

UNIVERSITY OF CAPE COAST

DIGITAL ATTENDANCE SYSTEM FOR UCC

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PROJECT REPORT

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DIGITAL ATTENDANCE SYSTEM FOR UCC

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Information Technology of the School of Physical Science, University of Cape
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Science degree in Information Technology

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DECLARATION

Candidate's Declaration

I hereby declare that this project work is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

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Supervisor's Declaration

I hereby declare that the preparation and presentation of the project work were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

Miss Linda Otoo

Supervisor's Signature: Date:

ABSTRACT

There is no doubt that the Student Attendance System is an essential component of educational institutions, as it offers efficient and accurate methods for tracking and managing the attendance of students throughout their educational career. Student Attendance Systems are an online solution for tracking, monitoring, and compiling student attendance data on a daily basis. This application automates attendance, reduces paperwork, enhances accuracy, and provides daily reports on attendance trends based on data. Student development can be monitored, at-risk children can receive early intervention, and regular missing students can be identified using student attendance systems. This paper explores the Student Attendance System, a technological solution designed to streamline and automate the process of tracking student attendance in educational institutions by utilizing new technologies. Traditional attendance tracking methods are time-consuming, susceptible to errors, and unable to analyze data in real-time, unlike some modern methods. The Student Attendance System utilizes advanced technologies like biometrics, fingerprint readers, and web-based applications to provide an efficient, accurate, and user-friendly solution for managing student attendance.

Keywords

Attendance System, Fingerprint Reader, Biometric

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DEDICATION

To God and our families

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LIST OF ABBREVIATIONS

API	Application Programming Interface
QR Code	Quick Response Code
MAC	Media Access Control
IoT	Internet of Things
RFID	Radio Frequency Identification
LMS	Learning Management System
CNN	Convolutional Neural Networks
K-NN	K-Nearest Neighbors
UML	Unified Modeling Language
UCC	University of Cape Coast

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Student attendance is widely acknowledged as a critical factor in shaping academic success and creating a conducive learning environment within educational institutions. When students attend classes regularly, they actively engage in classroom activities, interact with their peers, and benefit from the knowledge imparted by their educators. The significance of attendance management systems for educational institutions has been apparent for some time due to the well-established connection between attendance and academic achievements.

However, the conventional methods of tracking attendance, such as manual roll calls or sign-in sheets, have proven to be labor-intensive, time-consuming, and prone to errors. These traditional approaches are inadequate for efficiently managing attendance in modern educational settings.

In response to the evolving educational landscape, many universities have begun implementing attendance management systems. These systems aim to streamline the attendance tracking process, allowing educators to monitor student progress more effectively. They offer a way to identify patterns of absenteeism and provide timely interventions when necessary (C. Dobkin, R. Gil, and J. Marion, July 2007). Nonetheless, it's worth noting that, in certain instances, universities still rely on manual attendance recording methods. Two common methods include students manually signing attendance forms or professors taking the time to call out each student's name individually (Bakhri, F. b., 2020).

Recent advancements in technology have ushered in a transformative shift in attendance tracking. This transformation has largely replaced the conventional manual methods with

automated and efficient solutions. One such solution is the Student Attendance System, which promises enhanced accuracy, efficiency, and real-time data accessibility (Al-Mallah, R. H. A., Alhelal, D., & Abdulhammed, R., 2021).

1.2 Problem Statement

The conventional attendance tracking methods, rooted in manual processes, are beset with several issues. They are known to be time-consuming, prone to inaccuracies, and ineffective in providing comprehensive insights into student participation. These processes jeopardize the accuracy of academic data, leading to discrepancies and conflicts in attendance records. Moreover, they consume valuable instructional time that could otherwise be dedicated to productive teaching and learning activities. In light of these challenges, the need for an automated student attendance system that can improve accuracy, efficiency, and real-time data access has become pressing.

Some of the key problems and challenges surrounding this project include:

- 1. Incomplete or Incorrect Records:** Manual attendance methods often result in incomplete or erroneous attendance records.
- 2. Limited Insights:** Existing attendance approaches provide limited insights into student engagement and attendance patterns.
- 3. Resistance to Change:** Despite the availability of digital attendance tools, some educational institutions continue to use outdated methods, leading to inefficiencies and missed opportunities for enhancing student involvement and academic outcomes.

4. Manual Data Processing: The manual gathering and analysis of attendance data is a labor-intensive process that may introduce errors.

1.3 Objectives

The primary aim of this project is to design, develop, and implement a student attendance system that employs biometrics for student identification and attendance tracking. This innovative system seeks to automate the attendance-taking process, thereby enhancing efficiency and accuracy. Simultaneously, it provides educators and administrators with real-time access to attendance data.

The specific objectives of this project are as follows:

- 1. Develop an Accurate and Efficient System:** Create a system that accurately and efficiently tracks student attendance.
- 2. Real-Time Attendance Data:** Enable educators to access real-time attendance status information.
- 3. Reduce Manual Processes:** Minimize the need for manual attendance recording and data processing.
- 4. Improve Student Attendance:** Enhance student attendance and, consequently, academic performance through improved attendance tracking and analysis.

1.4 Research Questions

To guide this study, several pertinent research questions have been formulated:

- 1. Biometric Identification:** How can biometric technology be effectively employed to identify students within a student attendance system?

2. Technological Prerequisites: What technical requirements and considerations are crucial when implementing a biometric-based attendance system in an educational environment?

3. Stakeholder Attitudes: What are the attitudes and levels of acceptance among students, teachers, and administrators regarding the use of biometrics for attendance tracking?

4. Advantages and Disadvantages: What potential advantages and disadvantages are associated with the proposed student attendance system?

1.5 Significance of Study

The significance of this study lies in its potential to fundamentally transform the way educational institutions monitor student attendance. By combining web-based data management with biometric integration, this system offers unparalleled accuracy and efficiency. It has the capacity to significantly elevate educational standards and accountability by eliminating the shortcomings of manual attendance tracking.

1.6 Limitations

It's essential to acknowledge the potential limitations of this study. These limitations may encompass technical challenges related to biometric technology, concerns about privacy, and potential resistance to change among students and educators. Additionally, the focus of this study may be confined to a specific educational context or setting.

1.7 Summary of Introduction

In summary, this project is dedicated to the design and implementation of a student attendance system that utilizes biometrics for identification. Its purpose is to address the deficiencies of traditional attendance tracking methods in educational institutions. The problem

statement underscores the inefficiencies and inaccuracies associated with manual tracking and highlight the urgency for an automated and precise solution. The study's objectives and research questions provide a roadmap for investigating the technical, acceptance-related, and impact-related aspects of the proposed system. While recognizing certain limitations, the study's significance lies in its potential to revolutionize attendance tracking in the field of education.

CHAPTER TWO

LITERATURE REVIEW

Introduction

In this chapter, we delve into the extensive realm of class attendance tracking systems, ranging from traditional manual methods to the cutting-edge technological solutions of today. The aim is to explore the intricate relationship between student attendance and the learning process, emphasizing the significance of regular class attendance in the context of modern education.

2.1 Types of Class Attendance Systems

A plethora of class attendance systems have emerged over the years, each offering distinct features and mechanisms tailored to diverse educational settings.

1. Manual Attendance Systems

Manual attendance systems have long been the cornerstone of tracking student presence in educational institutions. This age-old approach involves instructors calling out students' names verbally or using physical attendance sheets for students to mark their presence.

Verbal Name Calling: Traditionally, instructors would call out students' names during roll call. However, as class sizes have grown, this method has become impractical, especially in larger classes, where misidentifications or discomfort for students may arise. Moreover, it consumes valuable instructional time.

Physical Attendance Sheets: Another common manual method involves circulating physical attendance sheets for students to sign or mark. While more organized than verbal name-calling, it has its challenges; such as sheets being misplaced, damaged, or forged, resulting in inaccuracies. Data compilation and entry can also be time-consuming.

2. Biometric Attendance Systems

Biometric attendance systems represent a significant leap in attendance tracking methods, utilizing unique biological features like fingerprints, facial characteristics, and iris patterns for identity verification.

Fingerprint Recognition: Fingerprint-based systems are among the most prevalent. Each person's fingerprint is unique, providing high accuracy and reducing the potential for errors in attendance records. Students' fingerprints are enrolled in the system, and during each attendance session, they simply place their finger on a sensor. The system then matches the captured fingerprint with the enrolled template, instantly verifying the student's identity. This process is rapid, non-intrusive, and provides a high level of accuracy, minimizing the potential for errors in attendance records.

Facial Recognition: This technology captures students' facial features, comparing them to enrolled templates in the system's database. It offers contactless identification but raises privacy concerns. It is another biometric modality gaining prominence. Advances in facial recognition algorithms have improved accuracy, even accommodating variations in lighting, angles, and facial expressions. However, concerns about privacy and the potential for false positives have led to careful consideration of implementation and data protection.

Iris Scans: Iris patterns are highly distinctive and stable over time. Iris biometric systems are incredibly accurate but require specialized hardware. This involves capturing the unique patterns in a person's iris, the colored part of the eye surrounding the pupil. Like fingerprints, iris patterns are highly distinctive and stable over time. Iris biometric systems are considered one of the most accurate methods available, offering extremely low error rates. By simply looking into an iris scanner, students can quickly and securely confirm their attendance. However, due to the specialized hardware required for iris scanning, these systems might be less common than fingerprint or facial recognition systems.

3. RFID Cards or Tags

Radio Frequency Identification (RFID) technology has developed as a formidable tool for institutions to automate attendance tracking with benefits such as dependability, time savings, and controllability (Al-Naima, F. M., & Saleh, M. A., 2015). RFID attendance systems equip students with RFID-encoded cards or tags, simplifying attendance tracking. Students scan their cards over a reader upon entering the classroom, ensuring real-time records and reducing errors associated with manual data entry.

4. QR Code Systems

QR code (abbreviated from Quick Response Code) is the trademark for a type of matrix barcode (Masalha F., & Hirzallah N., 2014). QR code systems have gained popularity in classrooms worldwide. Students can easily scan QR codes displayed in classrooms using their smartphones to register attendance, making the process efficient and engaging.

2.2 The Evolution of Class Attendance Tracking

To truly appreciate the importance of attendance tracking, we must delve into its historical evolution, which reflects shifts in educational practices and the integration of technology into classrooms.

Ancient Practices: In ancient civilizations, education occurred in intimate settings, with oral traditions marking attendance. The teacher's verbal roll call not only recorded attendance but also fostered a sense of community and shared responsibility for learning.

During the early years of oral tradition and personal accountability (pre-modern era), the landscape of education was much different from what we know today. In this era, formalized education existed within intimate settings, often comprising small clusters of eager minds or a singular student under the tutelage of a teacher. Within these unassuming environments, the method of attendance tracking and the concept of personal accountability created a unique educational engagement.

In the absence of advanced technology and mechanized systems, educators of ancient civilizations navigated the realm of attendance through the art of oral tradition. The process was akin to a melodic roll call, where the teacher's voice echoed through the learning space, uttering the names of each student. This auditory ritual not only served the practical purpose of marking attendance but also established a sense of solidarity and belonging within the learning community. Students' names, pronounced within the walls of the classroom, solidified their presence in the realm of education.

The teacher-student relationship of that era transcended the roles of mere educator and learner. It was a partnership forged with commitment and reliance. In the absence of technological intermediaries, the teacher's keen observation became a tool for attendance

tracking. A subtle nod, a direct gaze, or a gentle acknowledgment of a student's presence communicated volumes within the quiet realm of the classroom.

The Paper and Pencil Era (19th Century): While the ancient practices method was suitable for the educational settings of the time, it had limitations that became more pronounced as educational systems evolved, such as the absence of written records making it challenging to keep track of attendance history over time; taking attendance orally and waiting for each student to respond was time-consuming, resulting in a significant portion of class time being dedicated to attendance tracking; in larger classes, calling out names individually for attendance could become cumbersome and time-intensive; and this system lacked a reliable way to verify whether students were being truthful about their attendance status.

As educational institutions expanded during the Industrial Revolution, paper and pencil attendance registers became essential tools for organized attendance tracking. While more structured than oral traditions, this method was labor-intensive and prone to human error.

The 19th century's - Paper and Pencil (Industrial Revolution) marked a pivotal stage in the evolution of education, where the swell of industrialization reshaped not only economies but also the very foundations of learning. With the advent of larger and more complex educational establishments during this transformative era, the need for structured attendance tracking became increasingly noticeable. In response, the modest paper and pencil emerged as the instruments of choice, offering a resemblance of order in the midst of educational expansion.

As schools grew in size and complexity to meet the demands of a rapidly changing society, educators found themselves managing the details of monitoring student attendance. The paper and pencil method, while simple by today's standards, was a revolutionary leap

forward. It ushered in an era of more systematic attendance recording, laying the groundwork for the organized, data-driven systems we take for granted today.

Just as assembly lines streamlined production, the methodical task of marking attendance on a piece of paper brought a level of order to the classroom environment. The paper and pencil approach marked a transition from the oral traditions of the past to a more formalized system. It offered a tangible connection between the brief act of learning and the enduring nature of written records. Yet, even as this method promised greater accuracy and structured documentation, it still bore the limitations of its time. The process remained labor-intensive, often consuming a significant portion of instructional hours, and human error remained an ever-present companion.

Registers, Punch Cards, Barcode Scanning, and RFID (20th Century): The early 20th century saw the emergence of attendance registers, punch cards, and barcode scanning, streamlining the process and enhancing accuracy. RFID technology further improved efficiency, providing insights into student behavior.

During the mid-20th century, a transformative era in technology unfolded, introducing remarkable innovations. This period witnessed the emergence of punch cards and attendance machines, which ushered in a new wave of efficiency and automation. These cards are pieces of stiff paper that hold digital data represented by the presence or absence of holes in predefined positions. Each perforation on these cards represented a specific piece of information that could be read and interpreted by machines.

In the latter half of the 20th century, a significant technological transformation emerged in the form of barcode scanning and Radio-Frequency Identification (RFID). This era

witnessed the ascent of barcodes and RFID technology to a position of prominence, reshaping various aspects of our daily lives, including education.

During this era, a notable application of these technologies was observed within educational institutions. One innovative implementation involved equipping students with barcode cards, which could effortlessly be scanned upon entry to various campus facilities. This seemingly small modification translated into a substantial enhancement of administrative processes. The previously intricate and time-consuming attendance tracking procedures underwent a remarkable metamorphosis. Faculty and staff could swiftly verify student presence, effortlessly recording attendance with a simple swipe of the barcode card. This streamlined procedure not only mitigated the potential for errors stemming from manual attendance recording but also economized valuable instructional time that would have otherwise been expended on such administrative tasks.

The Digital Age: In the 21st century, technological advancements revolutionized attendance tracking. Mobile applications allowed students to check in while engaging with course materials. QR code systems bridged the physical and digital realms, while biometric solutions like facial recognition and fingerprint verification enhanced accuracy and security.

Media Access Control (MAC) Address-Based System: The system recommends installing the software on the instructor's mobile phone. It allows the instructor to query the student's cell phone over a Bluetooth connection by transferring the Media Access Control (MAC) address from the student's cell phone to the instructor's cell phone guide; student attendance can be confirmed (Jamil, T., 2011).

The invention of software that can be loaded on the instructor's smartphone to enable effective tracking of class attendance is the innovation. By connecting to the student's mobile device through Bluetooth and transmitting their Media Access Control (MAC) address to the instructor's device, this software verifies the student's attendance. It can be difficult to identify every student in huge lecture halls or online classes. More precise and effective techniques for tracking attendance in educational institutions are therefore becoming increasingly necessary.

The suggested remedy entails creating and setting up software on the instructor's mobile phone that can communicate via Bluetooth with the students' mobile devices. The student's cell phone's MAC address, a distinctive identifier for each device, is collected by the system to operate. In this manner, it certifies a student's attendance in class without requiring manual input. In summary, mobile attendance monitoring software that makes use of MAC addresses and Bluetooth technologies provides a novel approach to the age-old problem of reliably recording student attendance.

IoT-Based Systems: Internet of Things (IoT)-based attendance systems emerged, offering real-time tracking and connectivity. Internet of Things (IoT) is a design of special hardware, system software, Web API, protocol to be able to connect to the internet (A. Junaidi, 2015). These systems integrate hardware, sensors, data security, and compatibility with existing systems, revolutionizing attendance monitoring.

The application of technology has continuously revolutionized conventional procedures in the ever-changing educational scene. One of these breakthroughs is the creation of an Internet of Things (IoT)-based student attendance management system.

A paradigm shift in student attendance tracking and recording has been achieved with an IoT-based student attendance management system. There are a variety of factors to take into

account when building and studying an IoT-based student attendance management system, including the integration of hardware and sensors, data security and privacy, usability and accessibility, and compatibility with current systems.

A major advancement in the higher education sector is the creation of an IoT-based student attendance management system. It tackles many of the issues that colleges are currently facing by reliably tracking attendance, encouraging excellent attendance practices, boosting information collection, and fostering real-time connectivity. face. Successful implementations depend on careful consideration of system design and research issues, such as hardware integration, data security, usability, and integration with current systems. The Internet of Things (IoT)-based student attendance management system enhances administrative effectiveness while also helping students grow holistically and advancing higher education institutions.

QR code Based System: A QR code is a two-dimensional barcode that is readable by smartphones. It allows to encode over 4000 characters in a two-dimensional barcode. QR code may be used to display text to the user to open a URL, save a contact to the address book or to compose text messages (Arpankumar P., Ansel J., Shubham S., & Rohini N., 2019).

As the 21st century unfolded, reshaping conventional models and ushering in a new era of attendance tracking the explosion of cutting-edge solutions, ranging from mobile applications to QR code systems and complex biometric systems. At the forefront of this digital revolution were mobile applications, which emerged as powerful tools to augment traditional attendance mechanisms. These applications excelled beyond the limits of ordinary attendance recording, seamlessly fusing with an array of course-related activities (Masalha, F., & Hirzallah, N. 2014).

Learning Management System (LMS): It automatically detects and registers students attending a lecture. The system represents a supplemental tool for instructors, combining algorithms used in machine learning with adaptive methods used to track facial changes over a longer period of time (Shehu V., 2010).

The integration of attendance tracking within LMS platforms illustrates how educational institutions have embraced digitization to streamline their operations. This consolidation of technology and education not only simplifies administrative tasks for instructors but also empowers them to navigate the complex network of student engagement more effectively. By providing a centralized hub for attendance records, LMS systems eliminate the need for manual tracking, reducing the likelihood of errors and the time investment required for this administrative chore. However, the significance of this integration goes beyond its administrative utility. At its core, this technological relationship enhances communication between instructors and students.

The digital infrastructure of LMS platforms enables real-time updates, creating a channel through which instructors can efficiently disseminate information, share resources, and even address concerns. Likewise, students can pose queries and seek clarification without the constraints of traditional office hours, fostering a more dynamic and responsive learning environment. Yet the true power of this integration lies in its capacity to generate data-driven insights. As instructors engage with students through LMS platforms, a mass amount of information accumulates. This data, ranging from attendance patterns and assignment submissions to engagement with online materials, can be harnessed to inform academic strategies. By identifying trends and correlations, instructors gain a deeper understanding of

their students' learning behaviors and preferences, paving the way for tailored instructional approaches that resonate more effectively.

Fingerprint Verification Techniques: The crowning jewel of this era was the advent of biometric solutions, an indication of the peak of precision, security, and innovation. Fingerprint and facial recognition mechanisms emerged at the forefront of this biometric frontier. These methods, akin to intricate works of technology, authenticated student identities with a level of accuracy and security never seen before. The menace of students marking attendance on behalf of other students, which had long haunted manual systems, was decisively dismissed. Educational institutions savored the glory of fortified integrity as the very essence of each student's uniqueness was successfully integrated into attendance verification.

(Saraswat, Chitresh; Kumar, & Amit, 2010) propose a system in which fingerprint verification is done by using the extraction of minutiae technique and a system that automates the whole process of taking attendance. Since biometrics are concerned with the measurement of unique human physiological or behavioral characteristics, the technology has been used to verify the identity of users. It is becoming critical to be able to monitor the presence of the authenticated user throughout a session. Thus, another proposal discusses a prototype system that uses facial recognition technology to monitor authenticated users or students (Qinghan Xiao, 2009). A neural network-based algorithm was implemented to carry out face detection, and an eigenface method was employed to perform facial recognition. The experimental results demonstrate the feasibility of near-real-time continuous user verification for high-level security information systems (Qinghan Xiao, 2009)

Web-Based Systems That Uses Face Recognition: Web-based attendance systems using facial recognition technology further improved accuracy, real-time data, and administrative efficiency. A convolutional neural network (CNN) is used to detect faces in images, deep metric learning is used to produce facial embedding, and K-NN is used to classify students' faces (Sutabri, T., Pamungkur, K., Kurniawan, A., & Saragih, R. E. 2019). These systems automatically save attendance data, alleviating manual recording burdens.

The computer can recognize faces. From the experiments conducted, the system was able to recognize the faces of students who did attend, and their attendance data was automatically saved. Thus, the university administration is relieved from recording attendance data. The development of a web-based student attendance system incorporating face recognition technology is one of the new opportunities for enhancing educational procedures made possible by the introduction of technology. Computers can correctly identify students thanks to this cutting-edge technology, which uses convolutional neural networks (CNNs) for face detection, deep metric learning for facial embedding, and K-Nearest Neighbors (K-NN) for face categorization.

The web-based face-recognition student attendance system was created to address the problems with traditional attendance tracking in higher education. Face identification utilizing CNNs, facial embedding using deep metric learning, face categorization using K-NN, and automated attendance recording are some of its primary features.

2.3 The Significance of Attendance Tracking in Modern Education

In the contemporary educational landscape, attendance tracking has taken on a pivotal role. It's not merely about recording who is present in class; it's about optimizing the learning experience and ensuring student success. Here are some key aspects of the significance of attendance tracking:

1. Assessment and Adaptation: Attendance records serve as crucial tools for educators to assess and adapt their teaching methodologies. By monitoring student participation and progress, instructors can tailor their teaching to meet students' needs effectively.

2. Technology's Influence: Rapid technological advancements have led to the development of innovative class attendance systems that simplify the tracking process. These systems offer various advantages, but they also come with their unique challenges and impacts on educational institutions.

3. Data-Driven Insights: Modern attendance systems provide real-time data that allows institutions to analyze attendance patterns and identify students who may require additional support. These data-driven insights inform decision-making and enable instructors to customize their teaching strategies for specific student needs.

4. Efficiency and Accuracy: Automated attendance systems, such as RFID, QR code, and biometric solutions, significantly reduce the potential for errors associated with manual data entry and proxy attendance. This enhances the accuracy of attendance records and reduces administrative workload.

5. Privacy and Ethical Concerns: Biometric attendance systems, including facial recognition and fingerprint scanning, raise privacy and ethical concerns that need careful consideration when implementing such technologies in educational settings.

6. Engagement and Interaction: Modern attendance tracking methods, like QR code systems and mobile applications, transform the mundane task of attendance into an engaging and interactive experience for students. This fosters technological fluency among students and can contribute to a more dynamic learning environment.

7. Integration with Learning Management Systems (LMS): The integration of attendance tracking within LMS platforms simplifies administrative tasks for instructors and enhances communication between instructors and students. Real-time updates and data accumulation within LMS systems provide valuable insights for academic strategies (Shehu V., 2010).

8. Continuous Improvement: Attendance tracking has evolved continuously, driven by the pursuit of efficiency and accuracy. Each method, from manual systems to biometrics and IoT-based solutions, represents a step towards more precise attendance tracking and enhanced educational practices.

2.4 Conclusion

In conclusion, the significance of class attendance tracking cannot be understated in the modern education landscape. It is not merely a record-keeping exercise but a dynamic process that contributes to effective teaching, student engagement, and institutional improvement. As technology continues to advance, attendance tracking systems will evolve further, and it's essential for educational institutions to adapt and harness the benefits of these innovations while addressing the ethical and privacy considerations they entail. Ultimately, attendance tracking plays a crucial role in ensuring that no educational opportunity is lost and that every student has the chance to partake in the journey of learning.

CHAPTER THREE

SYSTEM DESIGN

Introduction

This chapter provides a comprehensive understanding of the methodology employed in developing the web-based attendance system with a biometric scanner. The system comprises two primary sections: student registration and lecturer-led attendance recording. To facilitate clarity, we present use case diagrams for both lecturer functions and student registration in Figure 3.2.2 and 3.2.3, respectively. This chapter also outlines the steps involved in implementing a biometric-based student attendance system.

3.1 Student Registration and Lecturer Attendance

The cornerstone of the web-based attendance system lies in its ability to efficiently manage student registration and attendance recording by lecturers. This section elucidates the essential steps involved in this process.

i. Registering Student Fingerprint and Student Index Number

This stage is integral to the system's operation. It encompasses the planning, collection, and categorization of student fingerprint data. The collected fingerprint information is securely encrypted and stored within a database. Students are required to register their index numbers and fingerprints through a designated interface, ensuring the acquisition of their fingerprint data.

ii. Staff Registration

Lecturers are mandated to register using their university-issued institutional email credentials. During registration, lecturers must also associate the courses they are assigned to teach in the current semester. The system sends a confirmation email to the provided email address to validate the lecturer's identity. Following email verification, lecturers can log in to the system to record attendance.

iii. Taking Attendance

Lecturers, when prepared to record attendance for a course, log in using their credentials. The system directs them to the "Take Attendance" page, where they select the specific course for attendance recording and specify the educational level of the students. A pop-up prompt instructs students to place their registered finger on the fingerprint scanner. The student's index number appears for verification, and upon confirmation, it is recorded in the attendance sheet. This process repeats until all students have confirmed their presence in class. To conclude the iteration, lecturers click the "Ok" button.

3.2 System Design

This section provides an introduction to the object-oriented analysis, design, and interactive development employed in shaping the system. The system's design is visualized using the Unified Modeling Language (UML), with a focus on structural and behavioral aspects.

Structural Diagram (Class Diagram)

To illustrate the structural components of the university attendance system, a class diagram is generated. The class diagram highlights the static attributes and relationships between system classes.

User:

- Attributes: userID, password
- Operations: login(), logout()

Instructor:

- Attributes: instructorID
- Operations: takeAttendance(), generateReport(), addCourse(), removeCourse()

Student:

- Attributes: studentID

Course:

- Attributes: courseID, name, instructor, students

Attendance:

- Attributes: attendanceID, courseID, date, status
- Operations: markPresent(), markAbsent(), markPermission(), checkAttendance()

System:

- Operations: addUser(), removeUser(), addCourse(), removeCourse()

The relationships are structured as follows:

- User, a generic class, represents system users. Instructors and Students inherit from the User class, each possessing unique attributes and operations.
- A one-to-many association between Instructor and Course enables a single instructor to be associated with multiple courses, while each course has only one instructor.
- The many-to-many association between Course and Student accounts for multiple students in a course and students enrolled in multiple courses.
- Attendance links individual student records to their presence in a specific course, establishing a reliance on the course entity.
- System manages user and course operations within the attendance system.

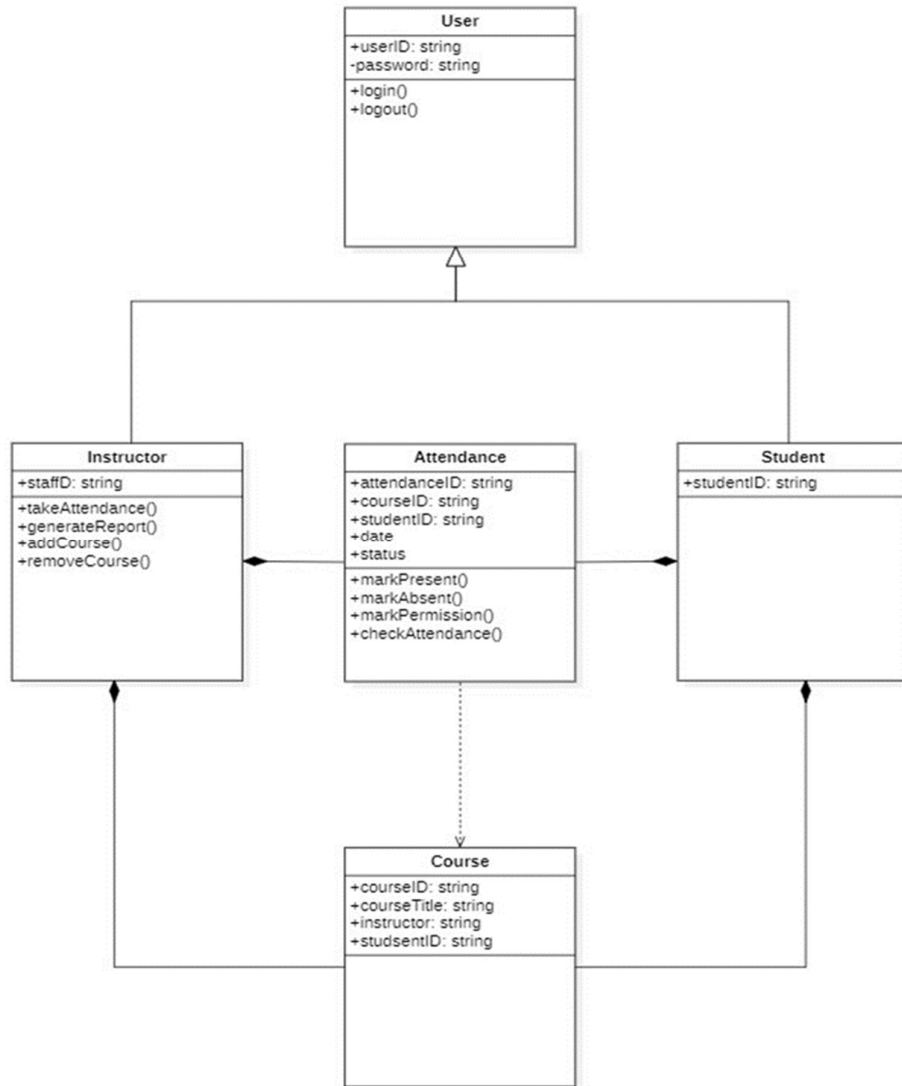


Figure 3.2.1 Class Diagram

Behavioral Diagram (Use Case Diagram)

The behavioral diagram, presented as a use case diagram, highlights the dynamic interactions within the system. It depicts the primary actor (instructor), the secondary actor (database system), and their roles in the university attendance system.

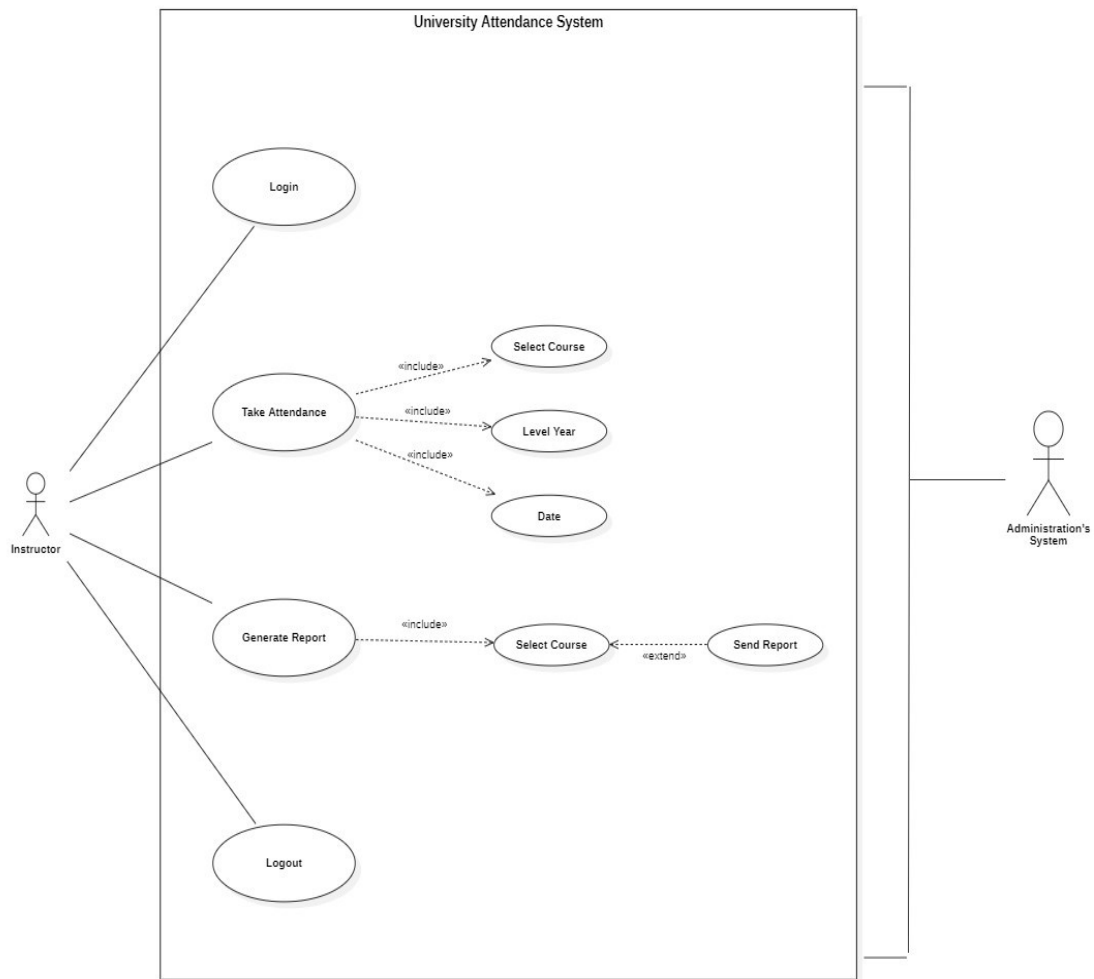


Figure 3.2.2 *Lecturers' Functions Class Diagram*

Key use cases include:

- Login
- Take Attendance
- Generate Report
- Logout

The diagram illustrates how these use cases are orchestrated within the system's operational framework.

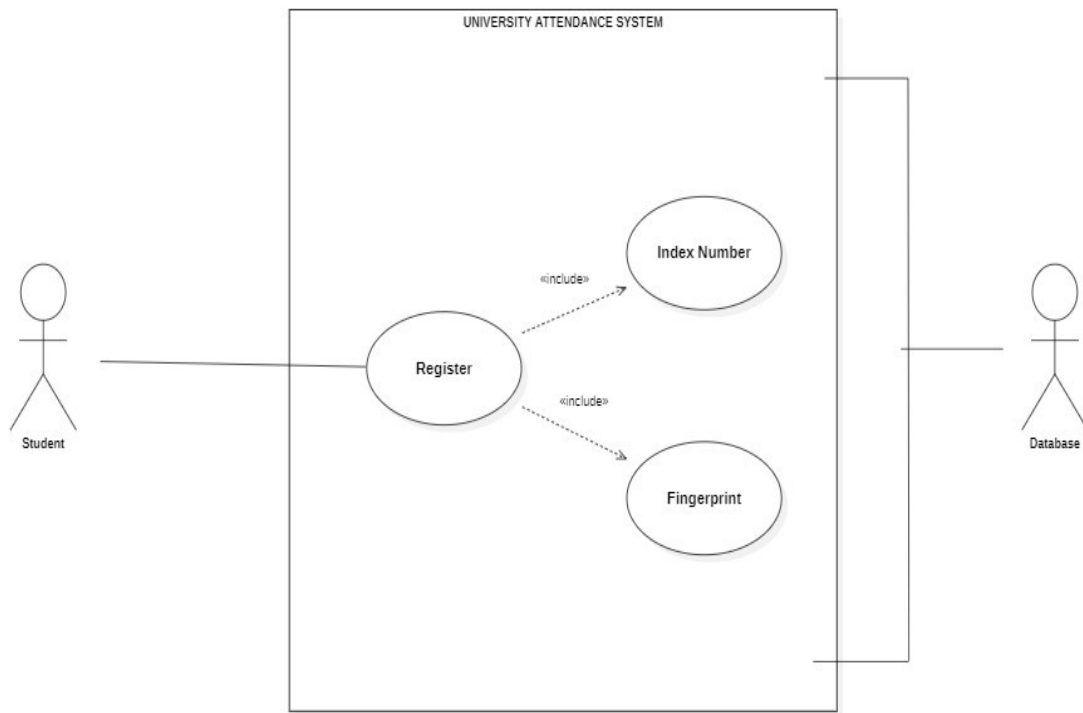


Figure 3.2.3 *Students' Registration Class Diagram*

Students' Registration – Registering Student Index Number and Fingerprint

3.3 Use Case Specification

The table below shows a use case specification example of an instructor who wants to take attendance before he or she starts lecturing.

Table 1: Use Case Specification Table

Name	Take Attendance
Primary Actor	Teacher/Instructor
Secondary Actor	Administration
Summary	Instructor wants to take attendance
Precondition	The system has been logged into by the instructor, who is now being taken to the attendance page. The professor then decides which class to take attendance for and decides which academic level of the students to take attendance for.
Postcondition	The teacher has finished collecting attendance, has entered the information into the database, and has produced a report based on the attendance for the current day.
Main Scenario	a. The students place their thumb finger on the fingerprint scanner.
	b. The system retrieves and verifies each student's fingerprint from the database of students' recorded fingerprints.
	c. In order for the student to affirm, the system prints out the student's index number.
	d. The system records the student's index number to be marked present in class during the lecture portion after receiving confirmation of it from the student.

Open Issues	a. If the instructor wants to print the report created from the attendance taken, the system should prompt them.
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3.4 Design Tools

The web-based attendance system leverages a set of tools and technologies for its development, encompassing both the front-end and back-end components.

3.4.1 Front-End: HTML, CSS, JavaScript

The front-end, the user-facing component of the system, is constructed using a combination of web technologies, including HTML, CSS, and JavaScript. HTML provides the structural foundation of web pages, CSS enhances styling, and JavaScript enables dynamic client-side interactions.

3.4.2 Back-End: Java Spring Boot

Java Spring Boot serves as the robust back-end framework responsible for connecting with the database and executing essential operations via SQL queries.

Database: MySQL

The MySQL database stores and manages critical system data, including user and attendance records, ensuring data integrity and accessibility.

3.4.3 Prototype Design

Model Design: Figma

The web application's user interface is designed using Figma, a versatile online software application that facilitates the creation of interactive and user-friendly interfaces.

CHAPTER FOUR

DESIGN AND IMPLEMENTATION

Introduction

In this chapter, we provide an in-depth exploration of the web-based biometric attendance system named "UniTend." Our aim is to offer a comprehensive understanding of its design, functionality, and the challenges encountered during its development and implementation.

4.1 Overview of the Web-Based Attendance System "UniTend"

UniTend is a cutting-edge web-based attendance system designed to streamline the process of tracking students' attendance during lecture hours. This section provides a detailed overview of the system, highlighting its core features and objectives.

Name Selection: The name "UniTend" was chosen to reflect the system's core purpose – attending to the attendance needs of educational institutions.

Objectives: The primary objectives of UniTend include enhancing attendance tracking accuracy, reducing administrative workload, and providing valuable data insights for instructors and institutions.

Technology Stack: The system is built using a robust technology stack, including programming languages (mention specific languages), databases, frameworks, and cloud infrastructure. This ensures its scalability and adaptability across diverse educational settings.

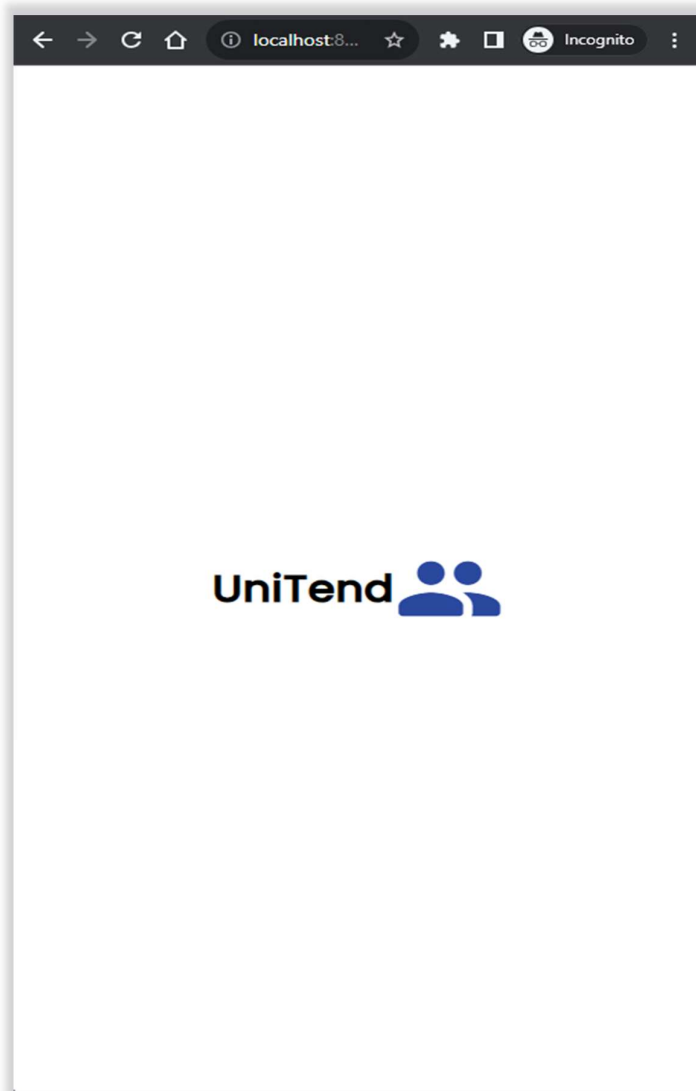


Figure 4.1.1 *First Interface of UniTend*

4.2 Staff Login

The staff login component plays a crucial role in ensuring secure access to the UniTend system. In this section, we delve deeper into the staff login process, emphasizing security measures and user convenience.

Security Measures: To protect sensitive data, UniTend implements robust security measures, including multi-factor authentication and password policies.

User Convenience: The system aims to provide a user-friendly experience, allowing staff members to access the system seamlessly using their institutional email addresses and strong, password-protected accounts.

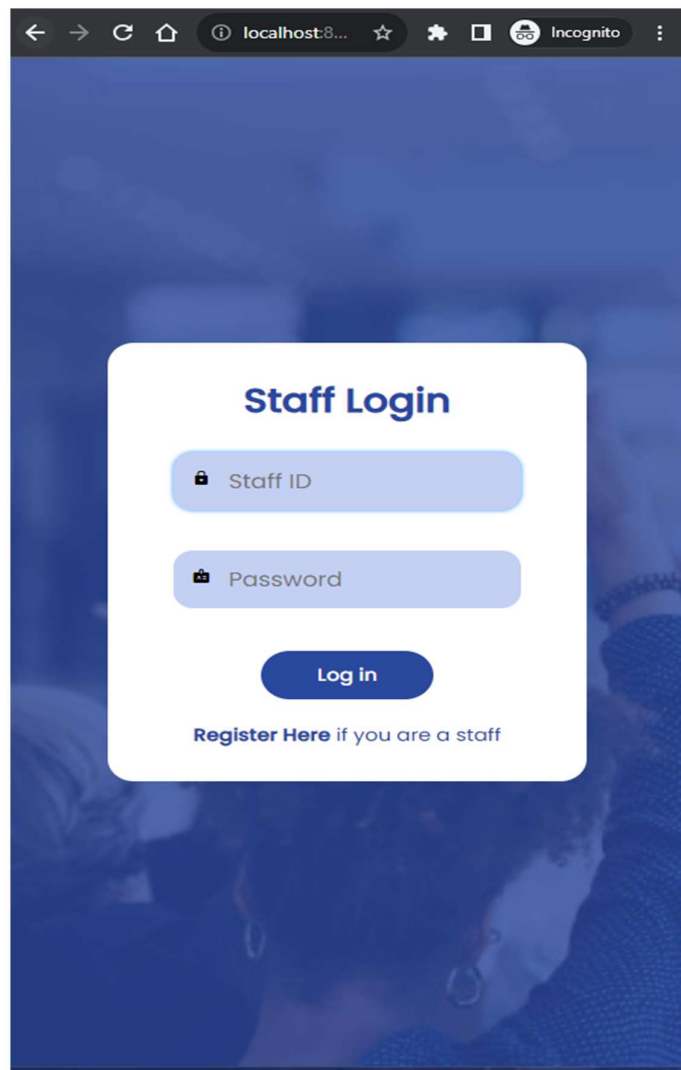


Figure 4.2.1 *Staff Login*

4.3 Staff Registration

Staff registration is a vital step that empowers lecturers to fully utilize UniTend's functionalities. This section elaborates on the registration process and its benefits.

Registration Steps: Lecturers must register using their institutional email addresses and create secure passwords. They are also required to associate the courses they wish to manage attendance for.

Email Verification: Following registration, lecturers are prompted to verify their email addresses to ensure the accuracy and integrity of user accounts.

Benefits: Registering with UniTend grants lecturers' access to advanced attendance management features, contributing to a more efficient teaching environment.

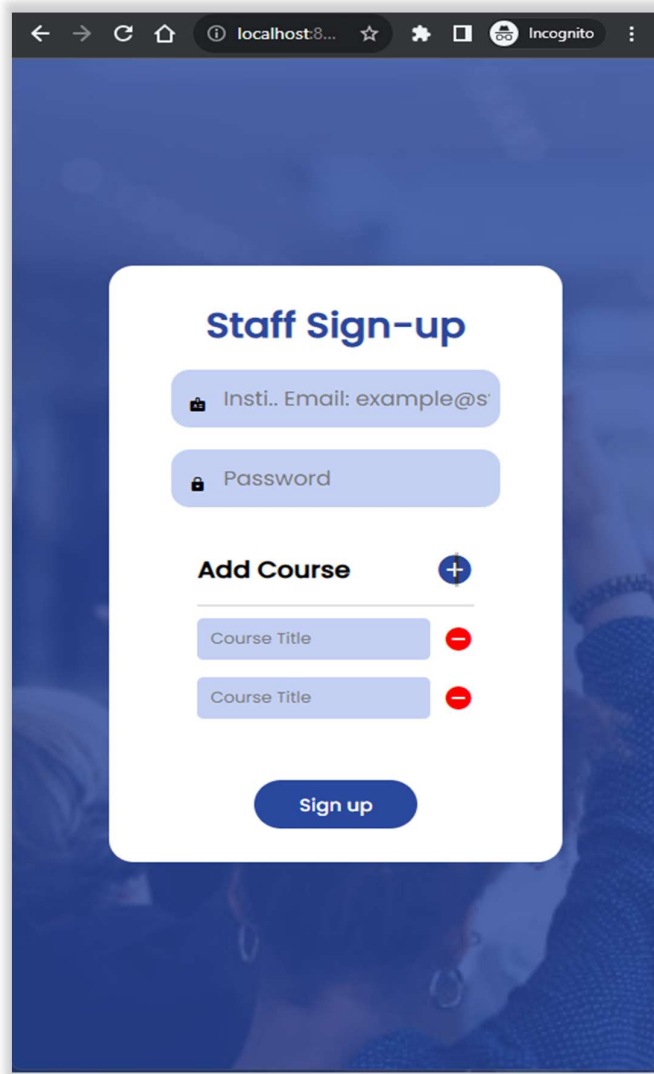


Figure 4.3.1 *Staff Registration*

4.4 Taking Attendance

Taking attendance is at the core of UniTend's functionality. Here, we provide a comprehensive overview of the attendance-taking process, focusing on its efficiency and real-time aspects.

Course and Educational Level Selection: Instructors choose the course and educational level for which they are recording attendance.

Fingerprint Scanning: The system employs fingerprint scanning for biometric verification. It matches the student's fingerprint with their index number, ensuring accuracy and reducing proxy attendance.

Real-Time Tracking: Real-time attendance tracking offers instructors immediate insights into student presence, enhancing the teaching and learning experience.

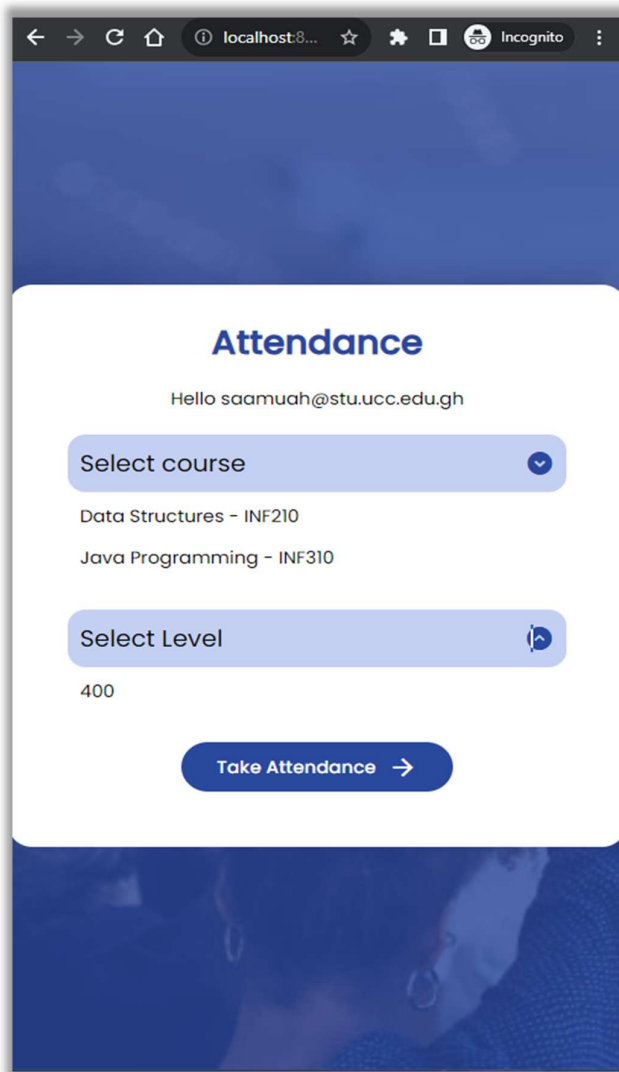
The image shows a web browser window with a dark blue header and footer. The main content area is white and contains a form titled "Attendance" in bold blue text. Below the title, it says "Hello saamuah@stu.ucc.edu.gh". There are two dropdown menus: "Select course" with a blue arrow icon, showing "Data Structures - INF210" and "Java Programming - INF310"; and "Select Level" with a blue arrow icon, showing "400". At the bottom of the form is a blue button with white text that says "Take Attendance" followed by a right-pointing arrow. The browser's address bar shows "localhost:8..." and the Incognito mode icon.

Figure 4.4.1 *Taking Attendance*

4.5 Attendance Interface Taken

This section continues from the attendance-taking process, detailing what occurs once attendance is recorded.

Time Out Functionality: Clicking the "Time Out" button signifies the end of the lecture session, providing a timestamp for record-keeping.

Log Out Option: The "Log Out" button allows users to exit the system securely.

Generate Report Feature: The "Generate Report" feature generates an Excel document with attendance data, including the number of students present, the date, the course, and the students' educational levels.

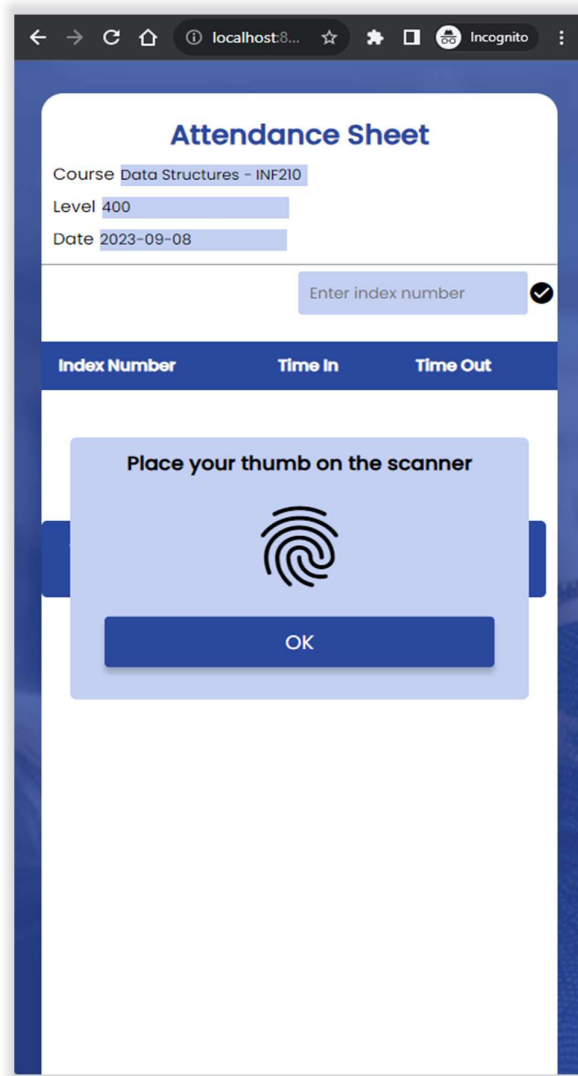


Figure 4.5.1 *Attendance Interface*

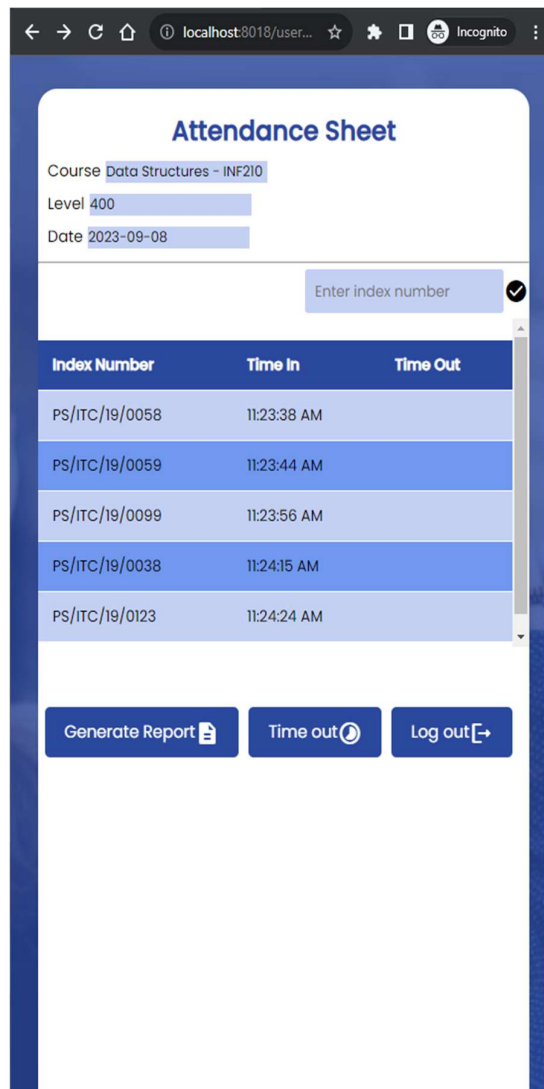


Figure 4.5.2 *Attendance Interface Taken*

4.6 Student Registration Interface

We explore the student perspective in this section, focusing on their involvement in registering their index numbers and fingerprint data.

Student Engagement: Students play an active role in ensuring the accuracy of their attendance records by registering their index numbers and fingerprints.

User-Friendly Registration: The registration process is designed to be user-friendly, making it easy for students to participate in the attendance tracking process.

Enhanced Student Experience: UniTend's biometric system aims to enhance the overall student experience by offering a secure and efficient attendance tracking solution.

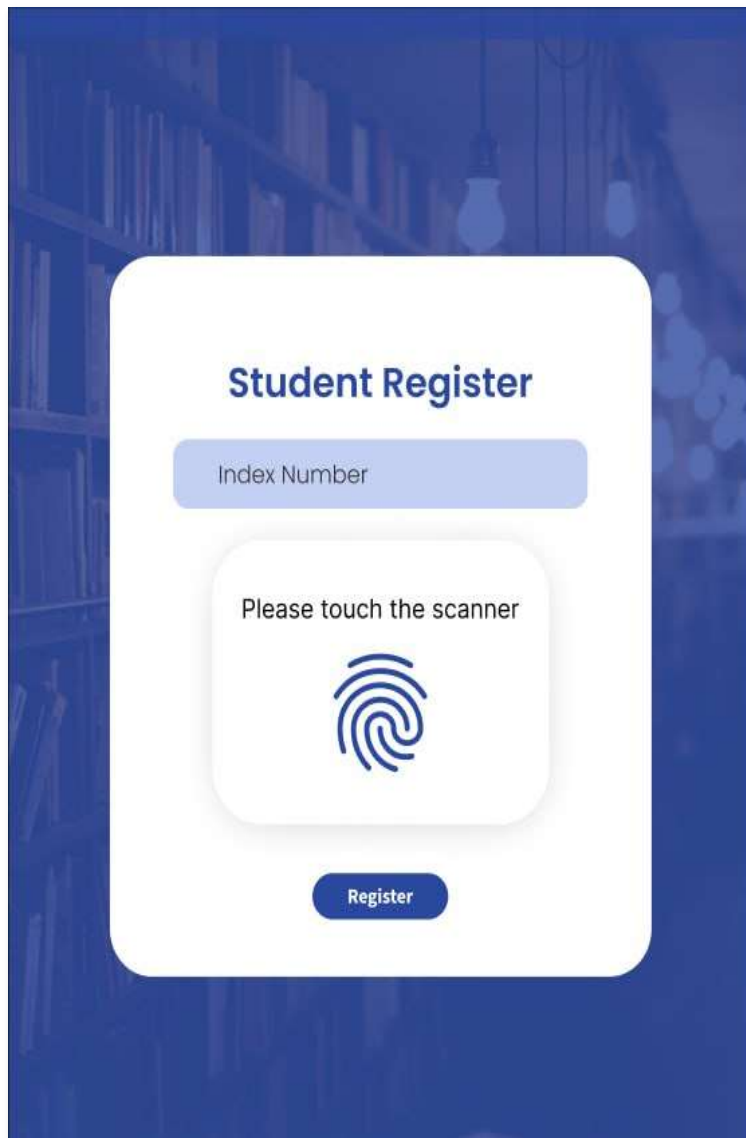


Figure 4.6.1 *Student Registration Interface*

4.7 Challenges Faced during Implementation

While the development of UniTend has been transformative, it has not been without its share of challenges. This section delves into the major difficulties encountered and the strategies employed to address them.

Privacy and Data Security Concerns: Protecting sensitive biometric data has been a paramount concern, leading to the implementation of robust encryption and access control measures.

User Acceptance and Privacy Concerns: UniTend addresses user acceptance and privacy concerns through transparent communication, informed consent procedures, and clear explanations regarding data use and protection.

Integration with Existing Systems: The process of integrating UniTend with existing student information databases and systems has required extensive customization and compatibility testing.

4.8 Conclusion

In conclusion, UniTend represents a significant advancement in attendance tracking technology for educational institutions. While challenges such as privacy, user acceptance, and system integration were encountered, they were addressed diligently. The potential benefits of UniTend for the education industry, including enhanced accuracy, reduced administrative workload, and valuable data insights, make it a promising addition to modern educational technology.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Conclusion and Recommendations

Nowadays, being current with technology is essential, especially in the realm of education. Using the most recent technologies, educational institutions have been looking for ways to improve the educational process. (Arpankumar P., Ansel J., Shubham S., & Rohini N., 2019).

A new era in education has arrived thanks to the development of biometric technology, especially in terms of monitoring student attendance. The creation and use of biometric student attendance systems mark a major advance in improving the effectiveness, precision, and security of this crucial area of educational administration. By summarizing major findings and offering suggestions for the successful integration of biometric attendance systems in educational institutions, this essay brings our investigation of the subject to a close.

5.1 Conclusion:

The voyage through the realm of biometric student attendance systems has highlighted the technology's amazing potential to transform the way attendance is tracked in educational institutions. In conclusion, a number of important realizations have emerged:

1. **Enhanced Accuracy:** Compared to manual techniques, biometric attendance systems provide a level of accuracy that is higher. The distinctive biometric characteristics, such as fingerprints or facial features, ensure accurate student identification while reducing mistakes and discrepancies in attendance records.

2. **Real-time Data Availability:** These systems offer real-time data, allowing teachers and administrators to immediately monitor attendance. When appropriate, this data-driven methodology enables early interventions and well-informed decision-making.

3. **Security and Privacy:** It is crucial to address privacy and data security issues. To ensure the privacy of biometric data, developers must integrate strong encryption, access controls, and compliance with data protection laws.

4. **User Acceptance:** Gaining user acceptability and addressing privacy issues require clear explanations of data usage, informed consent processes, and transparent communication.

5. **Technical Challenges:** Complex hardware and algorithms are needed for biometric systems. A talented and competent development team is required to overcome technical obstacles like sensor malfunctions or environmental conditions.

6. **Integration:** It might be challenging to integrate biometric technologies with current databases and systems. Integration success depends on customization and smooth data flow.

5.2 Recommendations:

Our investigation into biometric student attendance systems leads to numerous recommendations for educational institutions thinking about implementing them:

1. **Comprehensive Privacy Policies:** The collection, storage, and use of biometric data should be outlined in clear, comprehensive privacy rules that educational institutions should adopt. These guidelines ought to follow current data protection laws.
2. **User Education:** The usage of biometric attendance systems should be thoroughly explained and trained to educators, students, and administrative staff. Data security protocols, system operation, and privacy best practices should all be covered in this training.
3. **Ethical Oversight:** Institutions should set up ethics boards or committees to regulate the moral application of biometric information. These organizations can make sure the technology is applied sensibly and in the best interests of all parties involved.
4. **Continuous Monitoring:** Performance of biometric systems must be continuously monitored. Establishing procedures for routine system upkeep, calibration, and data integrity checks is important for educational institutions.
5. **Collaboration with Stakeholders:** Collaboration with important stakeholders should be ongoing, including teachers, students, and administrative staff. User participation and feedback sessions can help to inform system changes and promote a sense of ownership.
6. **Pilots and Testing:** Institutions should evaluate biometric attendance systems in pilot settings before using them on a large basis. This makes it possible to fine-tune and verify the technology's efficacy in the particular educational context.

7. Budget Planning: Planning a budget carefully is essential. Institutions should set aside funds for biometric attendance systems' initial adoption as well as continuous maintenance.

5.3 Summary

The ability to process academic data automatically and provide statistical data based on the attendance of students in each theory and practicum class lecture is expected of presence system modelling based on the Internet of Things with Fingerprint. Additionally, this presence approach lessens data tampering variables from negligent parties, allowing lecturers to indirectly monitor the data (Santoso, B., & Sari, M. W., 2019).

In summary, the development of biometric student attendance systems is a positive advancement in educational technology. Due to their unparalleled accuracy, real-time data, and improved security, these technologies have the ability to completely change the way attendance is tracked. However, careful planning, ethical considerations, user approval, and adherence to privacy laws are essential for their successful integration. Educational institutions can fully utilize the advantages of biometric student attendance systems, improving educational outcomes and administrative effectiveness, by adhering to the suggested practices and upholding a commitment to transparency and data protection.

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