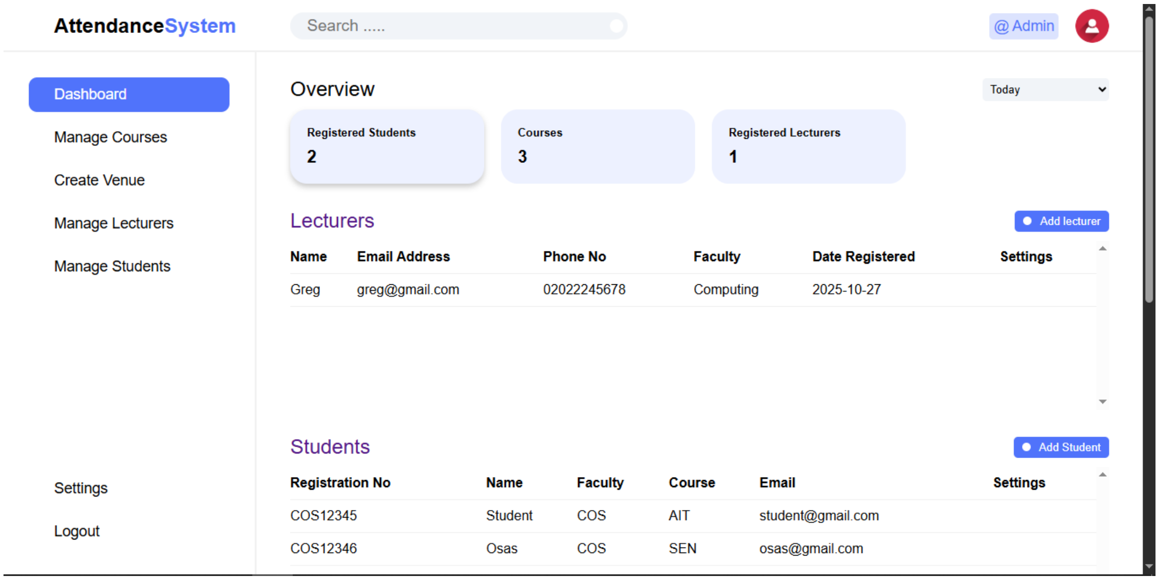


Figure 4.7: Dashboard Interface for Administrators

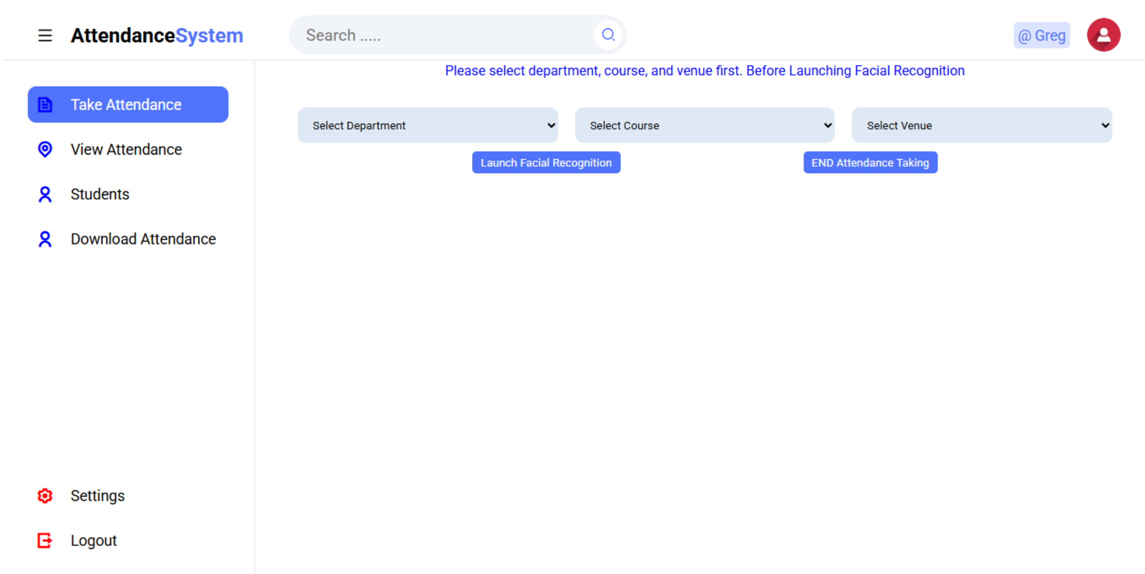


Figure 4.8: Dashboard Interface for Lecturers

Face Registration Page: This page allows users to register their facial images, which are stored in the system database for recognition purposes. The screenshots of Face Registration Page is shown in Figure 4.9.

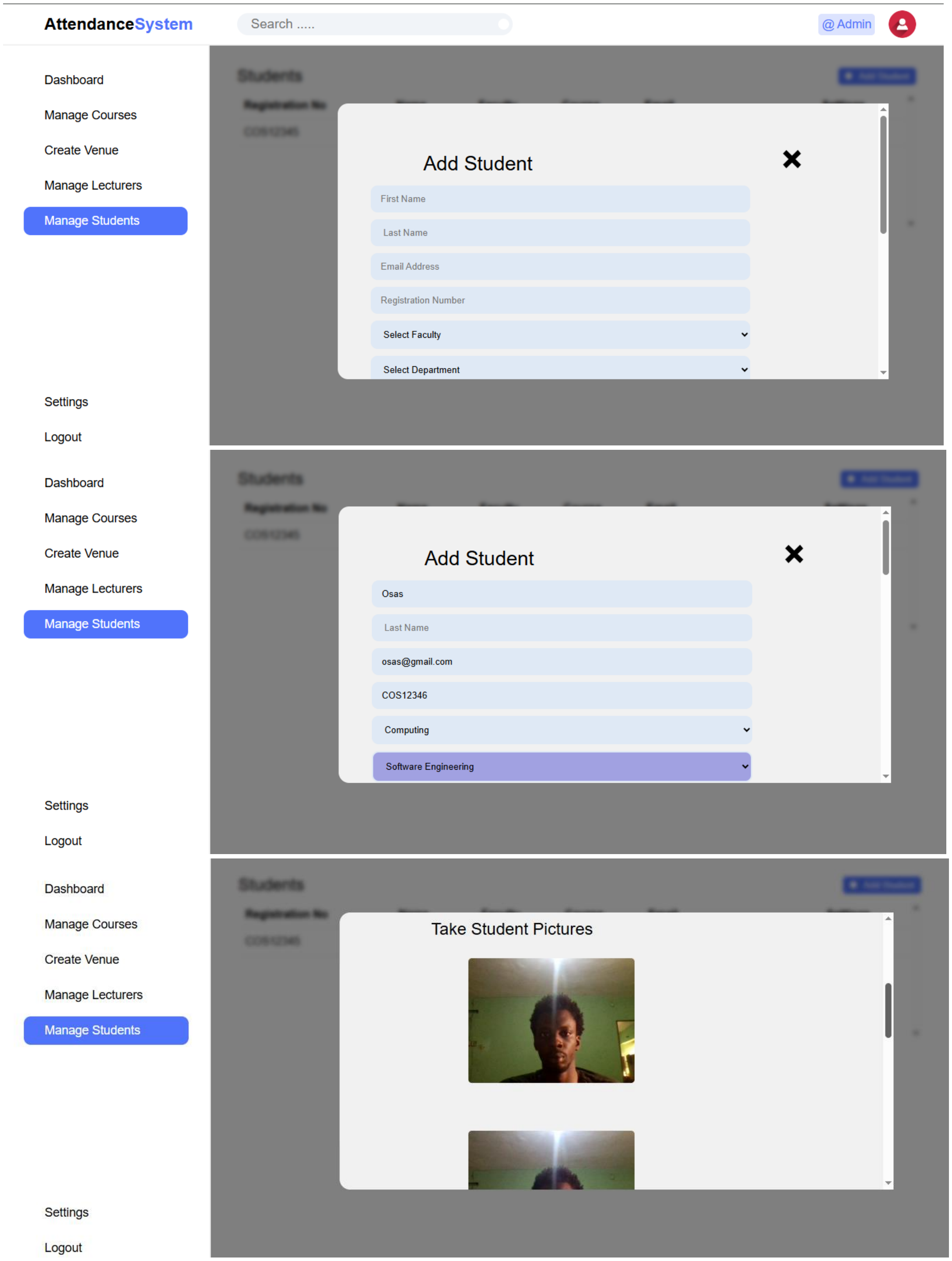


Figure 4.9: Face Registration Page

Attendance Capture Page: The attendance page automatically marks attendance when a registered face is detected through the webcam. The screenshots of Attendance Capture Page is shown in Figure 4.10.

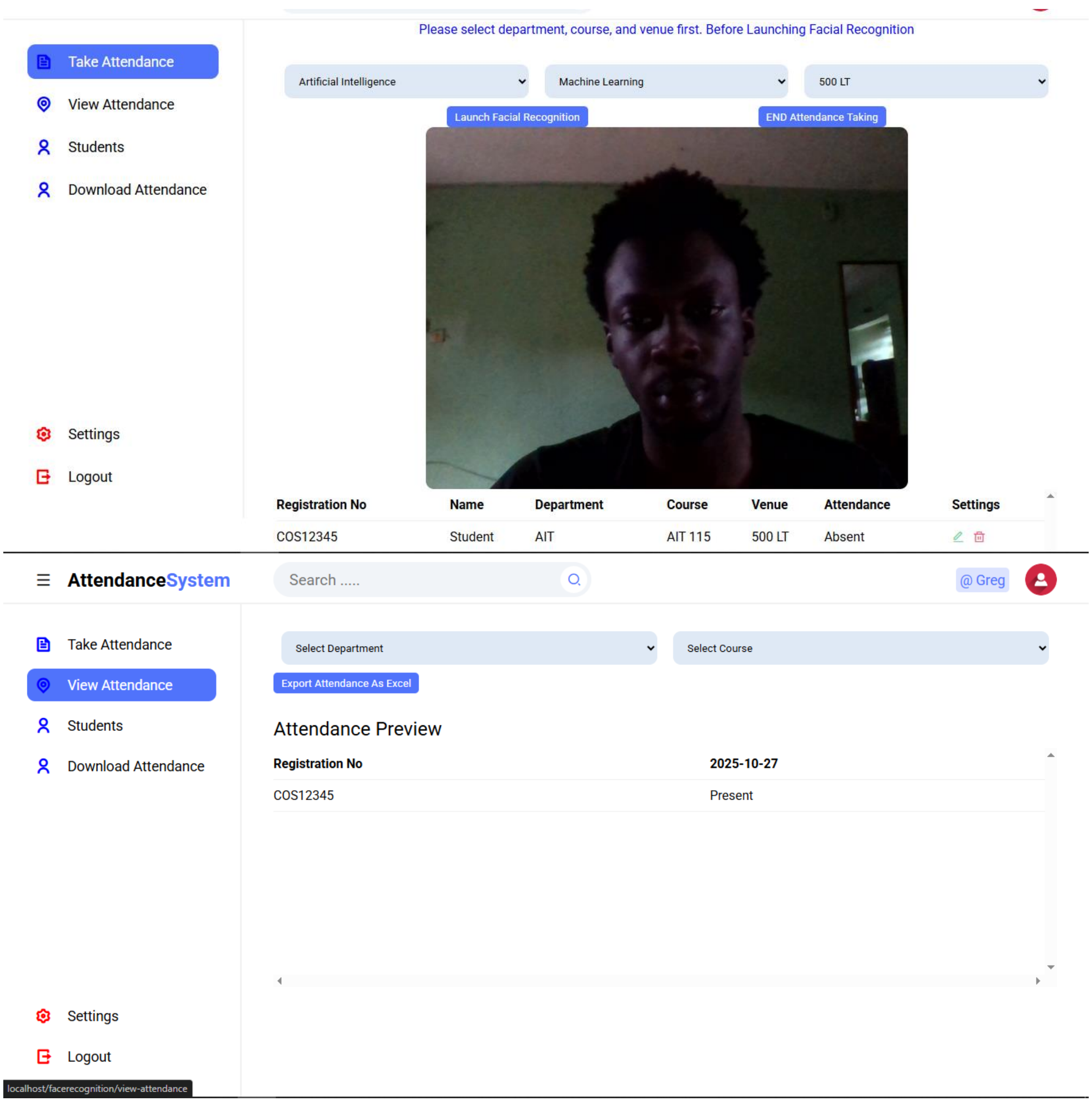


Figure 4.10: Attendance Capture Page

Attendance Report Page: This interface displays the list of users and their corresponding attendance records, which can be filtered or exported for analysis. The screenshots of Attendance Report Page is shown in Figure 4.11.

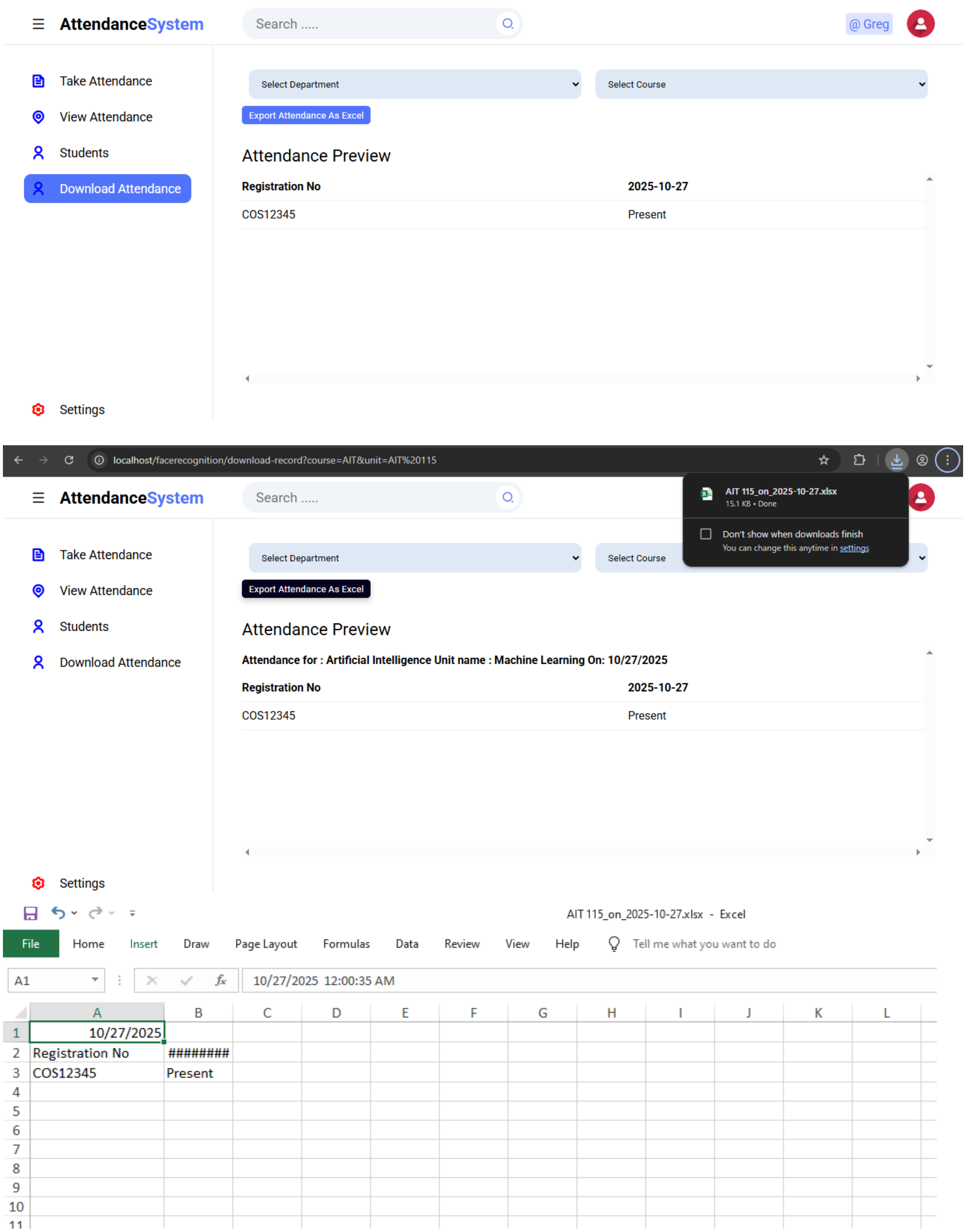


Figure 4.11: Attendance Report Page

4.3.2 System Testing and Validation

Each module (registration, recognition, reporting) was tested independently. Modules were combined and tested to ensure smooth data flow. Lecturers and administrators provided feedback on usability, speed, and accuracy. Recognition accuracy was validated with sample student images under different lighting conditions.

4.3.3 System Deployment

The system was deployed on a local machine (localhost) with a webcam for testing. In practice, it can be hosted on an institutional server or cloud environment for broader accessibility.

4.3.4 System Quality Assurance

The system meets meet key quality standards that ensure its effectiveness and sustainability. It guarantees reliability by consistently supporting real-time attendance marking while maintaining high usability through simple and intuitive interfaces tailored for lecturers and administrators. The database and system architecture are scalable, allowing the solution to accommodate large student populations without compromising performance. In addition, robust security measures are in place, with login authentication providing role-based access to safeguard data and maintain system integrity.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Summary

This project was developed to address the challenges associated with traditional methods of taking student attendance, which are often time-consuming, prone to errors, and susceptible to manipulation or impersonation. The proposed Face Recognition Attendance System was developed using deep learning models and facial recognition algorithms capable of capturing and recognizing students' identities during class sessions. Key functionalities of the system include facial image capture, real-time recognition, automated marking of attendance, and secure storage of records in the database. Through testing, the system demonstrated efficiency, reliability, and accuracy in identifying students and recording attendance. By automating the process, it significantly reduced manual workload for lecturers while ensuring transparency and accountability in attendance management.

5.2 Conclusion

The study concludes that the adoption of a Face Recognition Attendance System represents a viable and practical approach to modernizing attendance management in higher institutions of learning. The results indicate that automation of the process enhances operational efficiency, reduces human error, and strengthens security compared to conventional methods. However, some limitations were observed during implementation. Recognition accuracy was occasionally influenced by factors such as poor lighting conditions, substandard camera quality, and inconsistent student positioning during facial capture. Additionally, the system's performance depends heavily on the size and quality of the dataset used for training., which highlights the importance of data quality and diversity. Despite these limitations, the project provides a practical solution that can be adopted in academic institutions to streamline attendance management and offers a framework for further advancement.

5.3 Recommendations

In light of the findings, several recommendations are advanced. Future improvements should focus on the integration of advanced deep learning techniques and high-resolution imaging devices to improve recognition accuracy in diverse environmental conditions. Institutions intending to deploy the system should also ensure the availability of supporting infrastructure such as stable power supply, reliable network connectivity, and appropriate hardware resources. Furthermore, the system can be enhanced by incorporating additional features, including real-time statistical reporting, integration with Learning Management Systems (LMS), and notifications to keep both students and lecturers informed. Lastly, further research should focus on addressing privacy and ethical concerns by implementing strict access controls and ensuring compliance with data protection regulations. These measures will not only improve system performance but also enhance trust and acceptance among stakeholders.

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}

APPENDIX
SOURCE CODE

System Login Page

```
if ($_SERVER['REQUEST_METHOD'] === 'POST' && isset($_POST['login'])) {
    $email = filter_input(INPUT_POST, 'email', FILTER_SANITIZE_EMAIL);
    $password = $_POST['password'];
    $userType = $_POST['user_type'];

    if (!filter_var($email, FILTER_VALIDATE_EMAIL)) {
        $errors['email'] = 'Invalid email format';
    }

    if (empty($password)) {
        $errors['password'] = 'Password cannot be empty';
    }

    if (!empty($errors)) {
        $_SESSION['errors'] = $errors;
        exit();
    }
    if ($userType == "administrator") {
        $stmt = $pdo->prepare("SELECT * FROM tbladmin WHERE emailAddress = :email");
    } elseif ($userType == "lecture") {
        $stmt = $pdo->prepare("SELECT * FROM tbllecture WHERE emailAddress = :email");
    }
```

```
    $stmt->execute(['email' => $email]);
    $user = $stmt->fetch();



    if ($user && password_verify($password, $user['password'])) {

        $_SESSION['user'] = [
            'id' => $user['Id'],
            'email' => $user['emailAddress'],
            'name' => $user['firstName'],
            'role' => $userType,
        ];

        header('Location: home');
        exit();
    } else {
        $errors['login'] = 'Invalid email or password';
        $_SESSION['errors'] = $errors;
    }
}
if (isset($_SESSION['errors'])) {
    $errors = $_SESSION['errors'];
}

function display_error($error, $is_main = false)
```

```
{
    global $errors;
    if (isset($errors["{$error}"])) {


        echo '<div class="' . ($is_main ? 'error-main' : 'error') . '">
                    <p>' . $errors["{$error}"] . '</p>
          </div>';
    }
}
?>
```

Administrator Dashboard

```
<?php
                    $sql = "SELECT
                c.name AS course_name,c.Id AS Id,
                c.facultyID AS faculty,
                f.facultyName AS faculty_name,
                COUNT(u.ID) AS total_units,
                COUNT(DISTINCT s.Id) AS total_students,
                c.dateCreated AS date_created
                FROM tblcourse c
                LEFT JOIN tblunit u ON c.ID = u.courseID
                LEFT JOIN tblstudents s ON c.courseCode = s.courseCode
                LEFT JOIN tblfaculty f on c.facultyID=f.Id
                GROUP BY c.ID";
                    $stmt = $pdo->query($sql);
```

```
$result = $stmt->fetchAll(PDO::FETCH_ASSOC);
if ($result) {
    foreach ($result as $row) {
        echo "<tr id='rowcourse{$row["Id"]}'>";
        echo "<td>" . $row["course_name"] . "</td>";
        echo "<td>" . $row["faculty_name"] . "</td>";
        echo "<td>" . $row["total_units"] . "</td>";
        echo "<td>" . $row["total_students"] . "</td>";
        echo "<td>" . $row["date_created"] . "</td>";
        echo "<td><span><i class='ri-delete-bin-line delete' data-
id='{$row["Id"]}' data-name='course'></i></span></td>";
        echo "</tr>";
    }
} else {
    echo "<tr><td colspan='6'>No records found</td></tr>";
}

?>
```

Lecturer Dashboard

```
<?php

if ($_SERVER['REQUEST_METHOD'] === 'POST') {
    $attendanceData = json_decode(file_get_contents("php://input"), true);
    if ($attendanceData) {
        try {
```

```
            $sql = "INSERT INTO tblattendance (studentRegistrationNumber, course, unit, 
attendanceStatus, dateMarked)
                VALUES (:studentID, :course, :unit, :attendanceStatus, :date)";

            $stmt = $pdo->prepare($sql);

            foreach ($attendanceData as $data) {
                $studentID = $data['studentID'];
                $attendanceStatus = $data['attendanceStatus'];
                $course = $data['course'];
                $unit = $data['unit'];
                $date = date("Y-m-d");

                // Bind parameters and execute for each attendance record
                $stmt->execute([
                    ':studentID' => $studentID,
                    ':course' => $course,
                    ':unit' => $unit,
                    ':attendanceStatus' => $attendanceStatus,
                    ':date' => $date
                ]);
            }

            $_SESSION['message'] = "Attendance recorded successfully for all entries.";
        } catch (PDOException $e) {
```

```php
            $_SESSION['message'] = "Error inserting attendance data: " . $e->getMessage();
        }
    } else {
        $_SESSION['message'] = "No attendance data received.";
    }
}

?>
```

Face Registration Page

```php
<?php

if (isset($_POST['addStudent'])) {

    $firstName = $_POST['firstName'];
    $lastName = $_POST['lastName'];
    $email = $_POST['email'];
    $registrationNumber = $_POST['registrationNumber'];
    $courseCode = $_POST['course'];
    $faculty = $_POST['faculty'];
    $dateRegistered = date("Y-m-d");

    $imageFileNames = []; // Array to hold image file names

    // Process and save images
    $folderPath = "resources/labels/{$registrationNumber}/";
```

```
    if (!file_exists($folderPath)) {

        mkdir($folderPath, 0777, true);

    }


    for ($i = 1; $i <= 5; $i++) {

        if (isset($_POST["capturedImage$i"])) {

            $base64Data = explode(',', $_POST["capturedImage$i"])[1];

            $imageData = base64_decode($base64Data);

            $fileName = "{$registrationNumber}_image{$i}.png";

            $labelName = "{$i}.png";

            file_put_contents("{$folderPath}{$labelName}", $imageData);

            $imageFileNames[] = $fileName;

        }

    }


    // Convert image file names to JSON

    $imagesJson = json_encode($imageFileNames);


    // Check for duplicate registration number

    $checkQuery = $pdo->prepare("SELECT COUNT(*) FROM tblstudents WHERE
registrationNumber = :registrationNumber");

    $checkQuery->execute([':registrationNumber' => $registrationNumber]);

    $count = $checkQuery->fetchColumn();


    if ($count > 0) {
```

```
        $_SESSION['message'] = "Student with the given Registration No: $registrationNumber
already exists!";

    } else {

        // Insert new student with images stored as JSON

        $insertQuery = $pdo->prepare("

        INSERT INTO tblstudents

        (firstName, lastName, email, registrationNumber, faculty, courseCode, studentImage,
dateRegistered)

        VALUES

        (:firstName, :lastName, :email, :registrationNumber, :faculty, :courseCode, :studentImage, :
dateRegistered)

    ");


        $insertQuery->execute([

            ':firstName' => $firstName,

            ':lastName' => $lastName,

            ':email' => $email,

            ':registrationNumber' => $registrationNumber,

            ':faculty' => $faculty,

            ':courseCode' => $courseCode,

            ':studentImage' => $imagesJson, // Store JSON array of image file names

            ':dateRegistered' => $dateRegistered

        ]);


        $_SESSION['message'] = "Student: $registrationNumber added successfully!";

    }
```

```
}
```

Attendance Capture Page

```
<?php


include './includes/dbcon.php';


if ($_SERVER['REQUEST_METHOD'] === 'POST') {
    $attendanceData = json_decode(file_get_contents("php://input"), true);


    if (!empty($attendanceData)) {
        foreach ($attendanceData as $data) {
            $studentID = $data['studentID'];
            $attendanceStatus = $data['attendanceStatus'];
            $course = $data['course'];
            $unit = $data['unit'];
            $date = date("Y-m-d");


            $sql = "INSERT INTO tblattendance(studentRegistrationNumber, course, unit,
attendanceStatus, dateMarked)
                    VALUES ('$studentID', '$course', '$unit', '$attendanceStatus', '$date')";


            if ($conn->query($sql) === TRUE) {
                echo "Attendance data for student ID $studentID inserted successfully.<br>";
            } else {
                echo "Error inserting attendance data: " . $conn->error . "<br>";
```

```
            }
        }
    } else {
        echo "No attendance data received.<br>";
    }
} else {
    echo "Invalid request method.<br>";
}

?>
```

Attendance Report Page

```
<?php



$courseCode = isset($_GET['course']) ? $_GET['course'] : '';
$unitCode = isset($_GET['unit']) ? $_GET['unit'] : '';

$studentRows = fetchStudentRecordsFromDatabase($courseCode, $unitCode);

$coursename = "";
if (!empty($courseCode)) {
    $coursename_query = "SELECT name FROM tblcourse WHERE courseCode =
'$courseCode'";
    $result = fetch($coursename_query);
```

```
    if ($result) {
        foreach ($result as $row) {
            $coursename = $row['name'];
        }
    }
}
$unitname = "";
if (!empty($unitCode)) {
    $unitname_query = "SELECT name FROM tblunit WHERE unitCode = '$unitCode'";
    $result = fetch($unitname_query);
    if ($result) {
        foreach ($result as $row)
            $unitname = $row['name'];
    }
}

?>
```