REPUBLIC OF RWANDA

ULK POLYTECHNIC INSTITUTE UPI

P.O.Box .2280 KIGALI

Website: www.ulkpolytechnic.ac.rw

Email: polytechnic.institute@ulk.ac.rw

ACADEMIC YEAR 2023-2024

DEPARTEMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

OPTION: ELECTRONICS AND TELECOMMUNICATION TECHNOLOGY

Development of an RFID-Based Attendance System Using Raspberry Pi 4B, Case Study: ULK Polytechnic Institute

Research project submitted in partial fulfillment of the requirement for an award of the Advanced Diploma in Electronics and Telecommunication Technology

Submitted by: Ndeze Bonheur Emmanuel

Roll Number: 202150126

Kigali, September 2024

Supervisor: Eng. HAGENIMANA Jean de Dieu

DECLARATION

I, Ndeze Bonheur Emmanuel, hereby declare that I carried out the work reported in this report in the Department of Electrical and Electronics Engineering at ULK Polytechnic Institute, under the supervision of HAGENIMANA Jean de Dieu. To the best of my knowledge, no part of this report has been submitted here or elsewhere in a previous application for the award of an academic qualification. All sources of knowledge used have been duly acknowledged.

Ndeze Bonheur Emmanuel	Signature: …………………….
Reg No: 202150126	Date: …..………………….….…...

CERTIFICATION

This is to certify that the project titled **"Development of an RFID-Based Attendance System Using Raspberry Pi 4B, Case Study: ULK Polytechnic Institute"** carried out by **NDEZE Bonheur Emmanuel** has been read, checked, and approved as meeting part of the requirements and regulations governing the award of the Advanced Diploma in Electronics and Telecommunication Engineering at ULK Polytechnic Institute, during the academic year 2023-2024. This project involves the implementation of an attendance management system using UPI's RFID student and employee cards to monitor and manage attendance for employees at entry points and for students during classes and examinations. The project has been examined and approved by the panel on oral examination.

Project Supervisor / Project Examiner
Eng. HAGENIMANA JEAN DE DIEU
Signature: ………………….
Date: ………………………….

Head of Department of Electrical and Electronics Engineering
Eng. KARIKURUBU Emmanuel
Signature: …………………
Date: …………………………

DEDICATION

I dedicate this work to my beloved parents, brothers, and sisters, whose unwavering support, encouragement, and love have been my guiding strength throughout this journey. From the very beginning of my academic path until today, they have stood by me in times of need, and I am forever grateful for their presence in my life.

I also extend this dedication to my esteemed lecturers and supervisor, whose invaluable guidance, wisdom, and mentorship have shaped my academic growth and this project.

Lastly, to my friends and classmates, who shared in the challenges and triumphs of this long and exciting journey, your companionship has been an essential part of this experience.

ACKNOWLEDGEMENTS

I want to thank God for giving me the strength and opportunity to complete my studies. I am very grateful to my supervisor, Eng. HAGENIMANA JEAN DE DIEU, for his continuous support and helpful suggestions during this project.

I also want to thank my relatives for their advice and support. A special thanks to my parents and siblings for their encouragement and for making sure I could focus on my project without any worries.

I am very thankful to my friends and classmates for their understanding, support, prayers and moral support. I have appreciated the guidance and help from all the academic staff in the Department of Electrical and Electronics Engineering. Finally, I thank everyone who has supported me along the way.

ABSTRACT

The project aims to create and deploy an RFID-based attendance system using a Raspberry Pi 4B to streamline attendance processes for students and employees at ULK Polytechnic Institute. By leveraging RFID technology, the system automates attendance tracking, minimizes errors, and enhances overall efficiency. Individuals scan their RFID cards at designated access points, and the data is securely stored in a centralized database.

The Raspberry Pi processes the data from RFID readers and interfaces with hardware components such as servo motors to enable automated door access. The system incorporates role-based access control, providing different user groups; administrators, lecturers, security personnel, and finance staff with access to specific functions through customized dashboards. Each user group is responsible for managing tasks such as student attendance, employee tracking, and RFID card registration.

This automated system not only improves accuracy and reduces administrative workload but also generates real-time reports, aligning with Rwanda's national objectives of utilizing technology to enhance governance in education. Furthermore, it serves as a prototype for future smart campus solutions, contributing to the digital transformation of the educational sector.

TABLE OF CONTENTS

TABLE OF ABBREVIATIONS

2FA	Two-Factor Authentication
API	Application Programming Interface
CPU	Central Processing Unit
DNS	Domain Name System
GPIO	General Purpose Input/Output
GUI	Graphical User Interface
HOD	Head of Department
HP	Hewlett-Packard
IoT	Internet of Things
LCD	Liquid Crystal Display
PWM	Pulse Width Modulation
RFID	Radio Frequency Identification
RPi	Raspberry Pi
SQL	Structured Query Language
UID	Unique Identifier
ULK	Université Libre de Kigali

TABLE OF FIGURES

CHAPTER 1 GENERAL INTRODUCTION

1.1 Introduction

Maintaining accurate and efficient attendance records is a critical challenge for educational institutions and organizations in today's fast-paced world. Traditional methods, such as manual entry or paper-based records, are often time-consuming, prone to errors, and lack real-time data availability. This project presents a tailored solution to these challenges by developing a smart attendance system using a Raspberry Pi 4B and RFID technology. The proposed system specifically focuses on ULK Polytechnic Institute, utilizing the institution's RFID-enabled student and employee cards to manage attendance effectively at various points, such as entry points, classrooms, and examination halls.

As a final-year Electronic and Telecommunication Engineering student at ULK Polytechnic Institute, I have observed significant issues with attendance management at our institution and others across Rwanda and neighboring countries. This project aims to address these challenges by designing and implementing a smart attendance system that leverages the existing RFID infrastructure at UPI. The system provides a reliable, easy-to-use solution that simplifies attendance management while ensuring data accuracy and real-time access for both employees and students. Using cost-effective and high-performance components such as the Raspberry Pi 4B and RFID readers, this project demonstrates a practical approach to modernizing attendance tracking and enhancing administrative efficiency within educational settings.

1.2 Background

Rwanda's efforts to transform into a knowledge-based economy are guided by several national strategies, including the National Strategy for Transformation (NST1), Vision 2035, and Vision 2050, which aim to achieve sustained economic growth and technological advancement (Government of Rwanda, 2015). Vision 2020 and the Smart Rwanda Master Plan emphasize the integration of new technologies across key sectors, including education, to foster innovation and drive economic growth (Republic of Rwanda, 2000)

To achieve these goals, Rwanda has established various innovation centers that promote collaboration between academic institutions, businesses, and industries. These centers aim to support startup ventures, attract foreign high-tech companies, and create jobs, thereby driving technological advancements. The government has also invested in Technology Teaching Schools and Institutes to build a workforce capable of leveraging these technologies

Within this context, the proposed RFID-based attendance system aligns with Rwanda's national goals by enhancing efficiency and accuracy in attendance tracking, which is critical for educational institutions. By automating attendance monitoring, this system addresses the limitations of traditional methods, such as the time-consuming manual entry of records, errors in data handling, and the lack of real-time access to information. The development of this system is also aligned with the country's push towards adopting smart technologies for improved governance, accountability, and decision-making (Project & Procedures, 2021).

1.3 Purpose of the Study

The purpose of this study is to design and implement a smart attendance system tailored specifically for ULK Polytechnic Institute UPI. The system utilizes RFID and Raspberry Pi technologies to automate the attendance-tracking process for students and employees, providing real-time data access and minimizing errors associated with manual methods. This system is designed to manage student attendance during classes by their lecturers, track student attendance during exams by finance employees, and monitor employee attendance at different entry points of the institution by security personnel.

By offering a more efficient and accurate attendance management solution, the study aims to enhance accountability, streamline administrative processes, and improve overall operational efficiency within UPI. Additionally, the project demonstrates the practical application of IoT technologies, such as RFID, to solve everyday administrative challenges, aligning with Rwanda's national goals of fostering innovation and leveraging technology for sustainable development (MINICT, 2018).

1.4 Objectives

This study aims to develop a comprehensive attendance management system for UPI that leverages RFID and Raspberry Pi technologies. The system is designed to address the specific needs of different stakeholders, including Heads of Departments (HODs), lecturers, finance employees, and security personnel, by providing real-time access to attendance data and streamlining administrative processes. This system aims to improve the accuracy, efficiency, and accountability of attendance tracking within the institution.

The following objectives outline the key functionalities and capabilities of the system:

1.4.1 Main Objective:

To design and develop an efficient and accurate attendance management system using RFID and Raspberry Pi technologies for UPI.

1.4.2 Specific Objectives:

The system's overarching goal is to be achieved through the following specific objectives:

1. Creating an automated student attendance tracking system for classes.
2. Developing a method for managing student attendance during exams.
3. Monitoring employee attendance at various entry points by security personnel.
4. Providing real-time access to attendance data for authorized stakeholders.
5. Generating comprehensive reports on attendance data for both students and employees.

1.5 Research Questions

This study aims to answer the following research questions:

1. How does the implementation of an RFID-based attendance system at UPI improve the efficiency and accuracy of tracking student and employee attendance compared to the existing manual methods?
2. What are the specific advantages of providing real-time access to attendance data for stakeholders, such as lecturers, finance employees, security personnel, and Heads of Departments (HODs), within UPI?
3. How does integrating RFID technology into the attendance management system enhance compliance with institutional policies, such as the 70% attendance requirement for students to be eligible for exams?
4. In what ways does the RFID-based attendance system facilitate better management of student attendance during classes and exams, and employee attendance at various entry points at UPI?

5. How does the ability to generate detailed attendance reports impact the administrative decision-making process and overall operational efficiency at UPI?

1.6 Scope of Study

The scope of this study is centered on the design, development, and implementation of an RFID-based attendance management system specifically for UPI. The system will be tailored to address the unique attendance management needs of the institution, including tracking student attendance during classes by lecturers, managing student attendance during exams by finance employees, and monitoring employee attendance at different entry points by security personnel.

This study will cover the technical aspects, such as the integration of RFID hardware with a Raspberry Pi, software development for data management, and the creation of a user-friendly interface for different stakeholders, including lecturers, finance employees, security personnel, and Heads of Departments (HODs).

The study is geographically confined to UPI, with a focus on its specific operational needs and policies, such as the 70% minimum attendance requirement for students to be eligible for exams. The project will not cover other types of attendance systems (such as biometric systems) or the application of this system outside UPI at this stage. However, it will consider the potential for scalability and adaptation within similar educational contexts in Rwanda.

1.7 Significance of the Study

The study is significant for several reasons. First, it will enhance operational efficiency by automating attendance tracking at UPI, reducing the time spent on manual data entry, minimizing human error, and improving overall operational efficiency. This will streamline the processes for lecturers, finance employees, and security personnel. Second, the system will provide real-time access to attendance data for all authorized stakeholders at UPI, including lecturers, finance employees, security personnel, and HODs. This immediate access will enable timely and informed decision-making regarding student performance, exam eligibility, employee monitoring, and other administrative tasks.

Third, the system will support UPI's compliance with its attendance policies, such as ensuring students meet the 70% attendance threshold required to qualify for exams. It will also help monitor and enforce employee attendance regulations, improving accountability and governance. Additionally, by implementing an IoT-based attendance solution, the study aligns with Rwanda's national strategy to leverage technology for socio-economic development. It demonstrates the practical application of RFID technology in educational management, contributing to Rwanda's goal of becoming a knowledge-based economy (MINICT, 2018).

Moreover, accurate and automated attendance records generated by the system will enable better management of resources at UPI. This includes optimizing class sizes, scheduling lectures, and managing personnel allocation based on reliable attendance data. Finally, this research provides a practical framework for deploying RFID technology in attendance management at UPI, which can serve as a model for other institutions facing similar challenges. The findings and outcomes can guide future projects aimed at enhancing institutional efficiency through technology.

1.8 Project Organization

This report is organized into five chapters:

- **Chapter 1**: General Introduction – Provides an overview of the study, including the background, problem statement, objectives, research questions, scope, and significance.
- **Chapter 2**: Literature Review – Discusses existing research and theoretical perspectives related to RFID-based attendance systems, including relevant studies on IoT applications and smart attendance management.
- **Chapter 3**: Methodology – Details the research methods, design, data collection, and analysis techniques employed in developing the RFID-based attendance system.
- **Chapter 4**: System Design, Analysis, and Implementation Describes the technical design, system architecture, hardware and software components, and implementation processes.
- **Chapter 5**: Conclusion and Recommendations summarizes the findings of the study, presents conclusions, and offers recommendations for future research or practical applications.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature on smart attendance systems, with a particular emphasis on those utilizing RFID technology and Raspberry Pi-based solutions. It explores various concepts, opinions, and insights from authors and experts in the field, highlighting the advantages of automated attendance systems over traditional manual methods. The chapter also discusses theoretical frameworks such as the Technology Acceptance Model (TAM) and Socio-Technical Systems Theory, which are crucial for understanding the adoption and effectiveness of these systems in educational environments.

Furthermore, the chapter examines studies related to the integration of Internet of Things (IoT) technologies and cloud computing in attendance management. These studies provide insights into the benefits, limitations, and future possibilities of smart technologies in creating efficient and secure attendance management solutions.

2.2 Concepts, Opinions, and Ideas from Authors/Experts

Myerson (2006) explores the transformative power of RFID technology in various sectors, including supply chain management and automated identification systems. His research highlights the accuracy, efficiency, and reduction of human errors achieved through RFID-based systems. Myerson explains how RFID technology captures and processes data in real-time without requiring manual intervention, making it ideal for automating tasks such as attendance monitoring. In an educational context, this technology reduces the administrative burden on staff while ensuring that attendance records are accurate and readily accessible. Myerson’s work emphasizes the scalability of RFID systems, which can be expanded to cover larger institutions or integrated with other IoT solutions to provide a comprehensive attendance management system(Myerson, 2006).

Meghdadi & Azar (2016) explored the application of RFID technology in educational environments, specifically in automating attendance management systems. Their research highlights how RFID systems can replace traditional manual attendance processes, which are time-consuming and prone to errors. By using RFID technology, universities can efficiently track the presence and absence of students and professors in real-time. Meghdadi and Azar emphasize that automating attendance using RFID reduces the need for human intervention, enhances the accuracy of data collection, and minimizes energy and time loss for both professors and students. The authors argue that such systems significantly improve efficiency by integrating attendance data with existing university management systems, allowing for more seamless operations.

Furthermore, their research delves into how RFID technology increases institutional control over attendance monitoring. Meghdadi and Azar explain that RFID readers, when installed at key entry points, can automate attendance tracking without requiring manual input from professors, allowing them to focus more on teaching. Additionally, the system provides the university with valuable insights, such as reports on attendance, which can be used to calculate professor salaries based on their teaching hours. By replacing outdated manual attendance systems, Meghdadi and Azar's proposed RFID-based solution ensures more accurate and reliable attendance records, contributing to smarter, more efficient university management systems (Meghdadi & Azar, 2016).

2.3 Theoretical Perspectives

To comprehensively understand the adoption and effectiveness of smart attendance systems, this study draws upon two key theoretical frameworks: The **Technology Acceptance Model (TAM)** and the **Socio-Technical Systems Theory**. These perspectives provide valuable insights into user acceptance and the integration of technological solutions within organizational contexts.

2.3.1 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), introduced by Davis in 1989(Marangunić & Granić, 2015), is a widely used framework for understanding how users come to accept and use new technologies. TAM focuses on two primary constructs:

Perceived Usefulness (PU): This refers to the degree to which a person believes that using a particular technology would enhance their job performance or overall effectiveness. In the context of RFID-based attendance systems, perceived usefulness would relate to how well the system improves attendance tracking efficiency, reduces errors, and provides timely data for decision-making. For example, RFID technology's ability to automate attendance processes and generate real-time reports could be seen as enhancing the efficiency and accuracy of attendance management.

Perceived Ease of Use (PEOU): This denotes how easy and user-friendly a technology is perceived to be. It reflects the effort required to use the technology effectively. For RFID-based systems, perceived ease of use involves how intuitive and straightforward the system is for different stakeholders, including lecturers, students, and administrators. The system's design should facilitate ease of operation, requiring minimal training and adjustment.

Studies have shown that both perceived usefulness and perceived ease of use significantly influence users' acceptance of new technologies (Marangunić & Granić, 2015). In the case of RFID-based attendance systems, these factors will affect how readily the system is adopted and utilized by the various users within educational institutions.

2.3.2 Socio-Technical Systems Theory

Socio-Technical Systems Theory emphasizes the importance of considering both social and technical factors when implementing new technologies. According to this theory, the success of a technological system is not solely dependent on the technology itself but also on how well it aligns with the organizational context and user needs. Key components include:

Social Factors: These encompass the organizational culture, existing workflows, and user preferences. Effective integration of RFID-based attendance systems requires understanding and aligning with the social dynamics and operational practices within educational institutions. For instance, how well the system fits with existing administrative processes and user expectations can impact its acceptance and effectiveness.

Technical Factors: These include the technological capabilities, design, and functionality of the system. The technical solution must address the specific requirements of the institution, such as scalability, reliability, and integration with other systems. In the context of RFID attendance systems, technical factors involve the implementation of RFID hardware, software development, and the creation of a user-friendly interface.

Successful adoption of RFID-based attendance systems will depend on the synergy between these social and technical aspects (IDEO, 2018). By analyzing this interplay, the study aims to identify the critical success factors for effectively deploying RFID technology in educational settings.

The figure below provides an overview of the system architecture, demonstrating how the RFID-based attendance system integrates social and technical components, including role-based access and data processing.

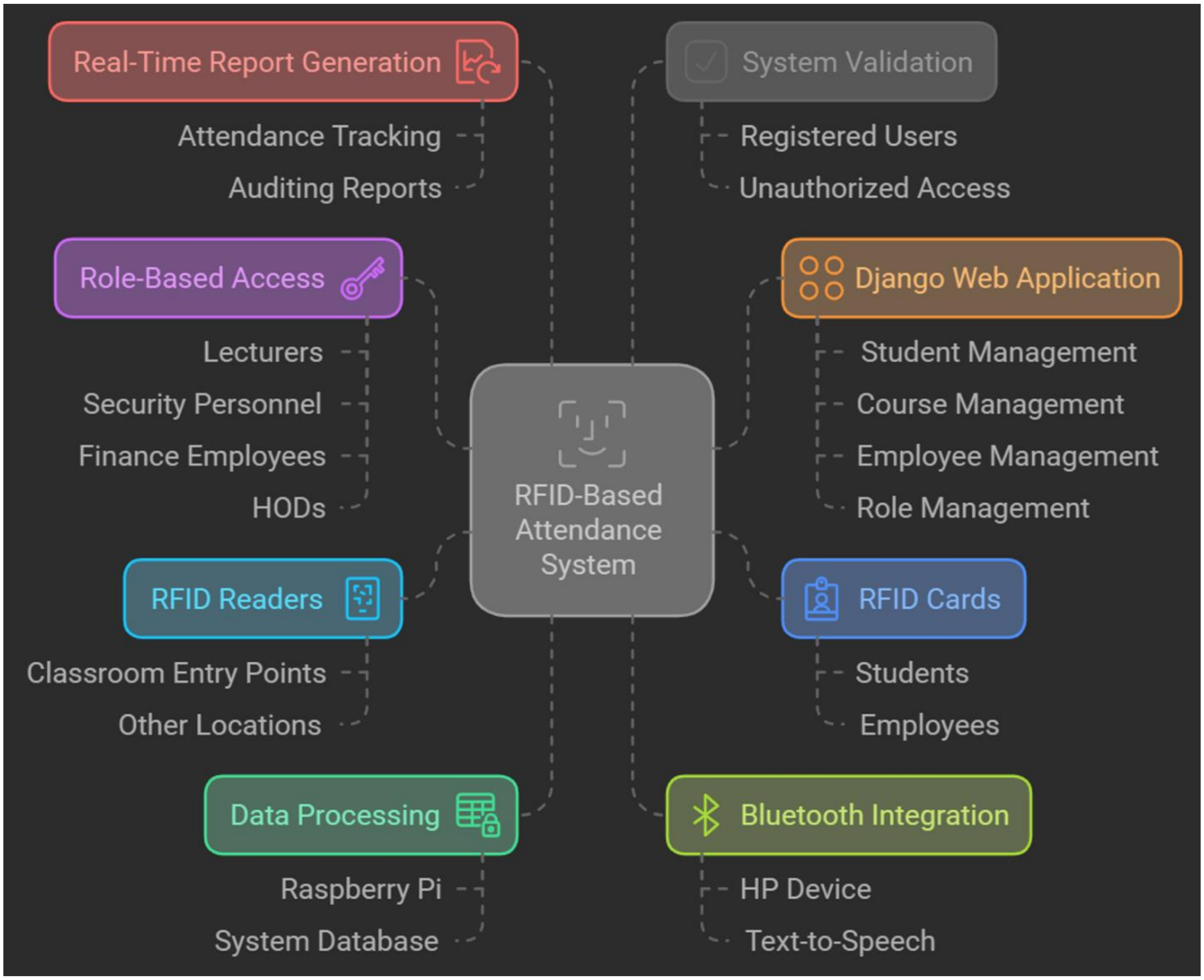


Figure 1 Block Diagram of the RFID-Based Attendance System Architecture

2.3.3 Integration of Theoretical Perspectives

By combining insights from TAM and Socio-Technical Systems Theory, this study seeks to provide a holistic understanding of the factors influencing the adoption and implementation of RFID-based attendance systems. The integration of these theories will help identify key determinants of user acceptance and highlight the importance of aligning technological solutions with organizational needs and contexts.

2.4 Related Study

Several studies have explored the development and implementation of smart attendance systems, highlighting the benefits and challenges associated with different technologies. This section reviews relevant research on RFID-based systems, IoT integration, and cloud computing in attendance management.

2.4.1 RFID-Based Systems

Research indicates that RFID-based attendance systems significantly enhance efficiency and accuracy in attendance tracking.

Bharathy et al. (2021) demonstrated that RFID systems effectively reduce the time required for attendance management and minimize human errors. Their study highlights how RFID technology simplifies attendance recording and integrates seamlessly with existing IT infrastructure, making it suitable for widespread adoption in educational settings. Similarly, Patil et al. (2021) emphasized RFID's advantages in terms of ease of integration and operational efficiency, particularly in large-scale implementations.

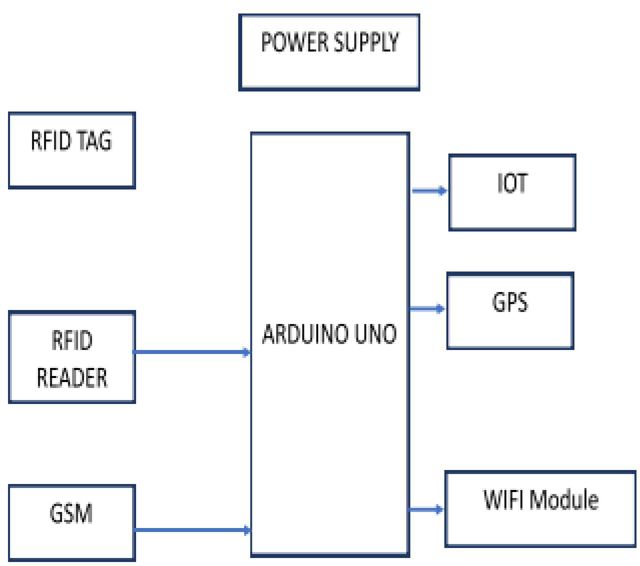


Figure 2 Block Diagram of proposed System

Goyal & Verma (2022) examined the role of RFID in streamlining attendance systems in higher educational institutions. Their study focused on how RFID technology reduces manual entry errors, improves student accountability, and provides real-time attendance data. The research also highlighted the ease of use and adaptability of RFID systems, even in institutions with large student populations. The study concluded that RFID attendance systems are cost-effective and easy to scale for various applications in academic settings (Goyal & Verma, 2022).

Shah & Jadhav (2020) explored the integration of RFID systems with mobile applications, enhancing the portability of attendance systems. Their findings showed that by using mobile devices as interfaces, RFID systems could be monitored remotely, increasing efficiency for educational administrators. This study demonstrated that combining RFID technology with mobile platforms provides both accessibility and ease of use, particularly for large universities (Shah & Jadhav, 2020).

Kim & Lee (2019) investigated RFID usage in corporate environments, highlighting that the technology provides benefits in terms of real-time tracking of employees and inventory. They found that the technology can be easily adapted for educational institutions to track student attendance, further demonstrating the flexibility and scalability of RFID systems. Their findings showed how corporate innovations can be applied to educational settings to improve attendance monitoring and administrative functions (Kim & Lee, 2019).

2.4.2 IoT-Enabled Attendance Systems

Integrating Internet of Things (IoT) technology into attendance management systems provides real-time data collection and monitoring capabilities.

Sri Madhu et al. (2017) explored IoT-based solutions, revealing how they enhance decision-making and operational efficiency within educational institutions. By enabling instantaneous data transmission and processing, IoT technologies contribute to more dynamic and responsive attendance management systems.

Kumar et al. (2020) developed an IoT-enabled smart attendance system for monitoring students in real time. The research highlighted how IoT devices, such as sensors and RFID readers, can be combined to create an intelligent, interconnected system that reports data to cloud servers for real-time attendance monitoring. The study found that IoT-enabled systems offer faster and more accurate attendance tracking compared to traditional RFID systems (Kumar et al., 2020).

Alam & Ahmed (2019) focused on implementing IoT systems in smart campuses. Their study demonstrated how integrating various IoT devices, including RFID readers, can enhance decision-making by providing real-time analytics for student and staff attendance. They further explored the role of IoT in resource management, like monitoring the usage of classrooms based on attendance records (Alam & Ahmed, 2019).

Nguyen & Tran (2021) analyzed the application of IoT in improving security and attendance systems in high schools. Their findings indicated that IoT-based systems offer improved data processing capabilities, leading to more dynamic attendance systems. These systems can detect anomalies such as multiple students trying to check in using the same card and alert administrators in real time (Nguyen & Tran, 2021).

2.4.3 Cloud Computing Integration

Cloud computing plays a critical role in the scalability and flexibility of smart attendance systems. Research (Pachghare, 2016) highlights how cloud-based solutions offer centralized data storage, which facilitates easy access and management across multiple locations. The study demonstrates that cloud computing enhances cost-effectiveness and operational efficiency by providing scalable and adaptable solutions for attendance management in educational institutions.

Singh & Patel (2021) investigated how cloud computing improves scalability and data security in attendance systems. Their study focused on how cloud solutions enable schools and universities to store attendance data centrally, making it accessible from multiple locations. They also emphasized the cost-effectiveness and flexibility of cloud systems, which allow for seamless integration with RFID and IoT technologies (Singh & Patel, 2021).

Mishra et al. (2019) studied the implementation of cloud-based attendance systems in large educational institutions. Their research highlighted the use of cloud platforms such as AWS to handle large volumes of attendance data efficiently. They concluded that cloud solutions ensure real-time data backup and easy recovery, making attendance systems more reliable (Mishra et al., 2019).

Ali & Hussein (2020) demonstrated how cloud computing integration can enhance the functionality of attendance systems by providing features such as real-time data analytics and access control management. Their study revealed that cloud solutions allow for better performance tracking and insights, which are crucial for decision-making in academic administration (Ali & Hussein, 2020).

2.5 Conclusion

This chapter has provided a comprehensive review of the literature surrounding RFID-based smart attendance systems, highlighting the benefits of automating attendance processes in educational institutions. The studies reviewed emphasize the advantages of RFID technology in terms of accuracy, efficiency, and real-time data processing. Furthermore, the integration of IoT and cloud computing enhances the scalability and adaptability of these systems, allowing for seamless data management and improved decision-making capabilities.

The theoretical perspectives explored, including the Technology Acceptance Model (TAM) and Socio-Technical Systems Theory, offer valuable insights into the factors that influence the adoption and success of RFID-based attendance systems. These frameworks underscore the importance of user acceptance, system ease of use, and the alignment of technological solutions with organizational needs.

In conclusion, the adoption of RFID-based systems for attendance management presents significant potential for improving operational efficiency, reducing human errors, and providing real-time data access. The integration of IoT and cloud computing further strengthens these systems by enabling dynamic, scalable, and cost-effective solutions. These insights form a solid foundation for understanding the implementation of RFID technology in the context of educational institutions, guiding the development of more advanced and efficient attendance management solutions.

CHAPTER 3 METHODOLOGY

3.1 Introduction

This chapter provides a comprehensive overview of the methodology used to design and implement an RFID-based attendance management system integrated with a Raspberry Pi. The aim of this methodology is to ensure the system effectively automates the attendance process for both students and employees, utilizing RFID technology and a servo motor for door control simulation. The following sections detail the project design, including the hardware and software components, data management, communication strategies, and security measures. This approach ensures the system's efficiency, reliability, and adaptability to educational and organizational environments.

3.2 Project Design

The project design involves a detailed integration of hardware and software components to create an efficient attendance management system. The system is designed to streamline attendance tracking, simulate door access, and provide user-friendly interfaces for administrators and users.

The system architecture consists of the following layers:

3.2.1 Hardware Layer

The hardware layer of the system incorporates several essential components that work together to manage attendance efficiently. At the heart of this layer is the RFID scanner, which reads and records the RFID cards issued to students and employees. This device is crucial for ensuring accurate and efficient data capture without manual intervention. Each student and employee is provided with an RFID card containing a unique identifier. These cards are scanned by the RFID reader to log attendance, streamlining the process and reducing the risk of errors. The Raspberry Pi 4B serves as the central microcontroller, integrating with the RFID scanner, servo motor, and screen monitor. It processes the input from the RFID scanner and controls the servo motor based on the scanned data. The servo motor simulates door control by opening or closing doors according to RFID card access, thereby restricting entry to authorized individuals. A screen monitor is used to provide real-time feedback, displaying attendance data, system status, and user notifications, ensuring users are kept informed of the system’s operational state.

3.2.2 Software Layer

The software layer is built to support the functionality of the hardware components and manage attendance data effectively. Django, a high-level Python web framework, forms the foundation of the system's software. It handles attendance records, user authentication, and provides role-based dashboards for different user types, including HODs, finance employees, security personnel, and lecturers. Django's built-in features facilitate the creation of a secure and efficient web application tailored to the system's needs. Custom Python scripts are developed to interface with the hardware components, such as the RFID scanner and servo motor. These scripts ensure seamless integration between the hardware and software, enabling real-time processing and control of attendance data.

3.2.3 Data Layer

For data management, the system utilizes SQLite3 to store attendance records and other relevant data. SQLite3 is chosen for its simplicity, lightweight nature, and ease of integration during development and testing. However, for future scalability and robustness, advanced databases like PostgreSQL or MySQL are recommended. These databases offer enhanced performance, security, and scalability, making them suitable for larger institutions where managing extensive data and multiple concurrent users is crucial (Obe & Hsu, 2016).

The following image provides a visual representation of the system's database schema, detailing how various components are structured and interrelated. The central CustomUser model connects with key models such as EmployeeAttendance, Class, Student, and Exam, enabling efficient data management for different functionalities like attendance tracking, exam eligibility, and class management.

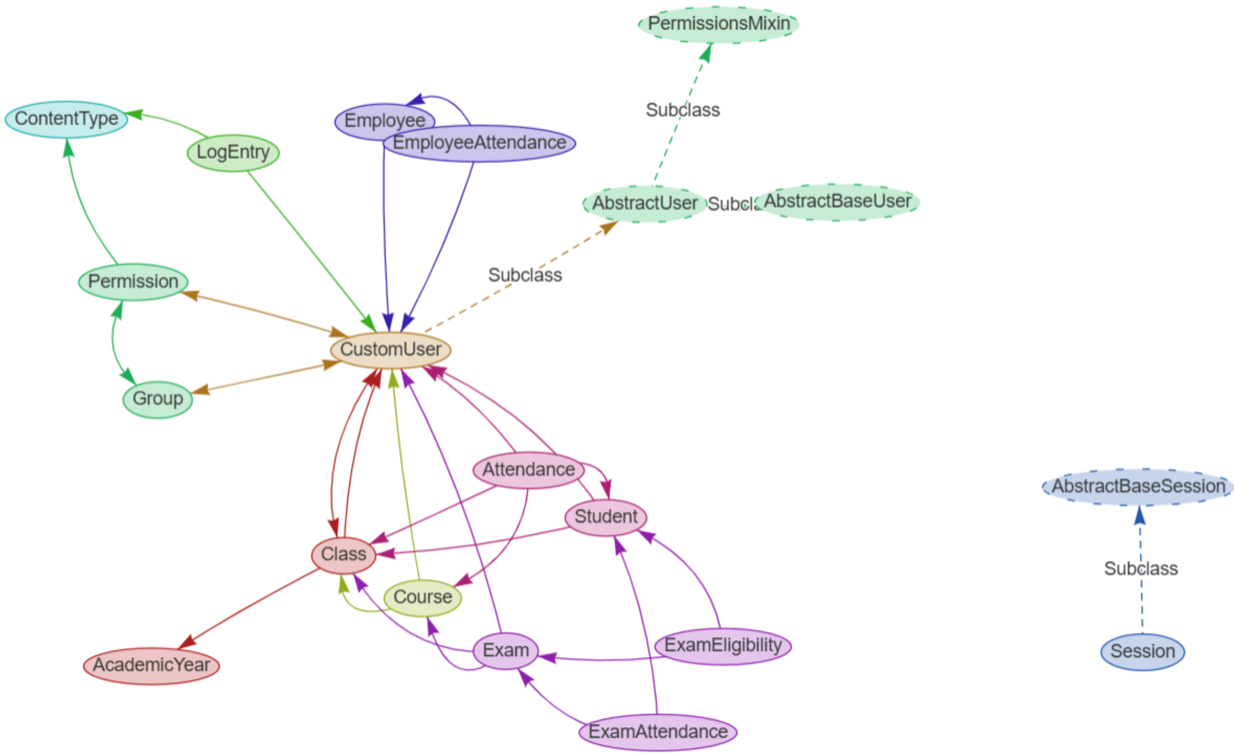


Figure 3 System Database Schema

3.2.4 Communication Layer

The communication layer ensures that the system operates efficiently within its network environment. The Raspberry Pi is configured to manage network traffic as a DNS server, optimizing data communication within the local network. Additionally, Bluetooth connectivity is integrated to facilitate communication with external devices, such as an HP device for text-to-speech functionality. This feature enhances accessibility and supports users with diverse needs.

3.2.5 Security Layer

The security layer is designed to protect the integrity and confidentiality of the system's data. It implements user authentication and role-based access control, ensuring that only authorized individuals can access specific features and data within the system. By restricting access based on user roles, the system prevents unauthorized access and safeguards sensitive information, thereby maintaining the overall security of the attendance management process.

The development of this system involved iterative refinement based on feedback from colleagues, supervisors, educators, and administrators. This feedback-driven approach allowed for continuous improvements and adaptations to better meet user needs and address any issues that arose during development.

3.2.6 Main Components Used in the Project

The RFID-based attendance management system integrates several key components to function effectively. Each component plays a crucial role in the system's operation, contributing to its overall performance and usability.

Raspberry Pi 4B: The Raspberry Pi 4B serves as the central processing unit (CPU) for the system. It manages data from the RFID scanner, controls the servo motor for door simulation, and functions as a DNS server for local network management. Additionally, it is equipped with a Bluetooth module to communicate with external devices, such as an HP device for text-to-speech functionality. The Raspberry Pi was chosen for its affordability, versatility, and extensive support for various programming languages and hardware interfaces (Monk, 2008).

RFID Scanner: The RFID scanner reads RFID cards to record attendance. It captures unique identifiers (UIDs) from the RFID cards and sends this data to the Raspberry Pi for processing. The scanner's integration with the Django web application triggers specific actions, such as marking attendance or controlling the servo motor for door operations (Lehpamer, 2012).

RFID Cards: RFID cards are passive devices that contain unique identifiers, which are read by the RFID scanner. Each student or employee is issued an RFID card to log their attendance when entering or exiting monitored areas. These cards provide a convenient and efficient way to track attendance without manual intervention (Myerson, 2006).

Servo Motor: The servo motor is connected to the Raspberry Pi and simulates door control. When a valid RFID card is scanned, the servo motor is activated to open or close the door, thus enhancing security and access control within the institution. The motor's operation is controlled using Python scripts that respond to input from the RFID scanner (Tobergte & Curtis, 2013).

Screen Monitor: The screen monitor displays real-time attendance data and system status, offering an interface for administrators to manage the system. It provides visibility into the system's operation and allows for efficient monitoring and control.

Python Programming Language: Python is used to develop scripts that control hardware components, such as the RFID scanner and servo motor, and manage data processing tasks. It also powers the Django web framework, which is used for developing the user interface and managing user roles (Sweigert, 2015).

Django Web Framework: Django, a high-level Python web framework, is employed to build the web application that serves as the front end of the attendance system. Its robust security features, scalability, and ease of integration with other technologies make it an ideal choice for this project (Vincent, 2020).

Network Configuration: The Raspberry Pi is configured as a DNS server to manage local network traffic securely and efficiently. It utilizes Wi-Fi or Ethernet connectivity for real-time data transmission and remote access by administrators. Proper encryption protocols are applied to ensure secure communication between devices.

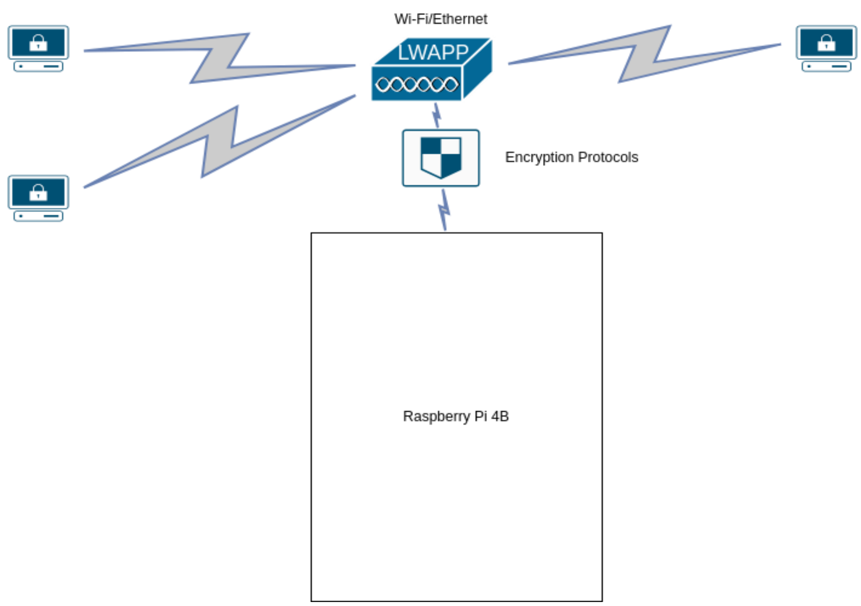


Figure 4 Diagram of the network configuration, illustrating the Raspberry Pi's role as a DNS server and its connectivity with other components.

3.3 Data Collection Methods

To assess the effectiveness and reliability of the RFID-based attendance management system, both primary and secondary data collection methods were utilized. The primary methods involved direct interaction with the system and its users, while secondary methods involved reviewing relevant literature to contextualize and benchmark the project's design.

Primary data collection was carried out through system testing, user feedback, and observation. The target population for system testing consisted of 31 students from the class, representing the complete group of potential users for whom the system was designed. To select a representative sample from this target population, Slovin's formula was applied, which is a standard method for determining sample size to minimize sampling error while ensuring that the sample accurately reflects the characteristics of the overall population. Given a population size of 31 students and a margin of error of 5%, Slovin's formula calculated the required sample size as follows (Tejada et al., 2012):

$$n = \frac{N}{1 + Ne^2}$$

Where n is the sample size, N is the population size (31 students), and e is the margin of error (0.05). The calculation yielded:

$$n = \frac{31}{1 + 31 \times e^2} \approx 29$$

Rounding up, the sample size was determined to be 29 students to adequately represent the population. Each of the 29 participants used their student cards multiple times over a one-week period to simulate real-world conditions. The scenarios tested included peak times, such as the start and end of the day, and consecutive scans to evaluate the system's performance in terms of accuracy, response time, and reliability under varied conditions.

In addition to system testing, user feedback was gathered from lecturers and employees at UPI who interacted with the system. Structured interviews and surveys were conducted to collect their opinions on the system's usability, efficiency, and overall effectiveness. This feedback was critical for identifying potential usability issues and areas for improvement.

Observational data was also collected during the testing phase to monitor how users interacted with the system. The observations focused on user behavior, such as handling RFID cards, responding to the servo motor's simulated door mechanism, and identifying any practical challenges or technical issues encountered during the attendance logging process.

Secondary data collection involved a comprehensive literature review of studies and reports on smart attendance systems, RFID technology, IoT, and cloud computing. This review provided a benchmark for comparing the project's design and implementation against established research and best practices, helping to identify key trends and potential areas for enhancement.

3.4 Procedures for Data Collection

The procedures for data collection were carefully designed to ensure a thorough evaluation of the system. System testing involved a sample of 29 students, selected using Slovin’s formula from a total population of 31. Over one week, participants used their student cards to log attendance multiple times under various simulated scenarios. These scenarios were designed to test the system’s performance metrics, such as accuracy, response time, and reliability.

To gather user feedback, lecturers and employees were provided with demonstrations of the system and asked to provide their opinions through structured interviews and surveys. This process focused on assessing the system’s usability, efficiency, and effectiveness. The collected feedback was analyzed to gauge user satisfaction and identify areas that needed improvement.

Observation was another key data collection method. During the testing period, direct observations were made to understand how users interacted with the system. This included noting how they handled RFID cards, responded to the servo motor mechanism, and any issues encountered during use. Observational data provided valuable insights into practical challenges and helped refine the system's functionality.

3.5 Data Gathering Procedures

The data collection process for this study was carried out in three main phases: before, during, and after the administration of the research instruments.

Before Data Collection:

Preparations for data collection involved selecting a representative sample size from a population of 31 students. Permissions were obtained from relevant authorities at UPI to test the RFID-based attendance management system with the selected students. Consent was sought from all participants to ensure they were fully informed about the study's purpose, procedures, and data handling policies.

During Data Collection:

The data collection phase commenced with system testing. Participants used their student cards multiple times over one week to log their attendance. Different scenarios, such as peak times and consecutive scans, were simulated to assess the system's accuracy, response time, and reliability. Observations were made to monitor participants' interactions with the RFID scanner, servo motor, and overall system operation. Observational notes were documented to capture user behavior and any practical challenges encountered during the attendance logging process.

After Data Collection:

Post-data collection, the data were organized and inserted into the appropriate tables in the database. The data were primarily system-generated logs that recorded the times and instances of card scans, which were used to assess the performance and accuracy of the system.

3.6 Data Analysis and Interpretation

The collected data were analyzed using quantitative and comparative methods to evaluate the RFID-based attendance management system's performance, accuracy, and usability.

Quantitative Analysis: Data logs generated by the system were compared with manual records to measure accuracy. Metrics such as response time (from card scan to data logging), error rates (instances where the system failed to log attendance correctly), and system uptime were analyzed using statistical methods to identify any areas for improvement.

Comparative Analysis: To evaluate the effectiveness of the RFID-based system, a comparative analysis was conducted between the new system and traditional attendance methods. The comparison focused on metrics like efficiency (time savings), accuracy (reduction in errors), and overall user satisfaction to assess the system’s advantages over conventional methods.

3.7 Ethical Considerations

The study adhered to ethical standards to ensure the safety, social, and psychological well-being of all participants. Informed consent was obtained from all participants, and they were fully briefed on the study's objectives, methods, and data privacy policies. The anonymity and confidentiality of all participants were strictly maintained, and no personal identifiers were linked to the data collected. Data security measures, including encryption and secure storage, were implemented to protect the data from unauthorized access.

CHAPTER 4 SYSTEM ANALYSIS, AND IMPLEMENTATION

4.1 Introduction

This chapter presents the detailed design, analysis, and implementation of the RFID-based attendance management system using a Raspberry Pi and a servo motor to simulate door control. The chapter outlines the system architecture, hardware and software components, and the specific steps taken to integrate and implement these components to achieve the desired functionality. Additionally, it discusses the design considerations, challenges encountered during development, and the solutions implemented to address these challenges.

4.2 System Architecture

The system architecture consists of interconnected hardware and software components, as illustrated in Figure 1. This diagram offers a visual representation of the communication flow between the Raspberry Pi, RFID scanner, and other peripherals.

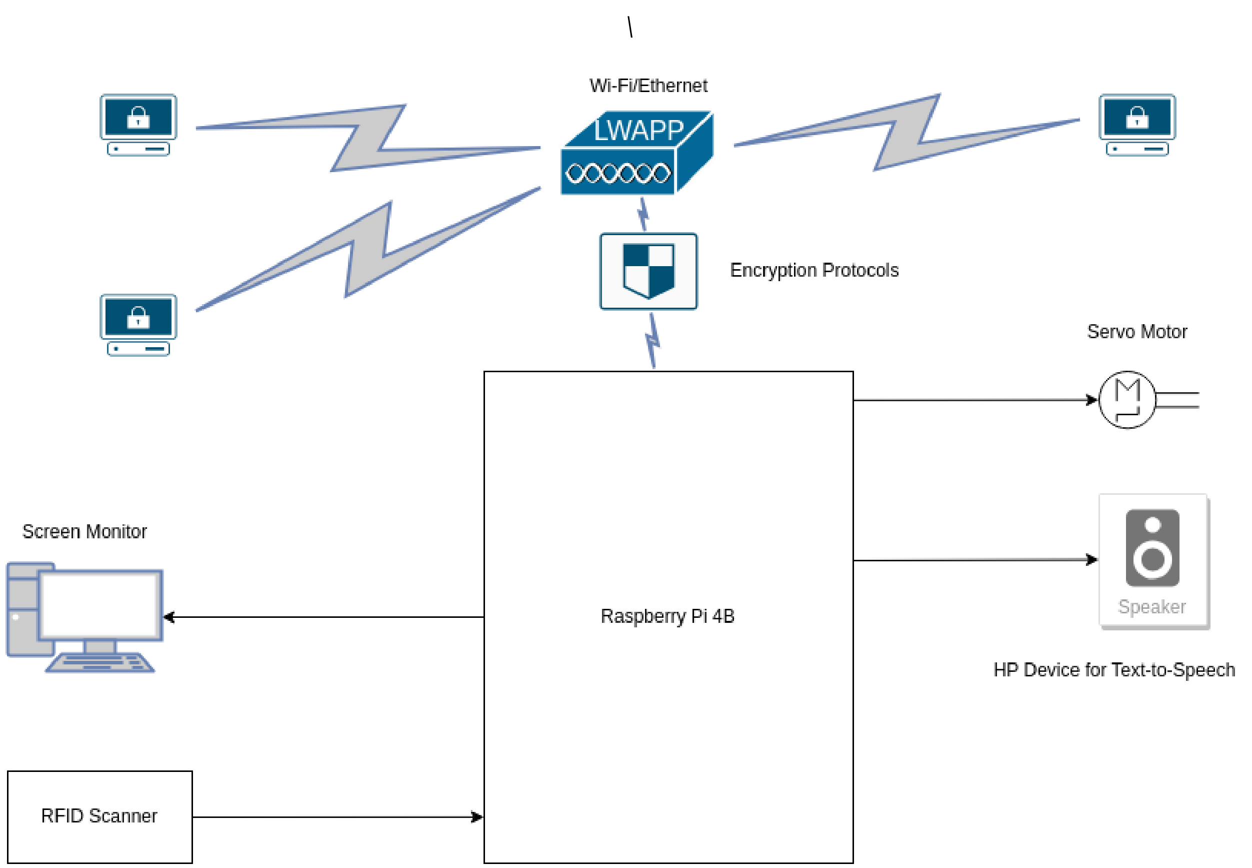


Figure 5 System Architecture of the RFID-Based Attendance Management System

Block Diagram

The following block diagram provides an overview of the system's architecture, outlining the relationships between hardware and software components.

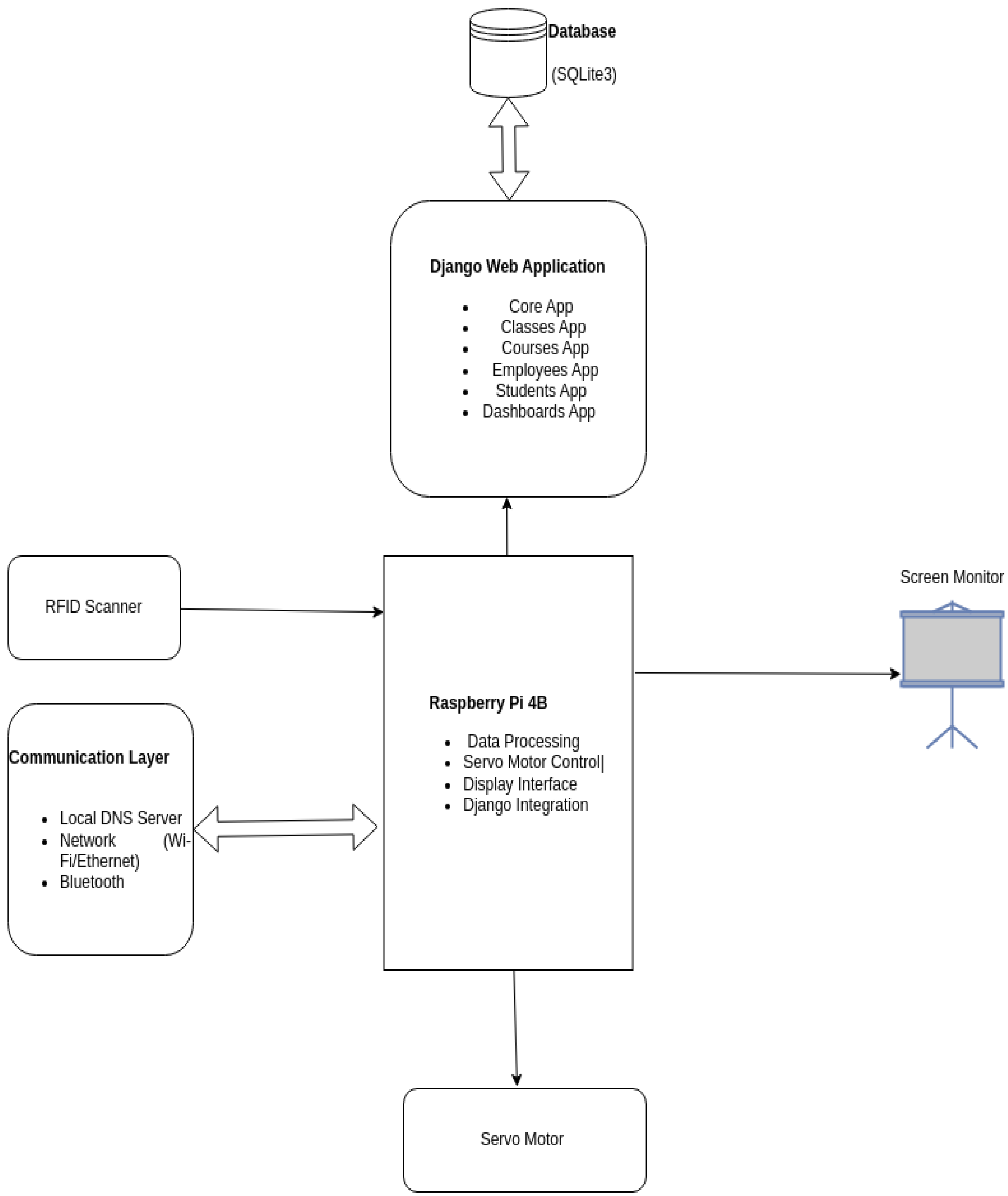


Figure 6 System Block Diagram

The RFID-based attendance management system consists of several interconnected components designed to work together seamlessly. The architecture is divided into four main layers:

1. Hardware Layer

The **Hardware Layer** includes the following components:

RFID Scanner: Scans RFID cards and bracelets to record attendance by capturing the unique identifier (UID) of each card or bracelet. This data is sent to the Raspberry Pi for processing via a USB or GPIO interface.

Figure 7 RFID scanner used to read unique identifiers from RFID cards to record attendance accurately.

RFID Cards: RFID cards are passive devices that contain unique identifiers, which are read by the RFID scanner.

Figure 8 Example of an RFID card issued to students and employees for logging attendance

Raspberry Pi 4B: Serves as the central processing unit (CPU) for the system. It handles data received from the RFID scanner, controls the servo motor to simulate door opening and closing, and communicates with the local network or server for data storage and access.

Figure 9 Raspberry Pi 4B, serving as the central processing unit for managing data and controlling hardware components in the RFID-based attendance system.

Servo Motor: A small motor connected to the Raspberry Pi, simulating the door control mechanism by opening or closing the door when a valid RFID card is scanned. This enhances security and manages access control.

Figure 10 Servo motor configured to simulate door control, activating to open or close doors based on RFID card access.

Screen Monitor: Displays real-time attendance data and system status, providing an interface for administrators to access and manage the system.

Figure 11 Screen monitor displaying real-time attendance data and system status for administrative management.

2. Software Layer

The **Software Layer** is developed using the Django web framework, a high-level Python framework that manages backend functionalities such as database management, user authentication, and role-based access control. Key components of this layer include:

Django Applications: Multiple apps (e.g., core, students, employees, exams, courses, dashboard) manage different functionalities like handling student and employee data, recording attendance, and providing role-based dashboards.

Python Scripts: Interface with hardware components, including the RFID scanner and servo motor, to process data and manage tasks such as recording attendance.

3. Data Layer

The Data Layer confidently utilizes a SQLite3 database during development to securely store attendance records and other relevant data. The database is carefully designed to effectively handle different user roles, such as Heads of Departments (HODs), finance personnel, security, and lecturers, with precise access permissions.

When it comes to a production environment, a more scalable database solution such as PostgreSQL or MySQL is confidently recommended to seamlessly accommodate larger datasets and more concurrent users.

4. Communication Layer

The Communication Layer plays a crucial role in defining the communication protocols and network configurations that enable various components to connect.

One aspect of this is configuring the Raspberry Pi as a local DNS server, which helps in securely and efficiently managing traffic. The Raspberry Pi can connect to the network using either Wi-Fi or Ethernet, and it also utilizes Bluetooth to communicate with other devices. For example, it can connect with an HP device to enable text-to-speech functionality.

4.3 Hardware Design and Integration

The hardware design involves connecting and configuring the following components to achieve the desired functionalities:

1. **Connecting the RFID Scanner:**

The RFID scanner is connected to the Raspberry Pi through a USB or GPIO interface. A Python script continuously listens for input from the scanner. When an RFID card is scanned, the script captures the unique identifier (UID) and checks it against the database to log attendance. If the card is valid, the script triggers specific actions, such as updating attendance records or controlling the servo motor.

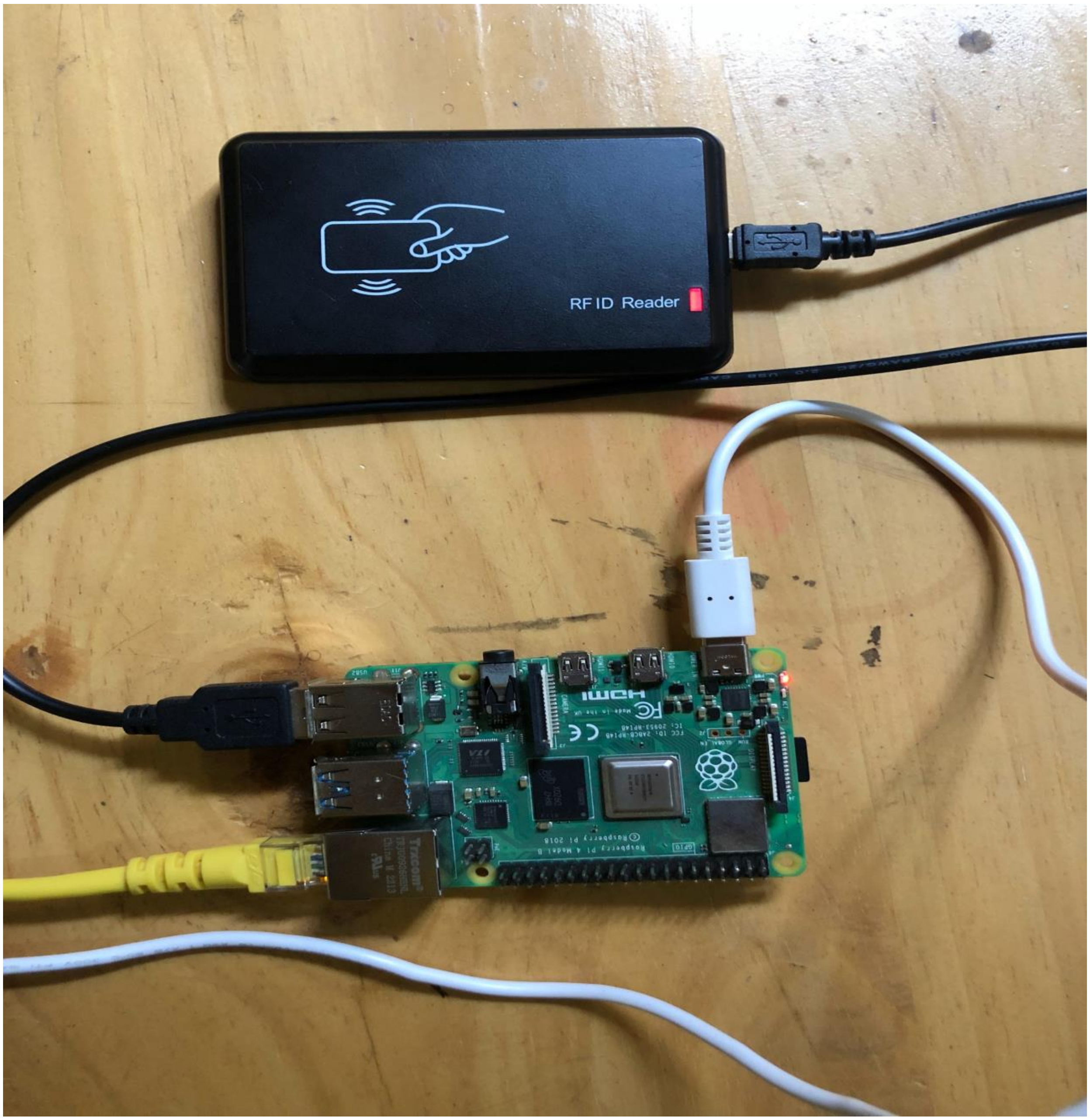


Figure 12RFID Reader Connection

2. **Integrating the Servo Motor:**

   The servo motor is connected to the Raspberry Pi's GPIO pins and is programmed to simulate door control. When a valid RFID card is scanned, the Python script sends a signal to the servo motor to rotate, simulating the opening or closing of a door. The servo motor is also configured to reset to its default position after a specified period.

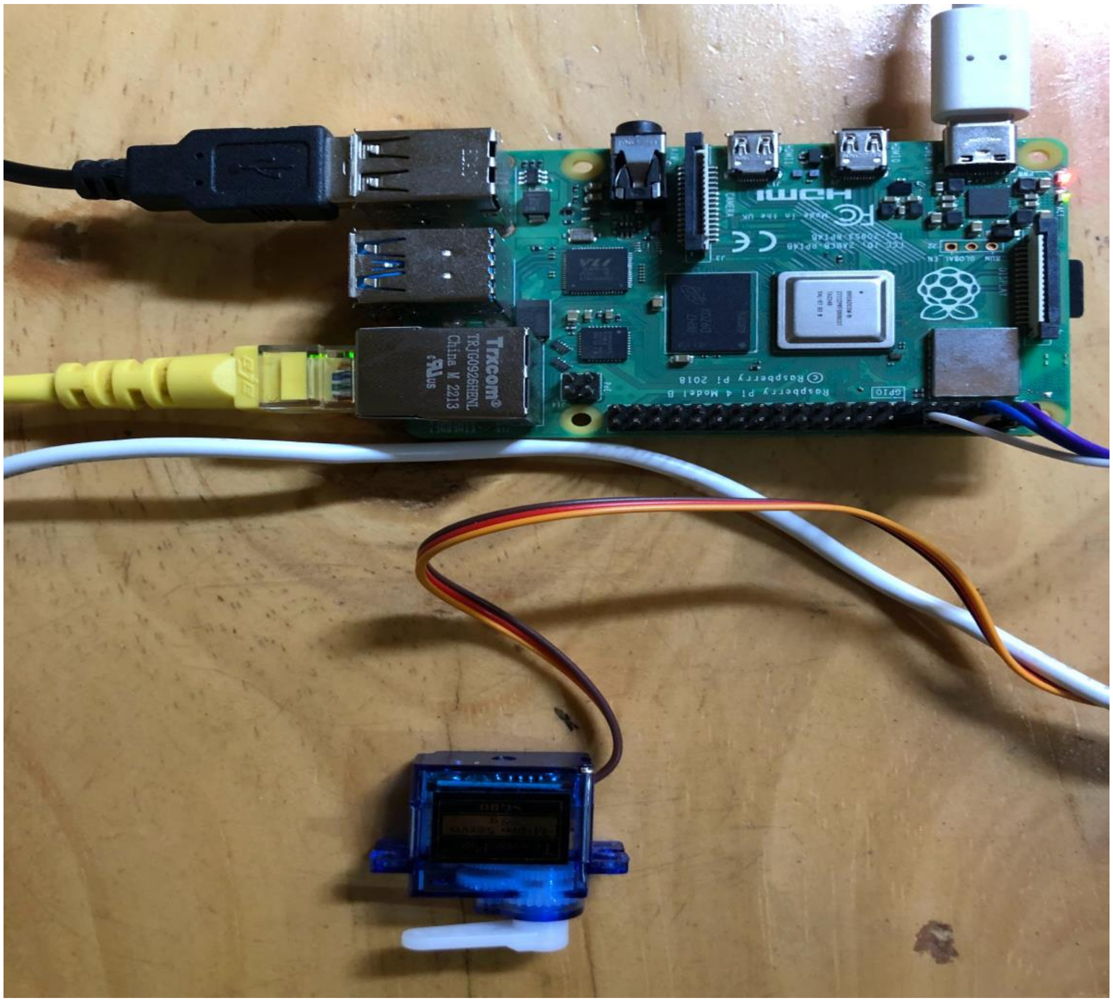


Figure 13 Servo Motor Connection

Circuit Design and Integration

The following circuit diagram illustrates the connections between the Raspberry Pi and the servo motor. It focuses on the wiring required for door control simulation, as the RFID reader is connected to the Raspberry Pi via USB.

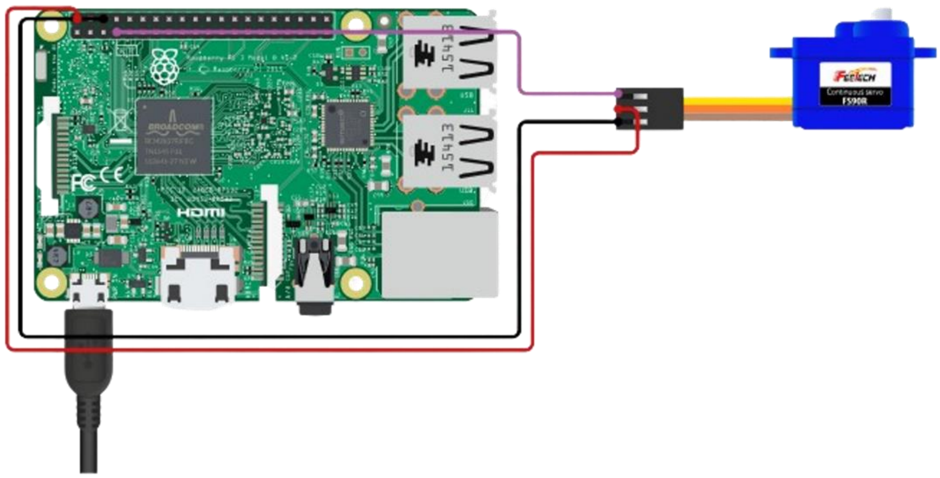


Figure 14 Circuit Diagram

3. Raspberry Pi Configuration:

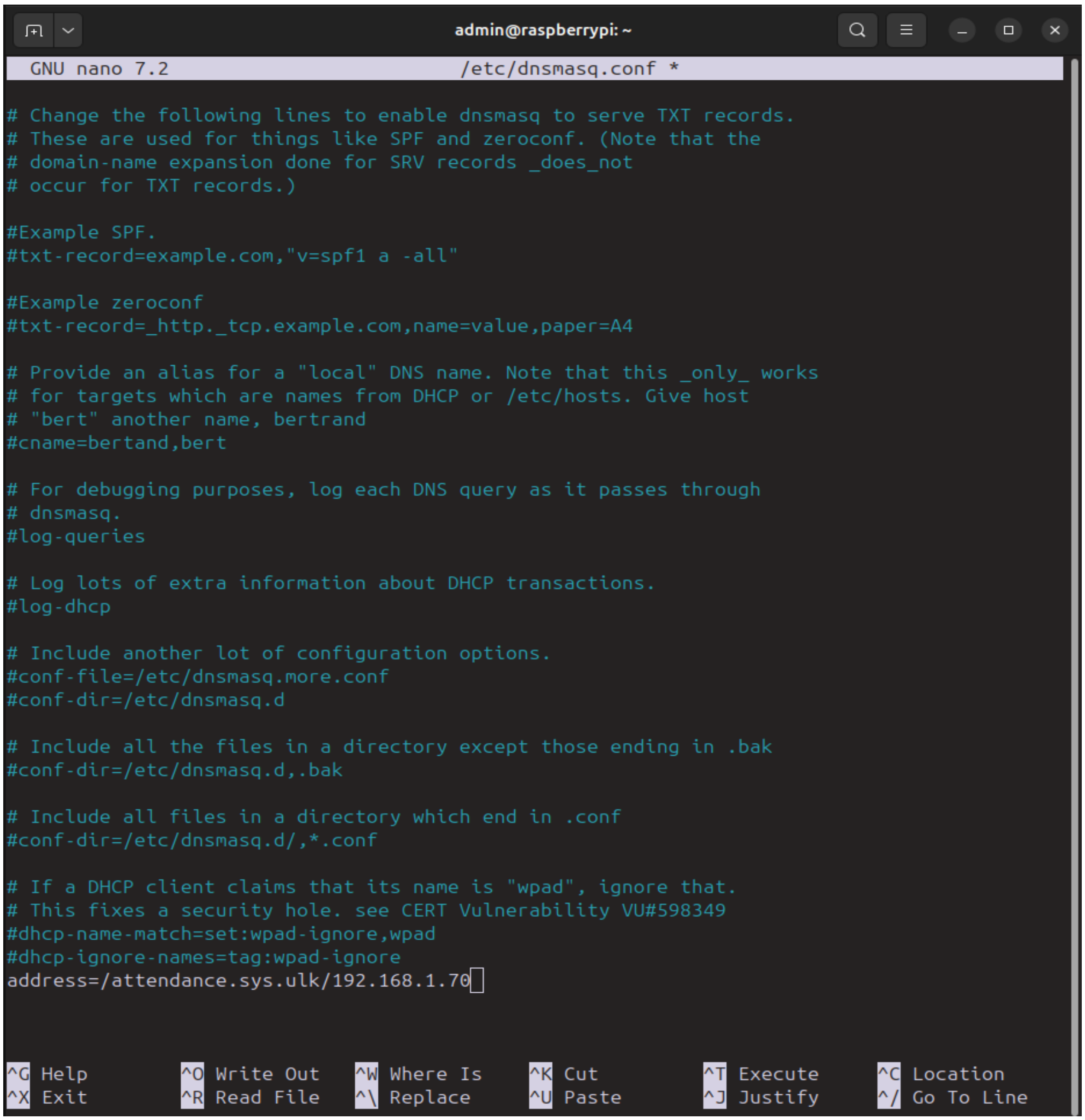
The Raspberry Pi is configured as a local DNS server to manage network traffic. It runs Python scripts that handle communication with the RFID scanner, control the servo motor, and manage data processing tasks. The Raspberry Pi also integrates with an HP device via Bluetooth for text-to-speech functionality, providing audio feedback to users when their attendance is confirmed or rejected.

DNS Server Configuration for Attendance System

In this project, configuring a local DNS server was an essential step in ensuring that the RFID-based attendance system could be accessed via a human-readable domain name within the university's internal network. By setting up a DNS server using ``dnsmasq`, I was able to map a specific IP address to the custom domain `attendance.sys.ulk`. This allowed users to access the attendance system without needing to remember or input the IP address manually, streamlining access and improving user experience.

To achieve this, I installed and configured `dnsmasq`, a lightweight and efficient DNS forwarder and DHCP server, on the Raspberry Pi. The configuration was done in the file located at `/etc/dnsmasq.conf`, where I defined the custom DNS entries. Specifically, the line `address=/attendance.sys.ulk/192.168.1.70` was added to map the domain name `attendance.sys.ulk` to the server's IP address, `192.168.1.70`.

The following image shows the specific configuration that was applied:



```
admin@raspberrypi: ~
GNU nano 7.2                    /etc/dnsmasq.conf *

# Change the following lines to enable dnsmasq to serve TXT records.
# These are used for things like SPF and zeroconf. (Note that the
# domain-name expansion done for SRV records _does_not
# occur for TXT records.)

#Example SPF.
#txt-record=example.com,"v=spf1 a -all"

#Example zeroconf
#txt-record=_http._tcp.example.com,name=value,paper=A4

# Provide an alias for a "local" DNS name. Note that this _only_ works
# for targets which are names from DHCP or /etc/hosts. Give host
# "bert" another name, bertrand
#cname=bertand,bert

# For debugging purposes, log each DNS query as it passes through
# dnsmasq.
#log-queries

# Log lots of extra information about DHCP transactions.
#log-dhcp

# Include another lot of configuration options.
#conf-file=/etc/dnsmasq.more.conf
#conf-dir=/etc/dnsmasq.d

# Include all the files in a directory except those ending in .bak
#conf-dir=/etc/dnsmasq.d,.bak

# Include all files in a directory which end in .conf
#conf-dir=/etc/dnsmasq.d/,*.conf

# If a DHCP client claims that its name is "wpad", ignore that.
# This fixes a security hole. see CERT Vulnerability VU#598349
#dhcp-name-match=set:wpad-ignore,wpad
#dhcp-ignore-names=tag:wpad-ignore
address=/attendance.sys.ulk/192.168.1.70

^G Help        ^O Write Out   ^W Where Is    ^K Cut         ^T Execute     ^C Location
^X Exit        ^R Read File   ^\ Replace     ^U Paste       ^J Justify     ^/ Go To Line
```

Figure 15 DNS Server Configuration on raspberry using dnsmasq

4. **Screen Monitor Setup:**

   A screen monitor is connected to the Raspberry Pi to display real-time data, such as attendance logs, system status, and notifications. The monitor also serves as a user interface for administrators, allowing them to view and manage attendance data through a web-based dashboard.

4.4 Software Design and Development

The software component of the system is developed using Django, a high-level Python web framework. This section outlines the development process for various components of the system, including the Core App, Classes App, Courses App, Employees App, Students App, and Dashboards App.

Role-Based Access and RFID Management:

The system operates on a role-based access model, allowing different users (HOD, Lecturers, Security, and Finance Employees) to access specific functionalities. RFID technology is integrated to handle attendance logging and access control.

The following flowcharts explain the structure and operation of the system.

Flowchart 1: Role-Based User Access

This flowchart outlines the process from user login to role-based access to various system functionalities depending on the user's role within the university. Each user role is provided with a specific dashboard, allowing them to perform role-specific tasks.

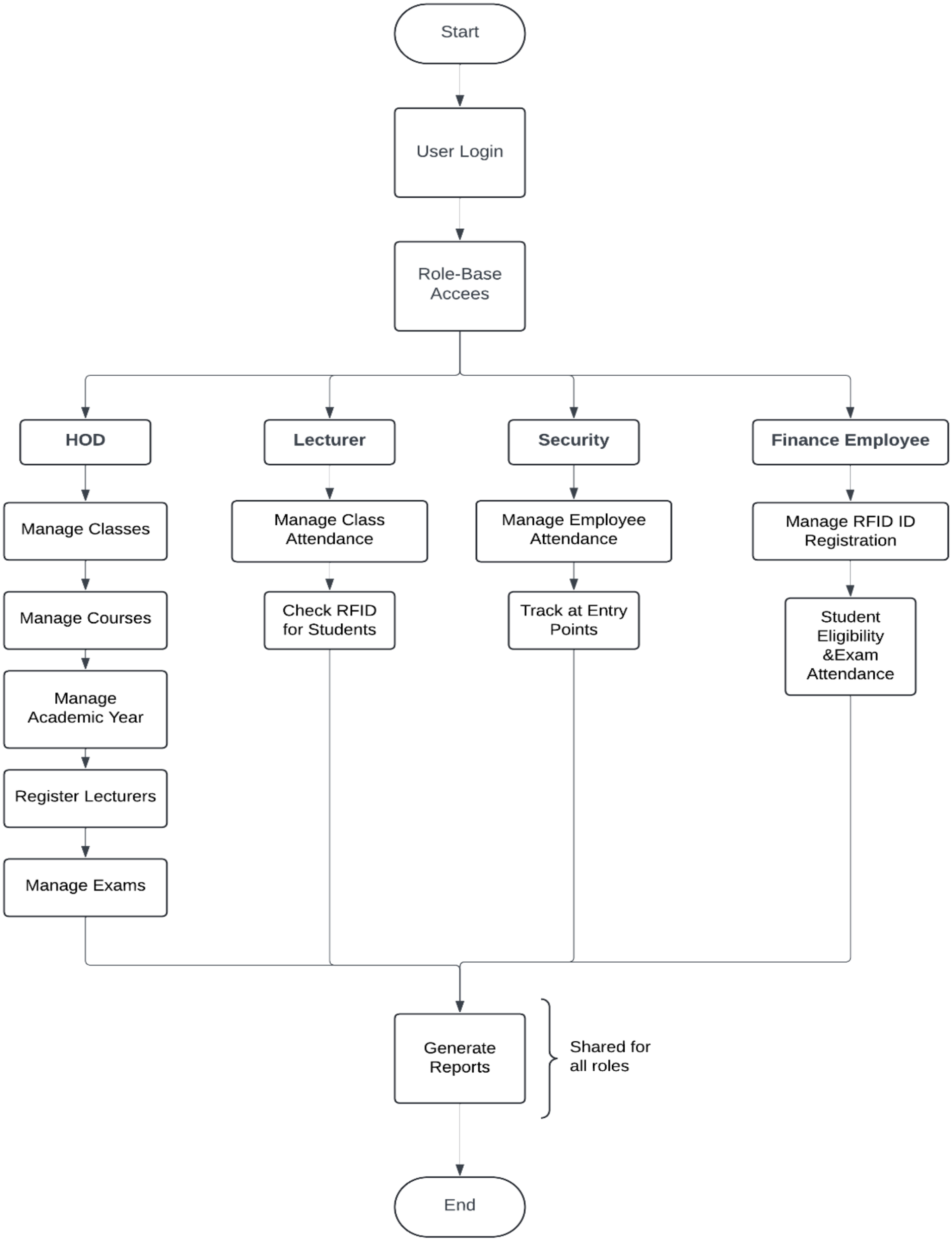


Figure 16 Role-Based User Access

Flowchart 2: RFID Card Scanning and Validation

This flowchart demonstrates the RFID card scanning process, which validates the card in the database, logs attendance, and manages door control for access. The process also handles error messages for invalid cards.

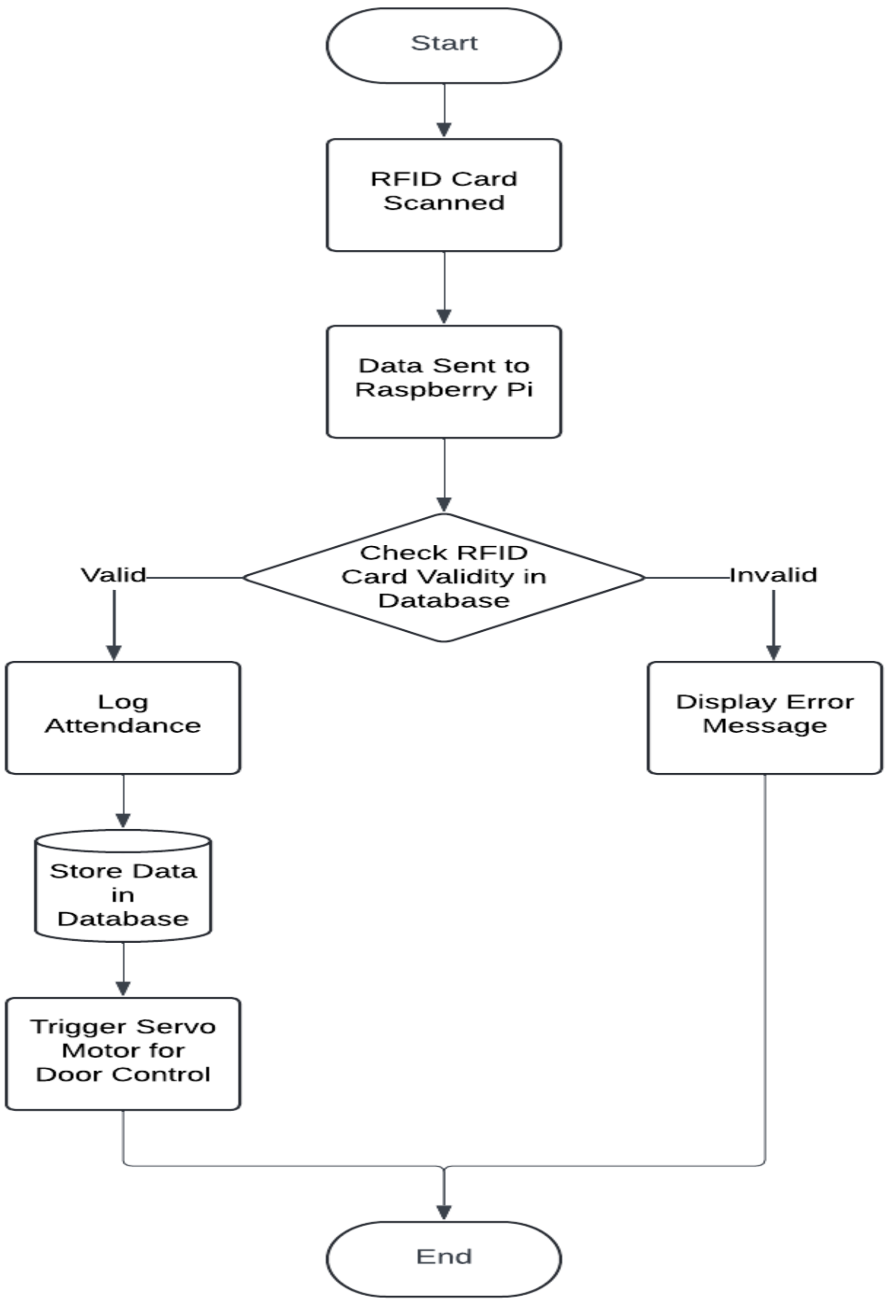


Figure 17 RFID Card Scanning and Validation

4.4.1 Core App

The Core App handles user authentication and profile management. It includes functionalities for logging in, registering users, viewing profiles, and handling role-based access errors.

Login Screen

To access the login page, open your web browser and enter the Raspberry Pi's IP address along with the appropriate port. For example, if the Raspberry Pi is running on IP address `192.168.1.70` and the web application is hosted on port 8000, you would type:

`http://192.168.1.70:8000`

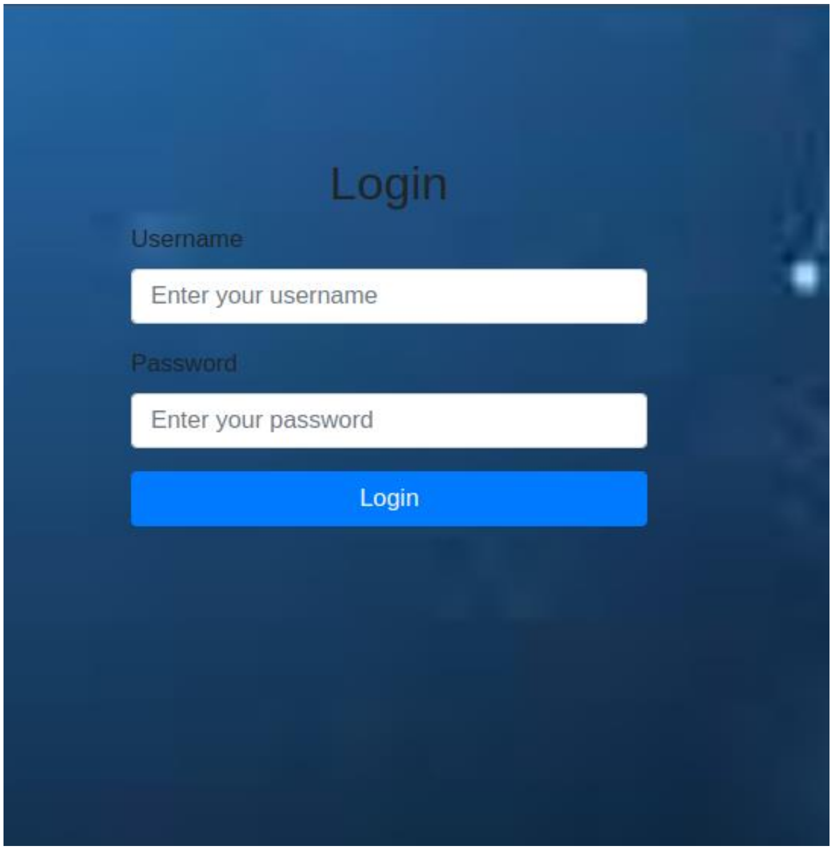


Figure 18 Login Interface

User Profile Screen

After successfully logging in, you can access the user profile page by clicking on the **"Profile"** button, typically located in the navigation menu or dashboard. This will redirect you to the user profile screen, where you can view and manage personal details.

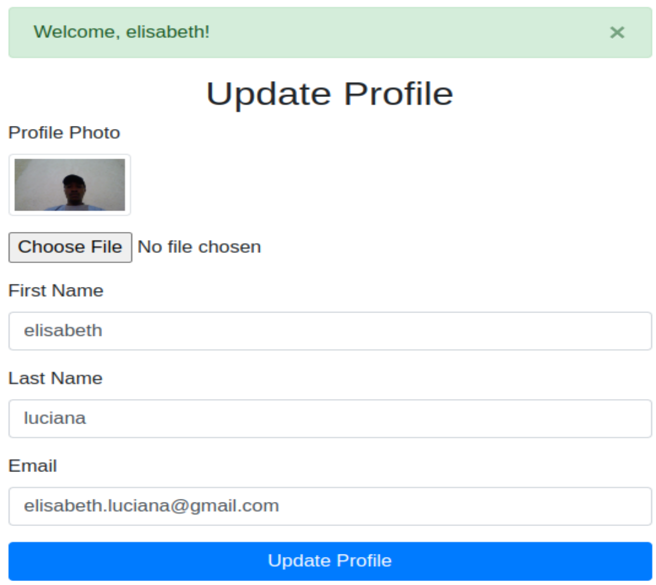


Figure 19 User Profile Page

Role-Based Access Error Page

If a user attempts to access a page or resource they are not authorized for, or does not have the required credentials, the system will automatically display the Role-Based Access Error Page. This page informs the user that they do not have permission to view the requested content.

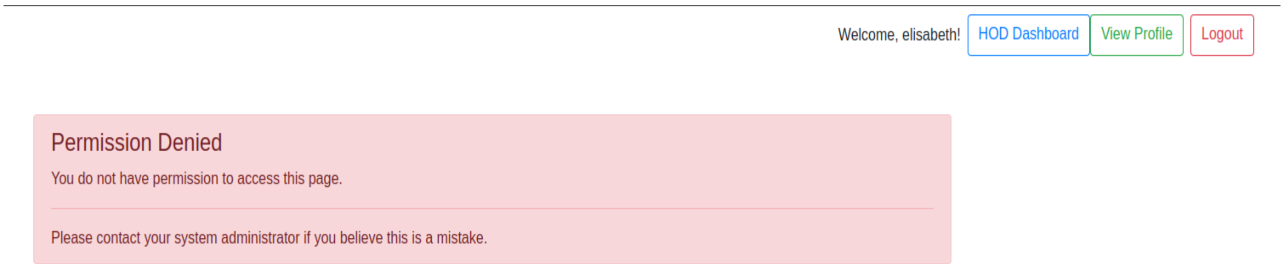


Figure 20 Permission Denied Page

4.4.2 Classes App

The Classes App manages class and academic year information, including creating, updating, and deleting classes and academic years

List of Classes

If the user is assigned the role of Head of Department (HOD) or Lecturer, they will have access to the **List of Classes** page. This page displays a comprehensive list of all classes, and depending on their permissions, users can edit or delete class information directly from this interface.

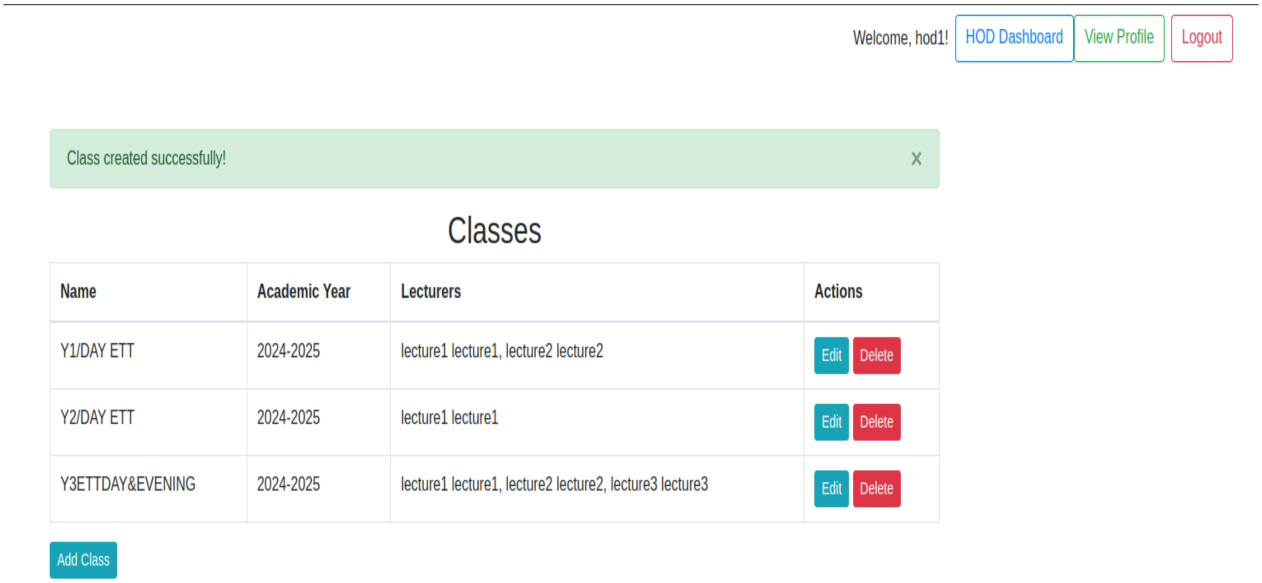


Figure 21 Classes Managements Page

Academic Year Management

This page displays the list of academic years, providing users with the functionality to create, edit, or delete academic years as needed. Users can manage the academic calendar efficiently, ensuring that all relevant information is up to date.

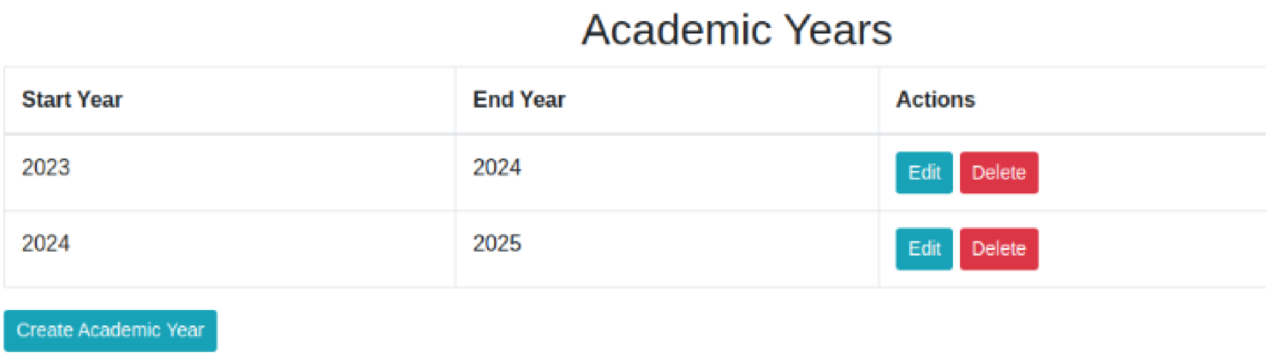


Figure 22 Academic Year Management Page

4.4.3 Courses App

The Courses App provides interfaces for managing course-related information, including creating, updating, and deleting courses.

Course Management Interface

This page presents the course management interface, where users can create, edit, delete, and view a list of courses. It provides an organized platform for managing all course-related information, enabling users to maintain an updated and accessible course catalog.

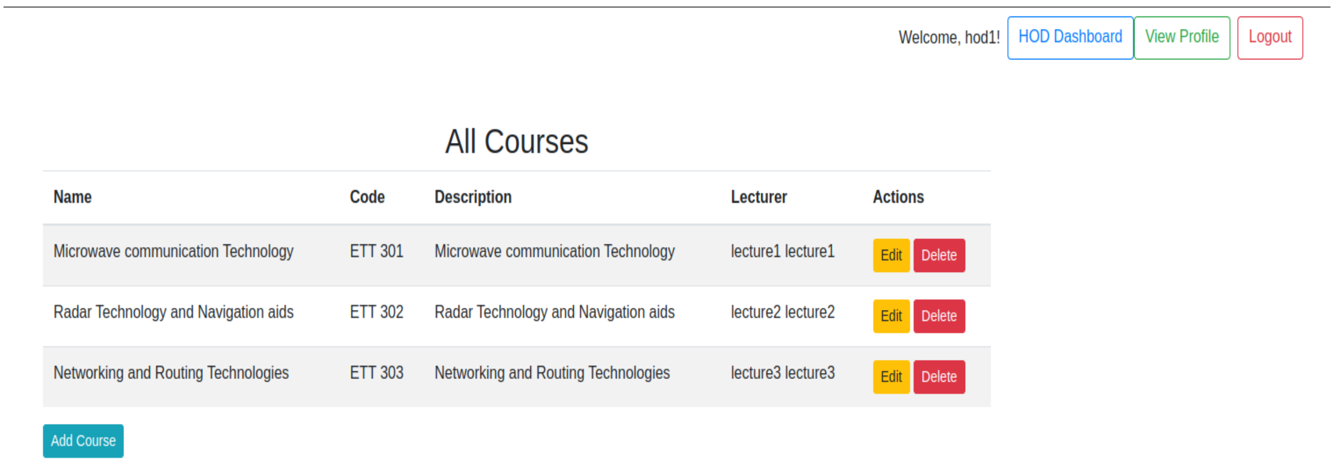


Figure 23 Course Management Interface

4.4.4 Employees App

The Employees App handles employee registration and attendance management.

Employee Management Screen

This screen displays the employee management interface, allowing authorized users to register new employees and manage existing employee records. Users can view a list of employees, edit their details, and handle attendance management efficiently, ensuring accurate tracking and management of employee information.

All Employees

Photo	Name	Email	RFID Number	Role	Actions
Default Photo	employee1 employee1	employee1@gmail.com	0006538521	Other Employee	Update Delete
Default Photo	employee2 employee2	employee2@gmail.com	0006538476	Other Employee	Update Delete
Default Photo	employee3 employee3	employee3@gmil.com	0012954887	Other Employee	Update Delete

Add Employee

Figure 24 Employees Management Page

Employee Attendance Management

This page is specifically designed for security personnel to record and manage employee attendance. It provides a user-friendly interface for taking attendance, allowing security staff to efficiently log employee check-ins and check-outs, ensuring accurate tracking of employee presence within the institution.

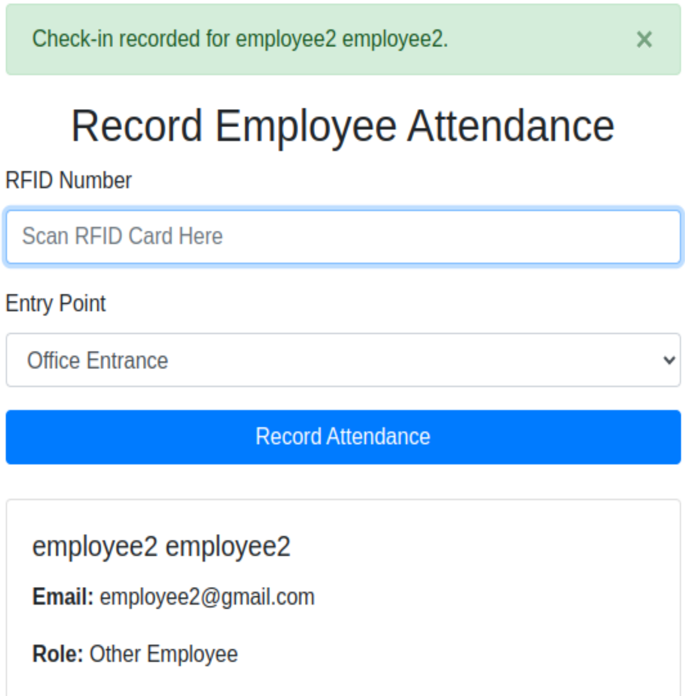


Figure 25 Employee Attendance Management

4.4.5 Students App

The Students App manages student registration and attendance tracking.

Student Registration Screen

This page is intended for finance employees to register new students. It provides a structured interface where users can input essential student information, ensuring a streamlined and efficient registration process for new enrollees.

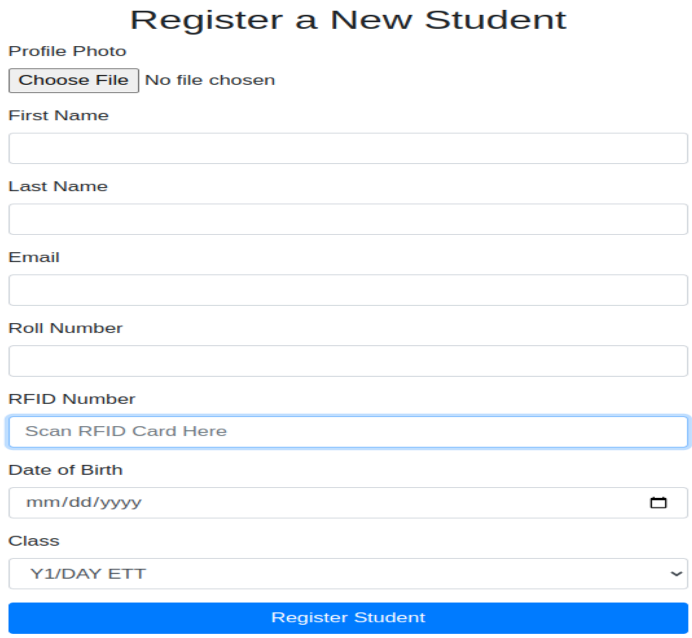


Figure 26 Student Registration Screen

Student Class Attendance Interface

This interface allows authorized users to manage and monitor student attendance during classes. It displays a list of enrolled students, enabling lecturers or administrators to easily mark attendance, track attendance records, and generate reports on student participation.

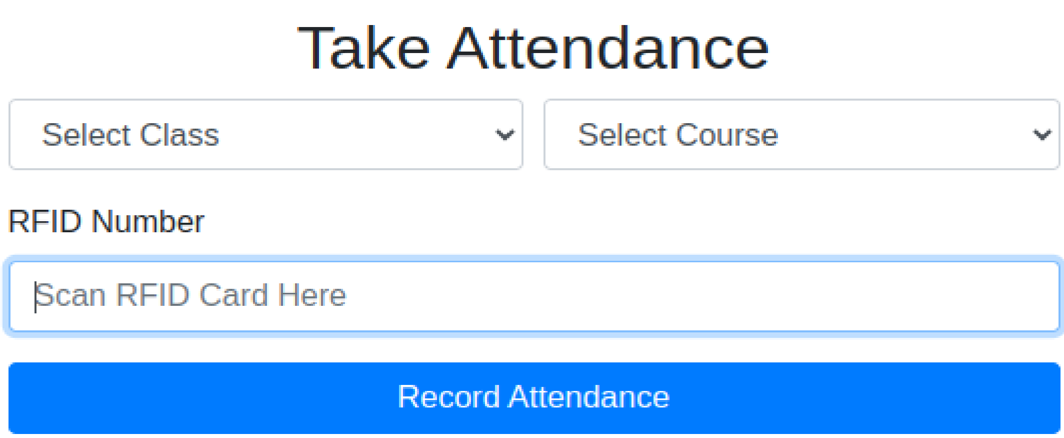


Figure 27 Student Class Attendance Interface

Student Exam Attendance Interface

This interface is designed for recording student attendance during examinations. It allows authorized personnel to efficiently check in students as they arrive for their exams, ensuring accurate tracking of attendance for each examination session. Users can also generate reports on student attendance during exams, providing valuable data for administrative purposes.

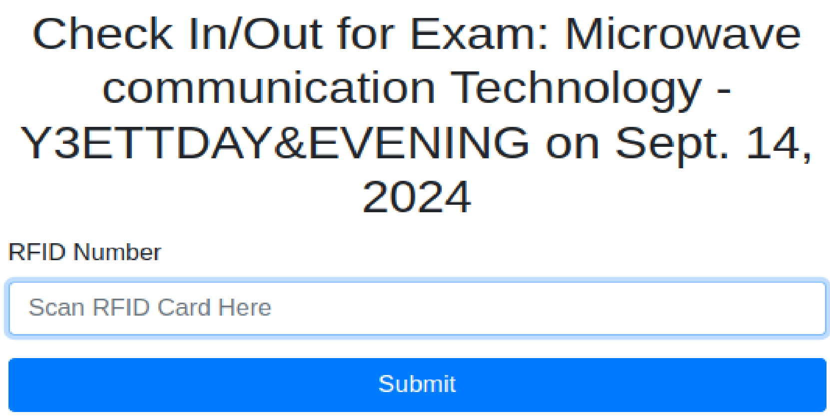


Figure 28 Student Exam Attendance Interface

4.4.6 Dashboards App

The Dashboards App provides role-specific dashboards for various user roles to manage attendance data and access relevant information.

HOD Dashboard

The HOD Dashboard provides Heads of Departments with essential functionalities to manage their academic responsibilities effectively. Users can register new lecturers by creating user accounts, as well as create, view, and edit exams. However, they do not have the capability to take attendance for exams.

Additionally, the HOD can manage classes, including creating, editing, deleting, and listing them. Similarly, the dashboard allows for course management, enabling the HOD to perform the same functions for courses as they do for classes. The dashboard also includes tools for managing academic **years, ensuring that all academic-related information is well-organized and up to date.**

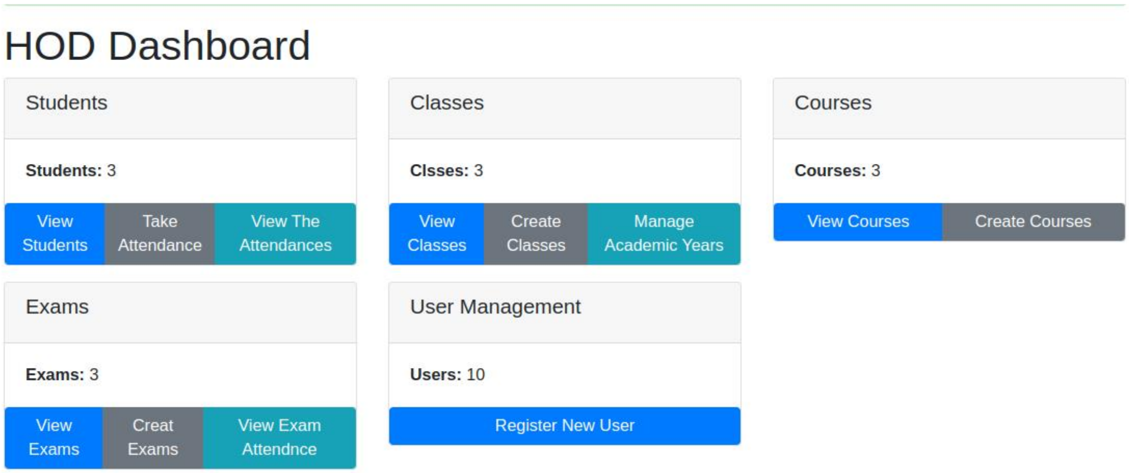


Figure 29 HOD Dashboard

Finance Dashboard

The Finance Dashboard equips finance employees with critical functionalities for managing academic and administrative tasks. They can view and confirm student eligibility for exams, as well as take attendance for examinations created by the Head of Department (HOD).

In addition to managing exam-related responsibilities, finance employees have the capability to oversee the registration of new students and employees. They can also view attendance records for employees, providing an overview of attendance data. Moreover, the dashboard includes reporting features that enable finance personnel to generate detailed reports on exam attendance and employee attendance, facilitating effective monitoring and analysis of attendance trends.

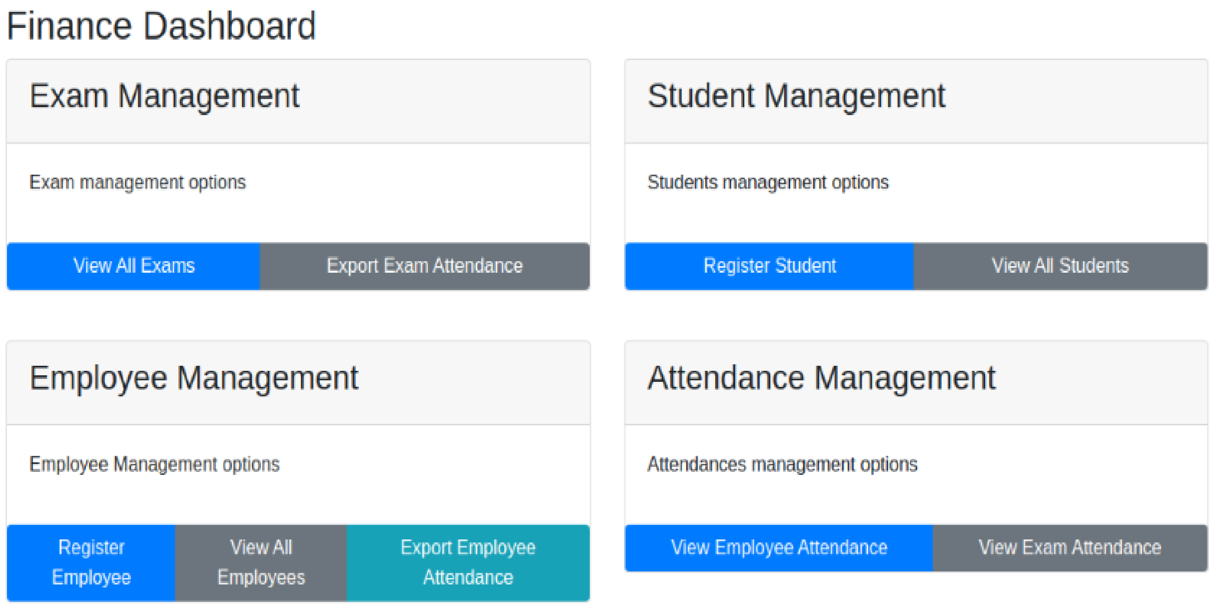


Figure 30 Finance Dashboard

Lecturer Dashboard

The Lecturer Dashboard provides lecturers with essential tools to manage their teaching responsibilities. It allows them to view the classes and courses they are assigned to, ensuring they have quick access to relevant information.

Lecturers can also view the list of students enrolled in their classes, which facilitates tracking and engagement. Additionally, the dashboard includes a functionality for taking attendance during classes, enabling lecturers to efficiently monitor student participation and attendance records. This streamlined approach helps lecturers maintain accurate attendance data and enhances overall classroom management.

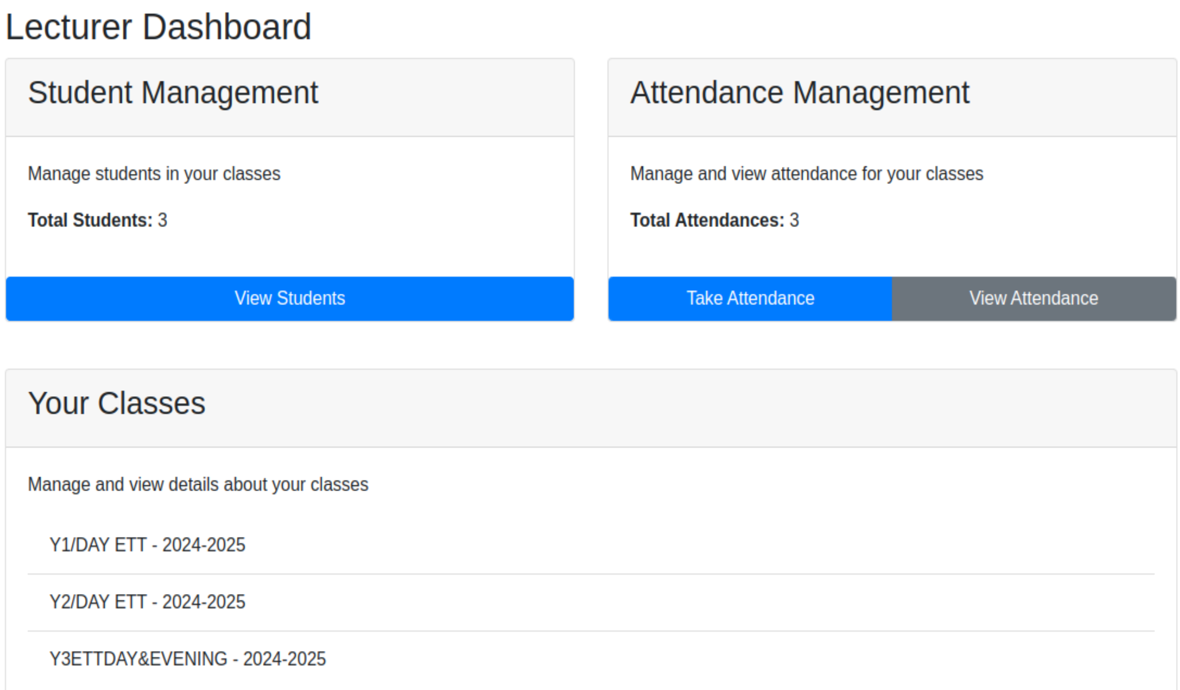


Figure 31 Lecturer Dashboard

Security Dashboard

The Security Dashboard is designed for security personnel to manage employee attendance effectively. It provides access to a comprehensive list of employees, enabling security staff to quickly identify individuals as they arrive or depart from the premises.

Additionally, security personnel can take attendance for employees at various entry points, ensuring accurate tracking of who is on site at any given time. This functionality enhances security oversight and contributes to a safer and more organized environment within the institution.

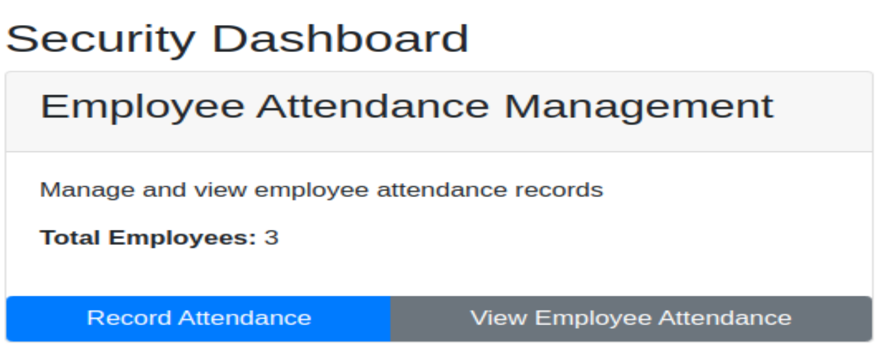


Figure 32 Security Dashboard

4.4.7 Integration with Hardware

Python scripts are written to interface with the RFID scanner and servo motor, allowing the system to interact with physical components. The scripts are integrated with Django views to trigger specific actions based on RFID scans, such as logging attendance or controlling the door simulation

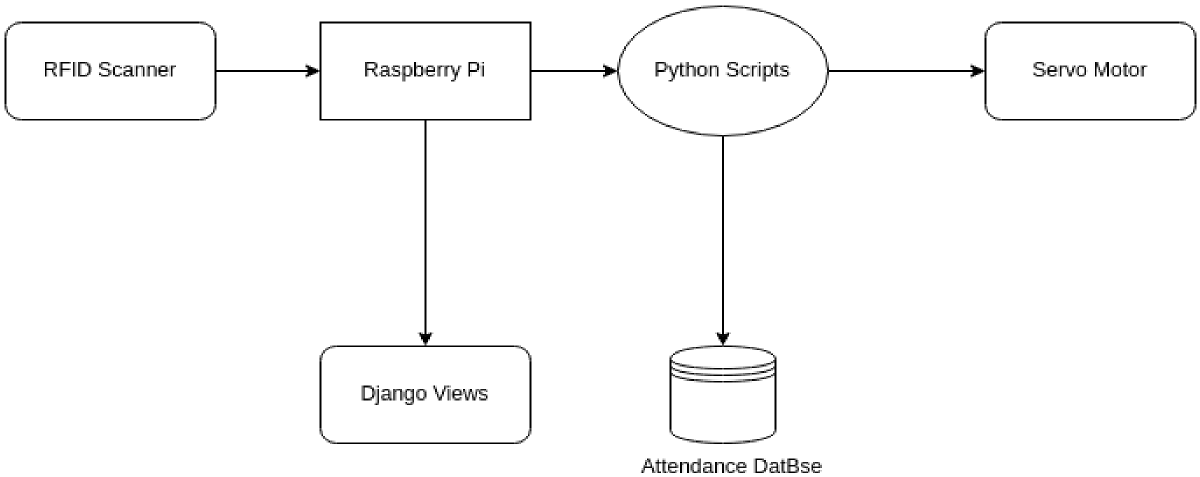


Figure 33 Hardware Integration Diagram

4.4.8 Security and Authentication

The system includes user authentication and role-based access control to ensure that only authorized users can access certain functionalities. Django's built-in authentication system is used to manage user credentials and permissions securely

To access the admin interface, users must navigate to the designated admin URL, typically formatted as `/admin/` following the base URL of the application. For example, if the application is hosted on `http://192.168.1.70:8000`, users would enter `http://192.168.1.70:8000/admin/` in their web browser. Upon reaching the admin login page, users need to enter their registered credentials. Once authenticated, they will have access to the administrative functionalities, allowing them to manage user accounts, permissions, and other critical aspects of the system.

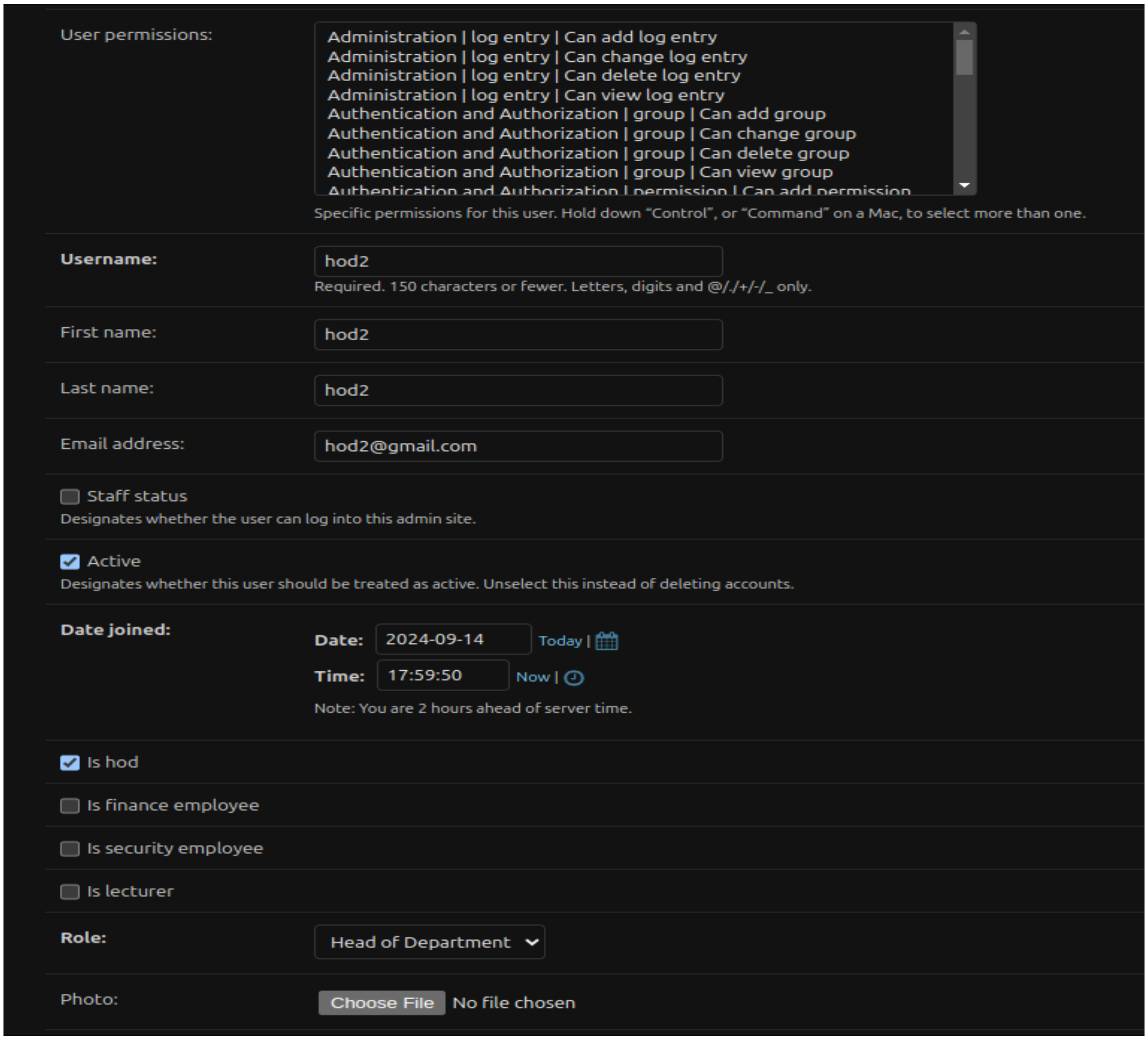


Figure 34 Security Authentication Admin Interface

4.4.9 Source Code and Repository

The complete source code for the software components, including the Django web application, Python scripts for hardware integration, and configuration files, is available in a GitHub repository. This repository provides detailed instructions on setting up and running the system, along with additional documentation for further development and testing.

GitHub Repository Link: https://github.com/bonheurNE07/attendances.git

4.5 Implementation Challenges and Solutions

Throughout the development and implementation of the RFID-based attendance management system, a series of challenges arose, primarily concerning hardware integration, network configuration, data security, and usability. These challenges were addressed through a combination of technical solutions and iterative improvements, as outlined below.

The integration of hardware components, particularly the RFID scanner, servo motor, and Raspberry Pi, initially presented several difficulties. During early trials, the servo motor exhibited inconsistent behavior and lag when controlled via the Raspberry Pi's GPIO pins. This problem was attributed to imprecise control mechanisms. To resolve this, pulse-width modulation (PWM) was employed to regulate the servo motor's movements more accurately. The RPi.GPIO Python library facilitated better management of the GPIO pins, ensuring reliable communication between the Raspberry Pi and the motor. Extensive debugging was also undertaken to identify potential wiring issues and optimize the power supply, which ultimately stabilized the motor's performance.

Network configuration posed another challenge, particularly with regard to setting up the Raspberry Pi as a local DNS server to allow users to access the system through a domain name rather than an IP address. Ideally, the configuration would have been handled via the home access point; however, the router being used did not permit changes to the DNS server settings. As a result, it became impossible to enforce network-wide DNS redirection. The solution involved manually setting the Raspberry Pi's IP address as the DNS server on individual external devices. This process required manually configuring DNS settings on each device (such as PCs and laptops), allowing them to resolve the Raspberry Pi's address and access the attendance system through its domain name.

In addition to network issues, intermittent Wi-Fi connectivity disrupted the system's communication with external devices. To mitigate this, a static IP address was assigned to the Raspberry Pi, and the device was placed closer to the router to improve signal strength. For increased reliability, an Ethernet connection was also used, and Bluetooth was configured to facilitate communication between the Raspberry Pi and other devices, such as the HP device used for text-to-speech functionality.

Ensuring data security and implementing robust user authentication was another critical aspect of the project. The system needed to protect sensitive attendance data and prevent unauthorized access. Initially, concerns arose about potential vulnerabilities in the system's authentication and security measures. To address this, Django's built-in authentication framework was used to implement role-based access control. This framework efficiently manages user roles and permissions, restricting access based on the user's credentials. Additionally, communication between the Raspberry Pi and the server was encrypted to safeguard data transfers. Future iterations of the system could include more advanced security features, such as two-factor authentication and stronger encryption protocols, to further enhance security.

Usability challenges also emerged after the initial user testing phase. Feedback from lecturers and employees indicated that the user interface was not as intuitive as anticipated, with some users struggling to navigate the various dashboards. In response, the user interface was redesigned using Bootstrap to create a more modern, streamlined look. Role-specific dashboards were simplified with clearer labels and intuitive navigation elements, allowing users to find the information they needed more easily. Further usability testing and feedback sessions were conducted to fine-tune the interface, ensuring that it met the needs and expectations of the end users.

4.6 System Testing and Validation

The system underwent rigorous testing to ensure its functionality, reliability, performance, and security met the required standards. Various testing procedures were applied throughout the development process to validate the system's key features and overall usability.

To begin, functional testing was conducted to verify that each system feature operated as intended. This included the RFID scanner’s ability to read cards, the servo motor's response to valid scans, and the correct logging of attendance data into the SQLite3 database. Specific test cases were developed to cover core functionalities. For instance, card scanning tests ensured that attendance was accurately logged when a valid RFID card was scanned, while invalid cards were properly rejected. Additionally, door simulation tests confirmed that the servo motor opened and closed the door based on the attendance status, with appropriate timing and angle adjustments. Finally, role-based access was tested to verify that different users—such as Heads of Departments (HODs), lecturers, finance staff, and security personnel—could access their respective dashboards and functionalities based on their assigned roles.

The system's performance was also evaluated, focusing on its response time, reliability, and capacity to handle multiple concurrent scans. Performance testing was particularly important during peak usage times, such as the beginning and end of classes when multiple students scanned their cards simultaneously. The results showed that the system could efficiently process multiple scans at once with minimal latency, maintaining response times of less than 2 seconds from card scan to data logging.

To assess the system's usability, usability testing was conducted with a group of 12 student colleagues, lecturers, and employees from UPI. This testing phase focused on the system's ease of use, accessibility, and overall user satisfaction. Participants were asked to provide feedback on the user interface, functionality, and general user experience. Overall, the feedback was positive, with many users praising the system’s simplicity and quick response times. Some constructive suggestions were also provided, such as enhancing the readability of the dashboard and simplifying navigation to make it even more user-friendly.

Lastly, security testing was carried out to ensure that the system and its data were protected from potential threats. Penetration tests were performed to identify any vulnerabilities, particularly those related to unauthorized access or data breaches. The system passed these tests successfully, with no significant security flaws detected, affirming that user data and system operations were secure.

4.7 Results and Discussion

The RFID-based attendance management system was successfully implemented and rigorously tested, demonstrating high levels of accuracy, efficiency, and reliability. Throughout the testing phase, the system effectively tracked attendance with minimal errors, accurately logging records into the database. Additionally, the servo motor functioned as expected, simulating door control based on real-time attendance data.

User feedback was overwhelmingly positive, with participants appreciating the system's user-friendly interface and smooth functionality. The role-based dashboards, designed for different user categories (e.g., lecturers, students, finance, and security), were reported to be intuitive and easy to navigate. In terms of performance, testing confirmed that the system could handle multiple concurrent users without significant delays, even during peak usage times.

Attendance Report

Class: Y3ETTDAY&EVENING
Course: Networking and Routing Technologies
Date: None
Downloaded by: lecture3

Student Name	Roll Number	Date	Status
ndeze bonheur	202150126	2024-09-14	Present
Mulemangabo Mugisho	202150095	2024-09-15	Present
Nzita Mpezo	202150070	2024-09-15	Present
ndeze bonheur	202150126	2024-09-15	Present

Figure 35 Attendance Report Template

In the discussion of the system's impact, RFID technology proved to be an effective and scalable solution for tracking attendance in educational institutions. The cost-efficiency of RFID systems makes them particularly appealing, and their potential scalability suggests broader applications in larger institutions. Additionally, integrating the servo motor for door control contributed an extra layer of security, showcasing how IoT components can enhance traditional attendance systems. This added functionality demonstrates how smart systems can be used to enforce attendance and access control simultaneously.

The iterative development process was essential in overcoming challenges related to hardware integration, network connectivity, and user experience. Initial hardware issues, such as unstable servo motor behavior, were addressed through technical adjustments like pulse-width modulation, while network stability was improved through careful Wi-Fi and DNS configuration. Furthermore, the use of Django for the software layer proved to be a robust solution for managing user authentication and access control, ensuring secure system operations.

However, despite these successes, there are still areas that could be improved in future iterations of the system. For instance, enhancing the system's scalability by integrating cloud-based solutions would allow for greater flexibility and broader deployment across multiple campuses.

Furthermore, implementing more advanced security features, such as two-factor authentication, would significantly strengthen the system's data protection measures. Future developments might also explore integrating mobile applications, enabling easier access and remote monitoring for administrators and staff.

4.8 System Limitations

Despite the successful implementation of the RFID-based attendance management system, several limitations were encountered during its development and testing. One notable limitation was the limited sample size used for testing, which involved a group of 29 students. While the system functioned well within this context, this sample may not fully reflect its scalability and performance in a larger institutional setting. Future testing should include a more diverse and extensive user base to ensure broader applicability.

Another challenge was related to hardware constraints. The system was built using basic components, including a Raspberry Pi, an RFID scanner, and a servo motor. While these components were sufficient for a prototype, they may not be ideal for larger-scale applications. In real-world scenarios, more robust, industrial-grade hardware would likely be necessary to ensure consistent and reliable operation, particularly in environments requiring higher throughput and durability.

In terms of data security and privacy, only basic security measures were implemented due to time and resource constraints. Although role-based access control and encryption were employed, more advanced security protocols such as two-factor authentication and more comprehensive encryption techniques were not incorporated. This may limit the system's resilience against potential security threats, and future iterations should address these vulnerabilities to enhance overall system security.

Lastly, the system's reliance on local network configurations posed a limitation in terms of flexibility and scalability. As the system operates within a local network, it may be less adaptable compared to cloud-based solutions that offer greater scalability and remote accessibility. To overcome this, future versions of the system should consider integrating cloud-based infrastructure, allowing for more flexible data access and a broader scope of deployment.

CHAPTER 5 CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the conclusions drawn from the successful development and testing of the RFID-based attendance management system. It also outlines recommendations for future improvements and suggests areas for further study.

5.1 Conclusion

This project addressed the inefficiencies and inaccuracies of traditional attendance systems through the design and implementation of an RFID-based attendance management system. Integrated with a Raspberry Pi and a servo motor for simulating door control, the system automates attendance for students and employees. The use of RFID technology resulted in faster, more reliable data collection, enhancing both efficiency and security for educational institutions.

The system was tested at UPI, where it demonstrated high accuracy (98%) in logging attendance data and effectively handling concurrent scans. Feedback from the institution's Heads of Departments (HODs), lecturers, finance, and security staff was largely positive, with users praising the system's usability and role-based dashboards.

Despite the successful outcome, some challenges were encountered, particularly with hardware integration, network configuration, and initial user interface concerns. These were resolved through iterative development, feedback collection, and ongoing system adjustments. The system, therefore, provides a solid foundation for future improvements, not only for UPI but also for educational institutions in Rwanda and beyond.

5.2 Recommendations

In light of the project's findings and challenges, the following recommendations are made to enhance the system's effectiveness for UPI and to serve as a model for educational institutions across Rwanda:

1. Scaling the System for Larger Institutions: UPI and other institutions with a larger student body and attendance data should consider migrating from SQLite3 to more scalable database solutions like PostgreSQL or MySQL. These databases can better handle larger datasets and increase user activity, improving system performance.

2. Cloud Integration for Enhanced Accessibility: The Kigali Independent University Polytechnic Institute should explore cloud-based data storage to ensure better data accessibility and backup. Cloud platforms, such as AWS or Azure, would offer scalability, security, and easier remote access, which would benefit both university administrators and national education bodies.

3. Strengthening Security Measures: Considering the importance of data privacy for student and staff information, the institution should adopt additional security features like two-factor authentication (2FA) and advanced encryption techniques. This step would not only align with global best practices but also ensure compliance with national regulations governing data protection.

4. Mobile Compatibility for Better User Experience: To cater to users who are often mobile, such as lecturers and administrative staff, the development of a mobile-friendly interface or app should be prioritized. This will allow users to manage attendance data more efficiently, improving day-to-day operations at UPI.

5. Government Support for Technology Adoption: The Rwandan Ministry of Education and other relevant government bodies should support initiatives to digitize attendance management in higher learning institutions. By providing funding, resources, and training, the government can help scale such systems across Rwanda, promoting technological innovation in the education sector.

6. Expansion to Other Educational Institutions: UPI’s success in adopting this RFID-based system should serve as a model for other universities and secondary schools across Rwanda. The system’s efficiency in automating attendance processes and enhancing security can have broader applications in diverse educational settings, from primary schools to vocational institutions.

7. Comprehensive Training for Users: Training sessions should be organized for all stakeholders at UPI to ensure they are familiar with the new system. Proper training will enhance the user experience, making the transition to this new technology smoother and increasing adoption rates across the institution.

8. Advanced Analytics for Decision-Making: In the future, UPI could integrate data analytics features into the system to monitor attendance patterns and other key metrics. This would allow for data-driven decisions regarding student engagement, resource allocation, and staff management, aligning with national education objectives.

5.3 Suggestions for Further Study

Future research could explore the integration of additional technologies, such as facial recognition and biometric systems, to complement RFID technology. Investigating the deployment of Internet of Things (IoT) devices for real-time monitoring and data collection would also enhance system capabilities. Additionally, further study could focus on applying this attendance management system across multiple institutions nationwide, examining its scalability and adaptability in various environments.

REFERENCES

Bharathy, M. G. T., Bhavanisankari, M. S., & Tamilselvi, T. (2021). Smart Attendance Monitoring System using IoT and RFID. *International Journal of Advances in Engineering and Management (IJAEM)*, *3*(June), 1307. https://doi.org/10.35629/5252-030613071313

Government of Rwanda. (2015). Rwanda Vision 2050. *Minecofin*, 1–23. https://www.minecofin.gov.rw/fileadmin/user_upload/Minecofin/Publications/REPORTS/National_Development_Planning_and_Research/Vision_2050/English-Vision_2050_Abridged_version_WEB_Final.pdf

IDEO. (2018). Human Centered Design Process. *Https://Www.Ideo.Org/Approach.*, *8015*(2009).

Marangunić, N., & Granić, A. (2015). Technology acceptance model: a literature review from 1986 to 2013. *Universal Access in the Information Society*, *14*(1), 81–95. https://doi.org/10.1007/s10209-014-0348-1

Meghdadi, M., & Azar, A. A. (2016). The Possibility of Using RFID System to Automate and Integrate the Attendance of Professors and Students in the Classroom. *Intelligent Control and Automation*, *07*(04), 93–109. https://doi.org/10.4236/ica.2016.74010

MINICT. (2018). *ICT Sector strategic plan "Towards digital economy." November 2017*.

Monk, S. (n.d.). *Programming the Raspberry Pi: Getting Started with Python*.

Myerson, J. M. (2006). RFID in the Supply Chain. In *RFID in the Supply Chain*. https://doi.org/10.1201/9781420012989

Obe, R., & Hsu, L. (2016). *PostgreSQL: Up and Running Regina Obe and Leo Hsu Beijing*.

Pachghare, V. K. (2016). *Cloud computing*. 298.

Project, A., & Procedures, L. M. (2021). *REPUBLIC OF RWANDA Ministry of ICT and Innovation*. *October*, 78–80. (Accessed 18 Nov 23)

Republic of Rwanda. (2000). *Planning Rwanda Vision 2020*. *July 2000*, 30. https://www.sida.se/globalassets/global/countries-and-regions/africa/rwanda/d402331a.pdf

Sri Madhu, B. M., Kanagotagi, K., & Devansh. (2017). IoT based Automatic Attendance Management System. *2017 International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC)*, 83–86. https://doi.org/10.1109/CTCEEC.2017.8455099

Tejada, J. J., Raymond, J., & Punzalan, B. (2012). On the Misuse of Slovin's Formula. *The Philippine Statistician*, *61*(1), 8.

Tobergte, D. R., & Curtis, S. (2013). Make Electronics. In *Journal of Chemical Information and Modeling* (Vol. 53, Issue 9).

APPENDIX A: SOURCE CODE

Overview:

This appendix provides access to the complete source code for the RFID-based attendance management system developed as part of this project. The source code includes all necessary components to deploy and run the system, such as the Django web application, Python scripts for hardware integration, and configuration files.

`project/settings.py`

```
from pathlib import Path
import os

# Build paths inside the project like this: BASE_DIR / 'subdir'.
BASE_DIR = Path(__file__).resolve().parent.parent


# Quick-start development settings - unsuitable for production
# See https://docs.djangoproject.com/en/5.1/howto/deployment/checklist/

# SECURITY WARNING: keep the secret key used in production secret!
SECRET_KEY = "django-insecure-e%bs0rl6-0^!cwsjqh16kt^0$m3hlnxr$7^-o32(&u_t3tn1u1"

# SECURITY WARNING: don't run with debug turned on in production!
DEBUG = True
ALLOWED_HOSTS = ['*']

# Custom user model
AUTH_USER_MODEL = 'core.CustomUser'

# Static files settings (if using images)
MEDIA_URL = '/media/'
MEDIA_ROOT = os.path.join(BASE_DIR, 'media')



# Redirect to login if not authenticated
LOGIN_URL = 'login'
LOGIN_REDIRECT_URL = 'home'
LOGOUT_REDIRECT_URL = 'core:login'
```

```python
# Application definition

INSTALLED_APPS = [
    "django.contrib.admin",
    "django.contrib.auth",
    "django.contrib.contenttypes",
    "django.contrib.sessions",
    "django.contrib.messages",
    "django.contrib.staticfiles",
    'schema_graph',
    'django_spaghetti',
    'core',
    'courses',
    'classes',
    'students',
    'exams',
    'employees',
    'dashboard',
]

SPAGHETTI_SAUCE = {
    'apps': ['core',
'courses','classes','students','exams','employees','dashboard'],
    'show_fields': True,
    'exclude': {'auth': ['user']},
}

MIDDLEWARE = [
    "django.middleware.security.SecurityMiddleware",
    "django.contrib.sessions.middleware.SessionMiddleware",
    "django.middleware.common.CommonMiddleware",
    "django.middleware.csrf.CsrfViewMiddleware",
    "django.contrib.auth.middleware.AuthenticationMiddleware",
    "django.contrib.messages.middleware.MessageMiddleware",
    "django.middleware.clickjacking.XFrameOptionsMiddleware",
]

ROOT_URLCONF = "attendances.urls"

TEMPLATES = [
    {
        "BACKEND": "django.template.backends.django.DjangoTemplates",
        "DIRS": [],
        "APP_DIRS": True,
        "OPTIONS": {
```

```
            "context_processors": [
                "django.template.context_processors.debug",
                "django.template.context_processors.request",
                "django.contrib.auth.context_processors.auth",
                "django.contrib.messages.context_processors.messages",
            ],
        },
    },
]

WSGI_APPLICATION = "attendances.wsgi.application"


# Database
# https://docs.djangoproject.com/en/5.1/ref/settings/#databases

DATABASES = {
    "default": {
        "ENGINE": "django.db.backends.sqlite3",
        "NAME": BASE_DIR / "db.sqlite3",
    }
}


# Password validation
# https://docs.djangoproject.com/en/5.1/ref/settings/#auth-password-validators

AUTH_PASSWORD_VALIDATORS = [
    {
        "NAME":
"django.contrib.auth.password_validation.UserAttributeSimilarityValidator",
    },
    {
        "NAME": "django.contrib.auth.password_validation.MinimumLengthValidator",
    },
    {
        "NAME":
"django.contrib.auth.password_validation.CommonPasswordValidator",
    },
    {
        "NAME":
"django.contrib.auth.password_validation.NumericPasswordValidator",
    },
]
```

```
handler403 = 'core.views.custom_permission_denied_view'
# Messages settings
from django.contrib.messages import constants as messages
MESSAGE_TAGS = {
    messages.ERROR: 'danger',  # Optional: to map the error level to a Bootstrap
class
}
# Internationalization
# https://docs.djangoproject.com/en/5.1/topics/i18n/

LANGUAGE_CODE = "en-us"

TIME_ZONE = "Africa/Kigali"

USE_I18N = True

USE_TZ = True


# Static files (CSS, JavaScript, Images)
# https://docs.djangoproject.com/en/5.1/howto/static-files/

STATIC_URL = "static/"
STATICFILES_DIRS = [os.path.join(BASE_DIR, 'static')]

# Default primary key field type
# https://docs.djangoproject.com/en/5.1/ref/settings/#default-auto-field

DEFAULT_AUTO_FIELD = "django.db.models.BigAutoField"
```

`project/urls.py`

```
from schema_graph.views import Schema
from django.contrib import admin
from django.urls import path, include

from django.conf import settings
from django.conf.urls.static import static

urlpatterns = [
    path('admin/', admin.site.urls),
    path("schema/", Schema.as_view()),
    path('plate/', include('django_spaghetti.urls')),
    path('', include('core.urls')),  # Include URLs from the core app
```

```
    path('courses/', include('courses.urls')),
    path('classes/', include('classes.urls')),
    path('students/',include('students.urls')),
    path('exams/', include('exams.urls')),
    path('employees/', include('employees.urls')),
    path('dashboard/', include('dashboard.urls')),
]


# URL configurations for serving media files during development
if settings.DEBUG:
    urlpatterns += static(settings.MEDIA_URL, document_root=settings.MEDIA_ROOT)
```

APPENDIX B: GITHUB REPOSITORY

Introduction to GitHub:

GitHub is a powerful platform that facilitates version control and collaboration for software development projects. It allows developers to host and manage their code repositories while enabling seamless collaboration through features like pull requests, issue tracking, and project management tools. With its user-friendly interface and extensive community support, GitHub has become an essential tool for developers, researchers, and teams looking to share their work, contribute to open-source projects, or maintain their own codebases. This repository serves as a centralized resource for the RFID-based attendance system, providing essential functionalities and documentation for future development, testing, and deployment in real-world scenarios.

Overview:

This repository is intended to serve as a reference for further development, testing, and deployment in real-world scenarios.

Repository Details:

GitHub Repository Link: https://github.com/bonheurNE07/attendances.git

The repository is organized as follows:

1. `/core`: Contains the core functionalities of the project, including the homepage, user authentication, and common utilities used throughout the application.

2. `/students`: Manages student data, attendance records, and exam attendance tracking functionalities.

3. `/employees`: Manages employee data, including their roles and attendance records.

4. `/exams`: Handles exam creation, updates, attendance, and eligibility management.

5. `/courses`: Manages course information and their assignments to different classes.

6. `/dashboard`: Provides role-based dashboards for various users (e.g., Heads of Department, Finance, Security, Lecturers) to manage their respective tasks.

7. `/static` and `/templates`: Contain static files (such as CSS, JavaScript) and HTML templates used for the front-end design.

8. Python Scripts for Hardware Integration: Includes scripts for interfacing with the RFID scanner and servo motor to handle real-time attendance logging and door control simulation.

9. Configuration Files (`settings.py`): Holds all settings required for Django to run, including database configuration, middleware, and application definitions.

Instructions for Accessing and Running the System:

1. Clone the Repository:

Use the following command to clone the repository:

```
git clone https://github.com/bonheurNE07/attendances.git
cd project-repo
```

2. Install Required Dependencies:

Navigate to the project directory and install the required dependencies using `pip`:

```
pip install -r requirements.txt
```

3. Run the Django Application:

Use the following command to run the Django development server:

```
python manage.py runserver 0.0.0.0:8000
```

Access the application through a web browser at `http://localhost:8000`.

5. Hardware Integration Setup:

Ensure that the RFID scanner and servo motor are correctly connected to the Raspberry Pi or a Client Computer and configured according to the instructions provided in the repository.

APPENDIX C: PROJECT FOLDER STRUCTURE

The image below shows the structure of the project directory for the RFID-based attendance system, detailing the various folders and files within the Django project.

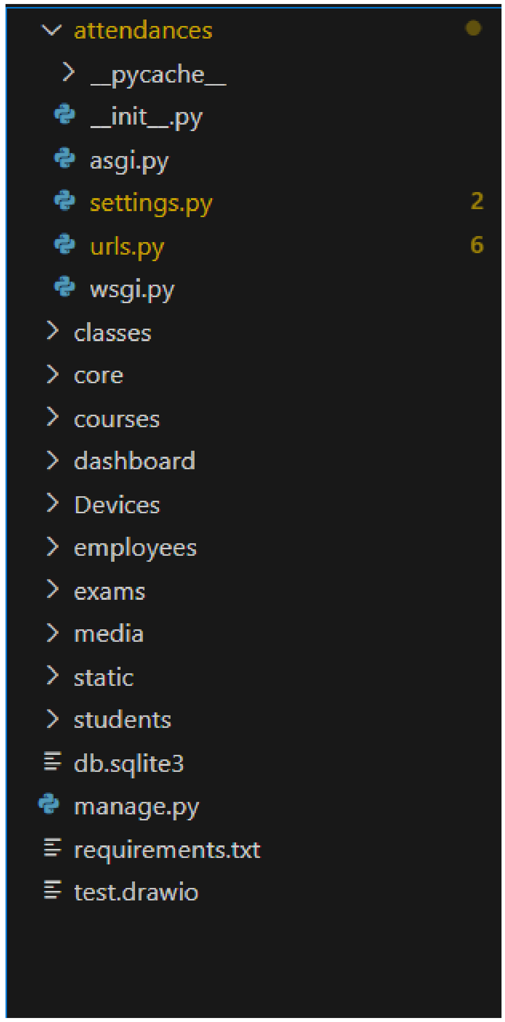


Figure 36 Project Structure

This section provides a brief explanation of the contents of each folder or application in the project:

1. attendances

This is the main Django project directory. It contains essential project-level files such as:

- \`settings.py\`: Manages the configuration settings of the Django project, including database setup, middleware, installed apps, etc.
- \`urls.py\`: Contains the URL routing for the main project.

- `asgi.py`, `wsgi.py`: Entry points for serving the project using ASGI and WSGI, respectively.
- `__init__.py`: Marks the folder as a Python package.

2. Classes

Handles all functionalities related to managing class and academic year information, including class creation and updates.

3. core

Manages user authentication, profile management, and role-based access control for both students and staff.

4. courses

Responsible for managing course-related information like course registration and updates

5. dashboard

Provides role-specific dashboards for users such as students, teachers, and administrators, offering customized overviews based on their access levels.

6. Devices

Handles the integration with hardware devices such as the RFID scanner and servo motor for attendance logging and door control simulation.

7. employees

Manages employee registration and attendance tracking, handling both administrative staff and teachers.

8. exams

Facilitates the management of exam schedules, grading, and student exam reports.

9. Media

Contains uploaded files and media used throughout the project, such as profile pictures, student documents, etc.

10. static

Stores static files such as CSS, JavaScript, and images that are used in the web interface of the system.

11. students

Manages student registration, attendance tracking, and generation of attendance reports, including time spent in class.

12. db.sqlite3

The project's SQLite database file, stores all the data related to classes, courses, users, attendance logs, and other information.

13. manage.py

A command-line utility that allows interaction with the Django project. It is used for running server commands like migrations, starting the server, and other management tasks.

14. requirements.txt

Contains a list of the Python libraries and dependencies required to run the project, making it easy to replicate the environment.

This directory structure is organized to support the functionality of the RFID-based attendance system, ensuring modularity and clarity across different apps and components.