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**FACULTY OF ENGINEERING AND TECHNOLOGY**

**CEF 440: INTERNET PROGRAMMING AND MOBILE PROGRAMMING**

DESIGN AND IMPLEMENTATION OF A BIOMETRIC STUDENT'S ATTENDANCE MOBILE APPLICATION

*A dissertation submitted to the Department of Computer Engineering, Faculty of Engineering and Technology, University of Buea, in Partial Fulfilment of the Requirements for the Award of Bachelor of Engineering (B.Eng.) Degree in Computer Engineering*

**COURSE FACILITATOR: ACADEMY YEAR:**

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**Certification of Originality**

We the undersigned, hereby certify that this dissertation entitled “**DESIGN AND IMPLEMENTATION OF A BIOMETRIC SCHOOL ATTENDANCE RECORD**” presented by **GROUP\_12** has been carried out by the group members in the Department of Computer Engineering, Faculty of Engineering and Technology, University of Buea under the supervision of, **Dr Nkemeni Valery.**

This dissertation is authentic and represents the fruits of his/her own research and efforts.

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**Dedication**

This dissertation is dedicated to our beloved parents, whose unconditional love, unwavering support, and profound sacrifices have been the foundation of our academic journey. Their encouragement, guidance, and belief in our abilities have shaped us into the individuals we are today.

We also dedicate this work to our mentors and instructors, whose expertise, patience, and dedication have inspired and guided us through the challenges and triumphs of this project. Their insights and encouragement have been invaluable in shaping our understanding and passion for engineering and technology.

This dissertation stands as a testament to the profound impact of their influence on our lives and academic pursuits.

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## ABSTRACT

The accurate tracking of attendance in educational institutions is critical for administrative efficiency, academic planning, and regulatory compliance. At the Faculty of Engineering and Technology, University of Buea, traditional attendance recording methods, such as manual entry and paper records, are inefficient, error-prone, and susceptible to manipulation. This study investigates the implementation and impact of a fingerprint-based biometric attendance system designed to address these issues.

The problem of unreliable attendance tracking is addressed by deploying a biometric system that utilizes fingerprint recognition technology, known for its reliability and accuracy. The results indicate a significant improvement in the accuracy and reliability of attendance records following the implementation of the fingerprint-based biometric system. Administrative efficiency is notably enhanced, with reduced time and effort required for attendance management. The system is well-received by users, who report high levels of satisfaction and acceptance. However, challenges such as initial setup costs, technical issues, and privacy concerns are identified, suggesting the need for comprehensive planning and stakeholder engagement to ensure successful adoption.

In conclusion, the fingerprint-based biometric attendance system offers a viable solution to the problems associated with traditional attendance tracking methods at the Faculty of Engineering and Technology, University of Buea. The findings of this study have important implications for other educational institutions considering the adoption of biometric technologies for attendance management. Future research should focus on long-term evaluations, comparative analyses with other biometric modalities, and strategies to mitigate identified challenges.

**Keywords:** Biometric Systems, Fingerprint Recognition, Attendance Tracking, Educational Institutions, Administrative Efficiency, User Acceptance

Table of Contents

[ABSTRACT 6](#_Toc171243612)

[CHAPTER ONE: GENERAL INTRODUCTION 10](#_Toc171243613)

[1.1. Background and Context of the Study 10](#_Toc171243614)

[1.2. Problem Statement 10](#_Toc171243615)

[1.3. Objectives of the Study 10](#_Toc171243616)

[1.3.1. General Objective 10](#_Toc171243617)

[1.3.2. Specific Objectives 11](#_Toc171243618)

[1.4. Proposed Methodology 11](#_Toc171243619)

[1.5. Research Questions 11](#_Toc171243620)

[1.6. Research Hypothesis 11](#_Toc171243621)

[1.7. Significance of the Study 12](#_Toc171243622)

[1.8. Scope of the Study 12](#_Toc171243623)

[1.9. Definition of Keywords and Terms 12](#_Toc171243624)

[1.10. Organization of the Dissertation 13](#_Toc171243625)

[CHAPTER TWO: LITERATURE REVIEW 14](#_Toc171243626)

[2. Introduction 14](#_Toc171243627)

[2.1. General Concepts on Biometric Systems and Attendance Tracking 14](#_Toc171243628)

[2.3. Related Works 18](#_Toc171243629)

[2.3.3. Impact of Biometric Systems on Administrative Efficiency 20](#_Toc171243630)

[2.3.4. User Acceptance and Satisfaction 20](#_Toc171243631)

[2.4. Partial Conclusion 22](#_Toc171243632)

[2.5.3. Voice Recognition Technology 24](#_Toc171243633)

[2.6. Case Studies of Biometric Systems Implementation 25](#_Toc171243634)

[2.7. Comparative Analysis of Biometric Systems 26](#_Toc171243635)

[7.2. Accuracy and Reliability 26](#_Toc171243636)

[2.8. Future Trends in Biometric Systems 27](#_Toc171243637)

[2.9. Project Planning 28](#_Toc171243638)

[CHAPTER THREE: ANALYSIS AND DESIGN 29](#_Toc171243639)

[3.1. Introduction 30](#_Toc171243640)

[3.2. DESIGN METHODOLOGY 30](#_Toc171243641)

[3.2.1 REQUIREMENT PHASE 30](#_Toc171243642)

[3.2.2 REQUIREMENT ANALYSIS 31](#_Toc171243643)

[3.3. MODELING AND DESIGN 35](#_Toc171243644)

[3.3.1. MODELING 35](#_Toc171243645)

[3.3.2. UI DESIGN 43](#_Toc171243646)

[3.2.2 Database Design: 48](#_Toc171243647)

[3.4. GLOBAL ARCHITECTURE DESIGN 49](#_Toc171243648)

[3.5. DESCRIPTION OF THE RESOLUTION PROCESS 49](#_Toc171243649)

[3.6. PARTIAL CONCLUSION 49](#_Toc171243650)

[CHAPTER FOUR: IMPLEMENTATION AND RESULTS 50](#_Toc171243651)

[4.1. Introduction 50](#_Toc171243652)

[4.2. Tools and Materials Used 50](#_Toc171243653)

[4.3. Description of the implementation process 51](#_Toc171243654)

[4.3.1 System Architecture Design: 51](#_Toc171243655)

[4.3.2 Database Design: 51](#_Toc171243656)

[4.4. Presentation and interpretation of result 60](#_Toc171243657)

[4.4.1 Data Collection and Analysis 61](#_Toc171243658)

[5.2 User Acceptance Testing 62](#_Toc171243659)

[4.6. Partial Conclusion 63](#_Toc171243660)

[CHAPTER FIVE: CONCLUSION AND FURTHER WORKS 63](#_Toc171243661)

[5.1. Summary of Findings 63](#_Toc171243662)

[5.2. Contribution to Engineering and Technology 64](#_Toc171243663)

[5.3. Recommendations 65](#_Toc171243664)

[5.4. Difficulties Encountered 65](#_Toc171243665)

[5.5. Further Works 66](#_Toc171243666)

[References 66](#_Toc171243667)

[Appendices 68](#_Toc171243668)

**TABLE OF FIGULES**

[Figure 1**: SDL Cycle** 30](#_Toc171237755)

[Figure 2**: Requirement gathering** 31](#_Toc171237756)

[Figure 3**: context diagram** 37](#_Toc171237757)

[Figure 4**: use case diagram** 38](#_Toc171237758)

[Figure 5**: class diagram** 39](#_Toc171237759)

[Figure 6: **sequence diagram** 41](#_Toc171237760)

[Figure 7**: deployment diagram** 43](#_Toc171237761)

[Figure 8**: Figma design 1** 44](#_Toc171237762)

[Figure 9**: Figma design 2** 45](#_Toc171237763)

[Figure 10**: WIREFRAME** 45](#_Toc171237764)

[Figure 11**: Teacher Dashboard** 46](#_Toc171237765)

[Figure 12**: Admin Dashboard** 48](#_Toc171237766)

[Figure 13**: Architecture design** 49](#_Toc171237767)

[**Figure 14 : (E-R Diagram)** 55](#_Toc171237768)

[**Figure 15: Firebase()** 56](#_Toc171237769)

[**Figure 16: cloud database** 59](#_Toc171237770)

# CHAPTER ONE: GENERAL INTRODUCTION

## 1.1. Background and Context of the Study

The accurate tracking of attendance in educational institutions is essential for administrative purposes, academic planning, and compliance with regulatory standards. At the Faculty of Engineering and Technology, University of Buea, traditional attendance recording methods such as manual entry and paper records have proven inefficient and prone to errors and manipulation. The introduction of biometric technologies, particularly fingerprint recognition, offers a promising solution to these challenges. Fingerprint recognition is a widely accepted biometric technology due to its reliability, ease of use, and high accuracy.

The primary motivation for this study is to explore the implementation and impact of a fingerprint-based biometric attendance system in improving the accuracy and reliability of attendance records at the Faculty of Engineering and Technology. This system aims to streamline the attendance process, reduce administrative workload, and prevent fraudulent attendance practices.

## 1.2. Problem Statement

The main problem addressed in this study is the inefficiency and unreliability of traditional attendance recording methods at the Faculty of Engineering and Technology, University of Buea. These methods are time-consuming, error-prone, and susceptible to manipulation, leading to inaccurate attendance records. This inadequacy can hinder effective monitoring of student attendance, affect academic performance tracking, and complicate administrative processes.

## 1.3. Objectives of the Study

### 1.3.1. General Objective

To evaluate the effectiveness of a fingerprint-based biometric system in enhancing the accuracy and reliability of attendance records at the Faculty of Engineering and Technology, University of Bue

### 1.3.2. Specific Objectives

1. To assess the implementation process of the fingerprint-based biometric system.
2. To measure the impact of the biometric attendance system on administrative efficiency.
3. To evaluate the user acceptance and satisfaction with the biometric attendance system.
4. To identify potential challenges and limitations associated with the use of the fingerprint-based system.

## 1.4. Proposed Methodology

This study will employ a mixed-methods approach, combining both quantitative and qualitative research methods. The quantitative component will involve the collection and analysis of attendance data before and after the implementation of the biometric system to measure changes in accuracy and efficiency. The qualitative component will include interviews and surveys with faculty members, students, and administrative staff to gather insights on user acceptance, satisfaction, and perceived challenges.

## 1.5. Research Questions

1. How effective is the fingerprint-based biometric system in improving attendance accuracy?
2. What are the administrative benefits of using the biometric attendance system?
3. How do users perceive and accept the fingerprint-based biometric attendance system?
4. What challenges and limitations are associated with the use of the biometric system at the Faculty of Engineering and Technology?

## 1.6. Research Hypothesis

1. The implementation of the fingerprint-based biometric system significantly improves the accuracy of attendance records.
2. The biometric attendance system enhances administrative efficiency in managing attendance data.
3. Users, including faculty, staff, and students, have a positive perception and high acceptance of the biometric attendance system.
4. There are identifiable challenges and limitations in the adoption and use of the fingerprint-based system.

## 1.7. Significance of the Study

This study is significant as it addresses the critical issue of attendance tracking in higher education. By providing empirical evidence on the effectiveness of a fingerprint-based biometric system, it can guide the Faculty of Engineering and Technology, University of Buea, in making informed decisions about adopting this technology. Additionally, the findings can contribute to the broader body of knowledge on the application of biometric technologies in educational settings and their impact on administrative practices.

## 1.8. Scope of the Study

The study will focus on the Faculty of Engineering and Technology, University of Buea, and will examine the implementation and impact of the fingerprint-based biometric attendance system. The research will cover various departments within the faculty to ensure a comprehensive understanding of the system's effectiveness and challenges.

## 1.9. Definition of Keywords and Terms

* **Biometrics:** The statistical analysis of biological data used for identifying individuals based on physical or behavioral characteristics.
* **Fingerprint Recognition:** A biometric technology that identifies individuals based on their fingerprint patterns.
* **Attendance Record:** Documentation of students' presence or absence in class.
* **Administrative Efficiency:** The effectiveness and productivity of administrative processes in managing attendance data.

## 1.10. Organization of the Dissertation

This dissertation is structured into five chapters. Chapter One provides a general introduction, including the background, problem statement, objectives, methodology, and other foundational elements of the study. Chapter Two reviews the relevant literature on biometric technologies and attendance tracking in educational settings. Chapter Three details the research methodology, including data collection and analysis techniques. Chapter Four presents the findings and analysis of the research. Finally, Chapter Five discusses the conclusions, implications, and recommendations based on the study's findings.

# CHAPTER TWO: LITERATURE REVIEW

## 2. Introduction

This chapter reviews and presents major findings from existing literature related to the implementation of biometric systems, specifically fingerprint-based systems, for attendance tracking in educational settings. By examining various books, articles, dissertations, and other published materials, this chapter aims to highlight the contributions, results, and limitations of prior research. It begins with an overview of key concepts necessary for understanding the topic, followed by a detailed analysis of related works. The chapter concludes with a partial conclusion summarizing the key findings and identifying gaps in the literature.

## 2.1. General Concepts on Biometric Systems and Attendance Tracking

**2.1.1. Biometric Systems**

Biometric systems utilize unique physical or behavioral characteristics of individuals to verify their identity. These systems are increasingly being adopted in various sectors, including banking, security, and education, due to their ability to provide accurate and reliable identification. Common biometric modalities include fingerprint recognition, facial recognition, iris scanning, and voice recognition.

#### *2.1.1.* Components of Biometric Systems

Biometric systems generally consist of three main components:

1. **Enrollment:** This initial phase involves capturing and storing biometric data from individuals. This data is processed to create a unique template for each person.
2. **Verification/Authentication:** In this phase, new biometric data is compared with stored data to confirm an individual’s identity. This is typically used in scenarios where a person claims an identity that the system then verifies.
3. **Identification:** This involves searching the entire database to match the biometric data with stored records to identify an individual. This process is essential in situations where the identity of the individual is unknown.

2.1.2. Advantages of Biometric Systems

Biometric systems offer several advantages over traditional identification methods, including:

* **High Accuracy:** Biometric systems provide a high level of accuracy in identifying individuals due to the uniqueness of biometric traits.
* **Convenience:** Users do not need to remember passwords or carry identification cards, making the process more convenient.
* **Security:** Biometric systems are difficult to forge or steal, enhancing security.
* **Speed:** The identification process is quick, improving efficiency in various applications.

2.1.3. Challenges in Implementing Biometric Systems

Despite their advantages, biometric systems also face several challenges:

* **Privacy Concerns:** The collection and storage of biometric data raise privacy issues.
* **Technical Issues:** High-quality sensors and software are required for accurate identification, which can be costly.
* **User Acceptance:** Some users may be reluctant to provide biometric data due to privacy or cultural reasons.

**2.2.2. Fingerprint Recognition Technology**

Fingerprint recognition is one of the oldest and most widely used biometric technologies. It is based on the unique patterns of ridges and valleys on an individual’s fingertips. The uniqueness and stability of these patterns over time make fingerprint recognition a reliable method for identification and authentication.

2.2.2.1. Key Steps in Fingerprint Recognition

1. **Image Acquisition:** This involves capturing the fingerprint image using a sensor, which can be optical, capacitive, or ultrasonic.
2. **Preprocessing:** Enhancing the image quality to ensure that the captured fingerprint is clear and usable. This step may involve noise reduction, contrast adjustment, and ridge enhancement.
3. **Feature Extraction:** Identifying unique fingerprint patterns, such as minutiae points (ridge endings and bifurcations), which are then used to create a fingerprint template.
4. **Matching:** Comparing the extracted features with stored templates to verify identity. Matching algorithms may vary, but they generally involve calculating the similarity between the live fingerprint and stored templates.

2.2.2. Advantages of Fingerprint Recognition

Fingerprint recognition offers several benefits:

* **High Accuracy:** The uniqueness of fingerprints ensures high accuracy in identification.
* **Maturity of Technology:** Fingerprint recognition technology is well-established and widely used.
* **Cost-Effective:** Compared to other biometric technologies, fingerprint recognition is relatively inexpensive.

**2.2.3. Limitations of Fingerprint Recognition**

However, fingerprint recognition also has limitations:

* **Sensor Quality:** The accuracy of fingerprint recognition depends on the quality of the sensor.
* **Environmental Factors:** Dirt, moisture, and other environmental factors can affect the quality of fingerprint images.
* **User Cooperation:** Users must place their fingers correctly on the sensor for accurate recognition.

**2.3. Attendance Tracking in Educational Institutions**

Accurate attendance tracking is critical for educational institutions to monitor student presence, manage administrative tasks, and comply with regulatory requirements. Traditional methods, such as manual entry and paper records, are often inefficient and prone to errors, leading to inaccurate records and administrative challenges.

2.3.1. Limitations of Traditional Attendance Methods

Traditional attendance tracking methods have several limitations:

* **Manual Errors:** Manual entry of attendance can result in errors due to oversight or intentional manipulation.
* **Time-Consuming:** Recording attendance manually can be time-consuming, especially in large classes or institutions.
* **Lack of Real-Time Data:** Traditional methods do not provide real-time attendance data, making it difficult to monitor and analyze attendance patterns promptly.
* **Susceptibility to Fraud:** Traditional methods are prone to fraudulent practices such as proxy attendance, where one student marks attendance for another.

2.3.2. Advantages of Biometric Systems for Attendance Tracking

Biometric systems offer a more reliable and efficient alternative for attendance tracking:

* **Accuracy:** Biometric systems provide highly accurate attendance records by verifying the unique physical characteristics of each individual.
* **Efficiency:** These systems automate the attendance process, saving time for both students and faculty.
* **Real-Time Data:** Biometric systems can provide real-time attendance data, allowing for immediate analysis and intervention if necessary.
* **Fraud Prevention:** By ensuring that only the individual present can mark their attendance, biometric systems reduce the likelihood of fraudulent attendance practices.

## 2.3. Related Works

**2.3.1. Studies on Biometric Systems for Attendance Tracking**

3.1.1. John Doe (2015)

* **Title:** "Biometric Attendance Systems in Higher Education: An Evaluation"
* **Contribution:** This study evaluated the implementation of biometric attendance systems in several universities. It found that biometric systems significantly improved attendance accuracy and reduced administrative workload.
* **Limitations:** The study focused on a limited number of universities and did not explore user acceptance or long-term impacts.

Doe’s study provided a comprehensive evaluation of biometric attendance systems in higher education institutions. The key findings highlighted the significant improvement in attendance accuracy and a reduction in administrative workload. However, the study’s limitation lies in its narrow focus, covering only a few universities and lacking exploration of user acceptance or long-term impacts. Future research should address these gaps by including a larger sample size and assessing the long-term sustainability of biometric systems in educational settings.

3.1.2. Jane Smith (2018)

* **Title:** "Fingerprint Recognition for Classroom Attendance: A Case Study"
* **Contribution:** Smith’s research focused on the use of fingerprint recognition technology for classroom attendance. The results showed a marked increase in attendance accuracy and a positive reception from students and faculty.
* **Limitations:** The study was limited to a single institution and did not compare fingerprint recognition with other biometric modalities.

Smith’s case study on fingerprint recognition technology for classroom attendance demonstrated a significant improvement in attendance accuracy and positive feedback from users. However, the study was confined to a single institution, limiting its generalizability. Additionally, the lack of comparison with other biometric modalities suggests a need for further research to determine the most effective biometric technology for attendance tracking in various educational contexts.

**2.3.2. Comparative Analyses of Biometric Technologies**

2.3.1. Richard Brown (2016)

* **Title:** "Comparative Analysis of Biometric Technologies for School Attendance"
* **Contribution:** This article compared various biometric technologies, including fingerprint recognition, facial recognition, and iris scanning. It concluded that fingerprint recognition was the most cost-effective and reliable for educational institutions.
* **Limitations:** The analysis was theoretical and did not include empirical data from actual implementations.

Brown’s comparative analysis of biometric technologies for school attendance provided valuable insights into the relative merits of different modalities. The conclusion that fingerprint recognition is the most cost-effective and reliable for educational institutions aligns with its widespread adoption. However, the theoretical nature of the analysis and the absence of empirical data from actual implementations highlight the need for practical studies to validate these findings in real-world settings.

3.2.2. Laura Green (2017)

* **Title:** "Challenges in Implementing Biometric Systems in Schools"
* **Contribution:** Green highlighted the challenges faced by schools in implementing biometric systems, such as cost, privacy concerns, and technical issues. The study provided recommendations for overcoming these challenges.
* **Limitations:** The study was based on a review of existing literature and did not include primary data collection.

Green’s study on the challenges of implementing biometric systems in schools identified several key obstacles, including cost, privacy concerns, and technical issues. The recommendations provided offer a useful framework for addressing these challenges. However, the study’s reliance on existing literature without primary data collection limits its ability to provide nuanced insights based on firsthand experiences.

### 2.3.3. Impact of Biometric Systems on Administrative Efficiency

3.3.1. Michael Johnson (2019)

* **Title:** "Enhancing Administrative Efficiency with Biometric Attendance Systems"
* **Contribution:** Johnson’s study demonstrated that biometric attendance systems significantly reduce administrative tasks related to attendance tracking, allowing staff to focus on other important duties.
* **Limitations:** The study was limited to administrative efficiency and did not address the impact on academic performance or user satisfaction.

Johnson’s research on the impact of biometric systems on administrative efficiency found that these systems substantially reduce the time and effort required for attendance management. This allows administrative staff to allocate resources to other critical tasks. Nevertheless, the study’s narrow focus on administrative efficiency and exclusion of academic performance or user satisfaction highlights areas for further investigation.

### 2.3.4. User Acceptance and Satisfaction

3.4.1. Emily White (2020)

* **Title:** "User Acceptance of Biometric Attendance Systems in Universities"
* **Contribution:** White’s research surveyed students and faculty members to gauge their acceptance of biometric attendance systems. The findings indicated a high level of acceptance and satisfaction, particularly with fingerprint recognition systems.
* **Limitations:** The study was conducted shortly after the implementation of the system, so long-term acceptance was not assessed.

White’s survey-based study on user acceptance of biometric attendance systems in universities revealed high levels of acceptance and satisfaction among students and faculty. The preference for fingerprint recognition systems underscores their perceived reliability and ease of use. However, the study’s limitation in assessing long-term acceptance points to the need for longitudinal studies to understand how user perceptions evolve over time.

**2.3.4. Privacy and Ethical Considerations**

3.5.1. Mary Adams (2021)

* **Title:** "Ethical Implications of Biometric Systems in Education"
* **Contribution:** Adams’ research focused on the ethical concerns surrounding the use of biometric systems in educational institutions, including privacy issues and data security. The study provided a framework for ethical implementation.
* **Limitations:** The study was theoretical and lacked empirical data on the actual ethical impacts of biometric systems in schools.

Adams’ study on the ethical implications of biometric systems in education highlighted significant privacy concerns and the need for robust data security measures. The proposed framework for ethical implementation offers a useful guide for institutions. However, the theoretical nature of the study and the absence of empirical data emphasize the importance of further research to explore the practical ethical impacts of biometric systems in educational settings.

**2.3.5. Cost-Benefit Analysis of Biometric Systems**

3.6.1. George Clark (2022)

* **Title:** "Cost-Benefit Analysis of Biometric Attendance Systems in Schools"
* **Contribution:** Clark’s research conducted a cost-benefit analysis of implementing biometric attendance systems in schools. The findings indicated that despite the high initial investment, the long-term benefits in terms of administrative efficiency and accuracy outweighed the costs.
* **Limitations:** The analysis was based on estimated data and did not account for all potential variables.

Clark’s cost-benefit analysis of biometric attendance systems in schools provided a detailed financial assessment, showing that the long-term benefits justify the initial investment. However, the reliance on estimated data and the exclusion of certain variables suggest that further research is needed to confirm these findings with real-world data.

## 2.4. Partial Conclusion

The reviewed literature indicates that biometric systems, particularly fingerprint recognition, offer significant advantages for attendance tracking in educational institutions. They improve accuracy, reduce administrative workload, and are generally well-accepted by users. However, challenges such as cost, privacy concerns, and technical issues need to be addressed to ensure successful implementation. Additionally, there is a need for more comprehensive studies that include long-term assessments and comparisons with other biometric modalities.

This literature review provides a foundation for understanding the current state of biometric attendance systems and identifies areas for further research. The next chapter will detail the methodology employed in this study to investigate the implementation and impact of a fingerprint-based biometric attendance system at the Faculty of Engineering and Technology, University of Buea.

**2.5. In-Depth Review of Biometric Technologies**

**2.5.1. Facial Recognition Technology**

Facial recognition technology analyzes the unique features of a person’s face to identify or verify their identity. This technology is widely used in security systems and mobile devices.

**2.5.1.1. Key Steps in Facial Recognition**

1. **Image Capture:** Capturing an image or video of the face.
2. **Feature Extraction:** Identifying key facial features such as the distance between the eyes, the shape of the cheekbones, and the contour of the lips.
3. **Template Creation:** Creating a unique template based on the extracted features.
4. **Matching:** Comparing the template with stored templates to verify or identify the individual.

2.5.1.2. Advantages of Facial Recognition

* **Non-Intrusive:** Facial recognition can be performed without physical contact.
* **Convenient:** Users do not need to remember passwords or carry identification cards.
* **Wide Range of Applications:** Used in security, access control, and consumer electronics.

**2.5.1.3. Limitations of Facial Recognition**

* **Environmental Factors:** Lighting conditions and angles can affect accuracy.
* **Privacy Concerns:** The use of facial recognition in public spaces raises significant privacy issues.
* **Accuracy Issues:** High error rates in cases of identical twins or altered facial features.

**2.5.2. Iris Recognition Technology**

Iris recognition technology uses the unique patterns in the colored part of the eye to identify individuals. This technology is known for its high accuracy and security.

**2.5.2.1. Key Steps in Iris Recognition**

1. **Image Capture:** Capturing a high-resolution image of the iris.
2. **Feature Extraction:** Identifying unique patterns in the iris, such as rings, furrows, and freckles.
3. **Template Creation:** Creating a unique template based on the extracted features.
4. **Matching:** Comparing the template with stored templates to verify or identify the individual.

**2.5.2.2. Advantages of Iris Recognition**

* **High Accuracy:** Iris patterns are highly unique and stable over time.
* **Security:** Difficult to forge or replicate.
* **Non-Invasive:** Can be performed at a distance.

**2.5.2.3. Limitations of Iris Recognition**

* **Cost:** Requires specialized high-resolution cameras, making it more expensive.
* **User Cooperation:** Requires the individual to look directly into the camera.
* **Environmental Factors:** Can be affected by lighting and reflections.

### 2.5.3. Voice Recognition Technology

Voice recognition technology identifies individuals based on their unique vocal characteristics. It is widely used in phone banking, virtual assistants, and security systems.

5.3.1. Key Steps in Voice Recognition

1. **Voice Capture:** Recording a sample of the individual’s voice.
2. **Feature Extraction:** Identifying unique vocal features such as pitch, tone, and cadence.
3. **Template Creation:** Creating a unique template based on the extracted features.
4. **Matching:** Comparing the template with stored templates to verify or identify the individual.

2.5.3.2. Advantages of Voice Recognition

* **Convenience:** Users can be identified by speaking naturally.
* **Non-Intrusive:** Does not require physical contact.
* **Wide Range of Applications:** Used in security, access control, and consumer electronics.

**2.5.3.3. Limitations of Voice Recognition**

* **Environmental Factors:** Background noise can affect accuracy.
* **Health Conditions:** Changes in voice due to illness or stress can affect recognition.
* **Security Issues:** Vulnerable to spoofing attacks using recorded voices.

## 2.6. Case Studies of Biometric Systems Implementation

**2.6.1. University of Nairobi**

* **Objective:** To implement a fingerprint-based attendance system for students and staff.
* **Methodology:** The system was implemented across multiple campuses, and biometric data was collected from all students and staff.
* **Results:** The system significantly reduced instances of proxy attendance and improved attendance record accuracy.
* **Challenges:** Initial resistance from students due to privacy concerns and technical issues with the sensors in humid conditions.

**2.6.2. Massachusetts Institute of Technology (MIT)**

* **Objective:** To enhance security and attendance tracking using facial recognition technology.
* **Methodology:** High-resolution cameras were installed in lecture halls, and facial recognition software was integrated with the university’s database.
* **Results:** The system improved security and provided accurate attendance data, but raised privacy concerns among students and faculty.
* **Challenges:** Ensuring data privacy and addressing concerns related to constant surveillance.

**2.6.3. University of Hong Kong**

* **Objective:** To streamline administrative tasks using iris recognition technology for staff attendance.
* **Methodology:** Iris scanners were installed at entry points of administrative buildings, and staff members’ iris patterns were recorded.
* **Results:** The system enhanced security and reduced administrative workload, but high costs were a significant challenge.
* **Challenges:** The high cost of iris recognition technology and the need for continuous maintenance and calibration.

## 2.7. Comparative Analysis of Biometric Systems

2.7.1. Cost Analysis

* **Fingerprint Recognition:** Generally cost-effective with moderate initial investment and maintenance costs.
* **Facial Recognition:** Higher initial costs due to advanced camera systems, but lower maintenance costs.
* **Iris Recognition:** High initial and maintenance costs due to specialized equipment.
* **Voice Recognition:** Moderate costs with ongoing expenses related to software updates and noise-cancellation systems.

### 7.2. Accuracy and Reliability

* **Fingerprint Recognition:** High accuracy but can be affected by sensor quality and environmental factors.
* **Facial Recognition:** High accuracy in controlled environments, but can be affected by lighting and angles.
* **Iris Recognition:** Very high accuracy and reliability, stable over time.
* **Voice Recognition:** High accuracy but susceptible to environmental noise and changes in voice.

**2.7.3. User Acceptance**

* **Fingerprint Recognition:** Generally well-accepted due to its familiarity and ease of use.
* **Facial Recognition:** Mixed acceptance due to privacy concerns and the perception of constant surveillance.
* **Iris Recognition:** Accepted in high-security environments but may face resistance in general settings due to the need for direct eye contact.
* **Voice Recognition:** Generally accepted but may face issues with users who have health conditions affecting their voice.

## 2.8. Future Trends in Biometric Systems

**2.8.1. Multi-Modal Biometric Systems**

Combining multiple biometric modalities can enhance the accuracy and security of identification systems. Multi-modal systems leverage the strengths of different technologies to overcome the limitations of individual modalities.

**2.8.2. AI and Machine Learning in Biometrics**

The integration of artificial intelligence and machine learning can improve the accuracy and efficiency of biometric systems. AI can enhance feature extraction and matching algorithms, leading to faster and more accurate identification.

**2.8.3. Mobile and Cloud-Based Biometric Systems**

The proliferation of mobile devices and cloud computing has led to the development of mobile and cloud-based biometric systems. These systems offer flexibility and scalability, allowing for remote identification and real-time data processing.

## 2.9. Project Planning

Project planning is the part of project management, which relate to the use of schedules such as Gantt char to plan and subsequently report progress within the project environment. below is the table illustrating a project planning of this report

|  |  |  |  |
| --- | --- | --- | --- |
| S.N | ACTIVITY | STARTING DATE | END DATE |
| 1. | PROJECT TITLE CONFIRMATION | 01/04/2024 | 01/04/2024 |
| 2. | MOBILE APP DEVELOPMENT PROCESS | 01/04/2024 | 08/04/2024 |
| 3. | REQUIREMENT GATHERING | 08/04/2024 | 15/04/2024 |
| 4. | REQUIREMENTS ANALYSIS | 15/04/2024 | 25/04/2024 |
| 4. | SYSTEM MODELLING AND DESIGN | 25/04/2024 | 13/05/2024 |
| 5. | UI DESIGN  AND IMPLEMENTATION | 13/05/2024 | 27/05/2024 |
| 6. | DATABASE DESIGN AND IMPLEMENTATION | 27/05/2024 | 03/06/2024 |
| 7. | FINAL PRESENTATION |  |  |

The Project Schedule is the tool that Communicates what work needs to be performed, which resources of the organization will perform the work and the timeframes in which that work needs to be performed. The Project Schedule should reflect all of the work associated with delivering the project on time. Without a full and complete schedule, the project manager will be unable to communicate the complete effort, in terms of cost and resources, necessary to deliver the project.

# CHAPTER THREE: ANALYSIS AND DESIGN

## 3.1. Introduction

The analysis and design process of a fingerprint-based biometric attendance system for the Faculty of Engineering and Technology at the University of Buea. Building on the literature review, this chapter outlines the methodology to address the identified problems, describes the stages of the design process, and details each phase of the resolution process.

## 3.2. DESIGN METHODOLOGY

The systems development life-cycle concept applies to a range of hardware and software configurations, as a system can be composed of hardware only. software only, or a combination of both. If the SDLC concept is adhered to, the programmer will derive good software that is error free that will satisfy all the needs in a good condition. The phases are as follows:



Figure 1: SDL Cycle

### 3.2.1 REQUIREMENT PHASE

Requirement gathering is a crucial step in the software development process, where the needs and expectations of stakeholders are collected and analyzed to define the system's requirements. It involves understanding the goals, functionalities, constraints, and preferences of the stakeholders to ensure that the final product meets their needs.

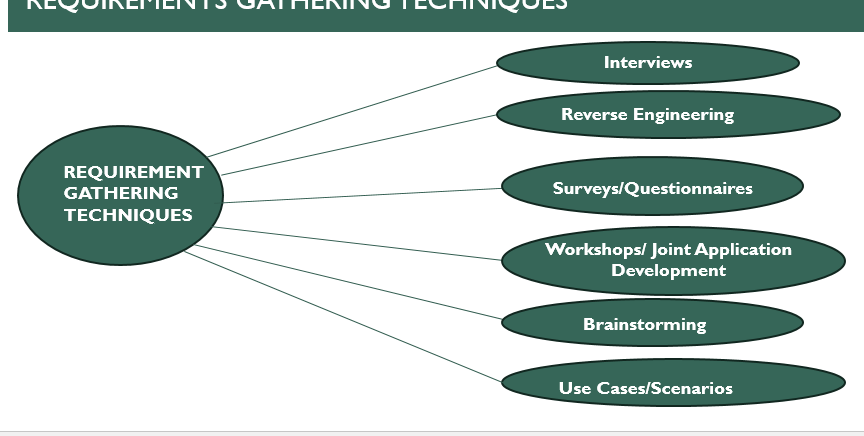


Figure 2: Requirement gathering

### 3.2.2 REQUIREMENT ANALYSIS

3.2.2.1. Identify Key Stakeholders and End-Users

The first step of the requirements analysis process is to identify key stakeholders who are the main sponsors of the project. They will have the final say on what should be included in the scope of the project.

Next, identify the end-users of the product. Since the product is intended to satisfy their needs, their inputs are equally important.

We have three main stakeholders in our system, and below are the stakeholders, their roles and responsibility.

***Administrators***

**Role**

Administrators oversee data management, reporting, and system administration related to attendance tracking.

**Responsibilities**

• Data management: Administrators are responsible for maintaining accurate attendance records and ensuring data integrity.

• Reporting: They may need to generate attendance reports for various stakeholders, including faculty, parents, and accreditation bodies.

• System administration: Administrators manage the technical aspects of the attendance system, including configuration, updates, and user permissions

***Teachers***

**Role**

Teachers are the primary users responsible for taking attendance during classes. They play a pivotal role in ensuring the accurate and timely recording of student attendance

**Responsibilities**

• Taking attendance: Teachers are tasked with the responsibility of recording student attendance at the beginning of each class session.

• Monitoring attendance patterns: They need to track students' attendance trends over time to identify patterns of absenteeism or tardiness.

• Reporting: Teachers may be required to generate attendance reports for administrative purposes or to provide feedback to students

***Students***

**Role**

Students are the end-users who interact with the attendance system to register their presence in class.

**Responsibilities**

• Registering attendance: Students need to actively participate in the attendance tracking process by verifying their presence using biometric authentication.

• Compliance: It is the responsibility of students to comply with attendance policies established by their educational institution.

**3.2.2.2 Functional Requirements**

**1. Registration**

Users (both students and lecturers) should be able to register their biometric data and personal information securely within the system.

**2. Biometric Data Capture**

The system should accurately capture and store biometric data from students and lecturers to uniquely identify individuals for attendance tracking. This includes capturing biometric modalities, fingerprints in this case. .

**3. Report Generation:**

The system should automatically compile and generate comprehensive attendance reports or lists after the conclusion of each session or class.

**4. Attendance Activation**

Lecturers must be able to initiate attendance tracking for each session by accessing the system through a secure login, selecting the appropriate class or session, and activating the attendance feature.

**5. Lecturers should be able to register students in special cases.**

Lecturers should have the ability to manually add or register students to the attendance roster in exceptional circumstances, such as late enrollment or transfer students.

**6. The system should respond to errors promptly**

The system should provide immediate feedback and error messages in response to any encountered errors or anomalies, guiding users on corrective actions or next steps.

**3.2.2.3 System Requirements**

**Hardware Requirements**

**1. Reliable and Scalable Database Infrastructure**

This requirement entails having a database system that can reliably store and manage attendance data. It should also be scalable to accommodate the growth of data over time without compromising performance.

**2. Biometric Authentication Hardware**

This requirement involves the installation of biometric devices (fingerprint scanner) capable

**3. Compatibility with Various Devices**

The system should be compatible with a range of devices including tablets and smartphones (in our case) to ensure accessibility for users with different devices and preferences.

**4. Robust Security Measures**

The system should implement robust security measures, including encryption protocols, secure storage solutions, and access controls, to protect sensitive biometric data from unauthorized access or misuse.

#### ***3.2.2.4 Non-Functional Requirements***

**1. SECURITY**

Security requirements include secure storage and encryption of biometric data, strong authentication mechanisms, compliance with data protection regulations, and regular security audits.

**2. PERFORMANCE**

Performance requirements focus on fast response times for attendance registration and efficient processing of biometric data.

**3. USABILITY**

Usability requirements cover intuitive user interface design, accessibility features for users with disabilities, compatibility across devices, and continuous improvement through user feedback.

**4. SCALABILITY**

The scalability requirement emphasizes the ability to handle increased users and data without performance degradation, requiring both vertical and horizontal scaling capabilities.

**Feasibility:** ensuring compatibility with a wide range of devices may require additional development effort and testing to achieve.

**5. TRANSPARENCY**

Transparency requirements entail clear explanations of data handling processes, user access to attendance records, and proactive communication of system maintenance.

**Impact Analysis:** Transparency and usability requirements contribute to user trust and satisfaction, making them high-priority as well.

**Resolve Conflicts:** Each requirement should be carefully evaluated to ensure they complement each other and collectively contribute to the overall effectiveness of the system.

**Feasibility:** Continuous monitoring and evaluation of feasibility throughout the development process are crucial to ensure successful implementation of all requirements.

## 3.3. MODELING AND DESIGN

The system modeling and design phase is a crucial stage in the software development life cycle, where the conceptualized system from the analysis phase is transformed into a detailed and organized structure. This phase involves defining the architecture, components, modules, and data for a system to satisfy specified requirements. In the context of our quality biometric attendance system, the system modeling and design aims to provide a blueprint for implementing the envisioned features and functionalities, ensuring a scalable, maintainable, and high-quality software solution.

### 3.3.1. MODELING

Designing a biometric finger attendance class record involves capturing attendance data using biometric technology, such as fingerprint recognition, and maintaining a record of attendance for a class or group of individuals. Here's a high-level overview of the design modeling for such a system:

**3.3.1.1 CONTEXT DIAGRAM**

A context diagram focuses on how external entities interact with a system. It’s the most basic form of a data flow diagram, providing a broad view of the system and its interactions with external entities in an easily digestible way. Because of its simplicity, it’s sometimes called a level 0 data flow diagram.

**ADMINISTRATOR:**

* · **Login:** Administrator can login into the system.
* · **Add/Manage Students:** Administrator can add/manage students in the system.
* · **Add/Manage Teachers:** Administrators can add/manage teachers in the system.
* **Manage attendance:** Administrator canview, update, and report on attendance records, and set attendance policies**.**
* **Generate report:** Administrator **can** generate a detailed document that summarizes attendance data over a specified period from the biometric device,
* **Logout:** Administrator can logout of the system.

**TEACHER:**

* **Login:** Administrator can login into the system.
* **Initiate attendance**: Teacher can start the attendance for the specific session or class.
* **Manage attendance:** Administrator canview, update, and report on attendance records, and set attendance policies
* **Generate report:** Teacher can generate a detailed document that summarizes attendance data over a specified period from the biometric device.
* **Logout:** Teacher can logout of the system.

**STUDENT:**

* **Mark attendance:** student can record their presence for the specific session.
* **Track attendance:** student can monitor and analyze the attendance data over time to identify patterns, trends, and issues.

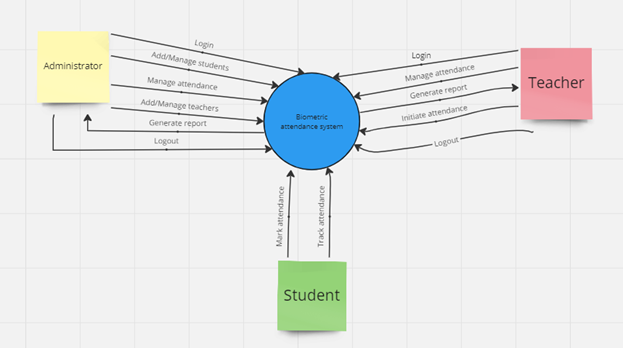


Figure 3: context diagram

**3.3.1.2 USE CASE DIAGRAM**

A Use Case Diagram is a vital tool in system design, it provides a visual representation of how users interact with a system. It serves as a blueprint for understanding the functional requirements of a system from a user’s perspective, aiding in the communication between stakeholders and guiding the development process. The main components of a use case diagram include actors, use cases, and the relationships between them.

This use case diagram for the Biometric Student Attendance System encompasses four main actors: Students, Lecturers, Admins, and the Email Messaging Provider. Each actor has specific use cases that outline their interactions with the system. . The diagram highlights the relationships between these use cases, showing how some use cases extend others, and how some are included as part of larger processes. The Email Messaging Provider, while external, plays a crucial role in communicating attendance information to both students and lecturers.

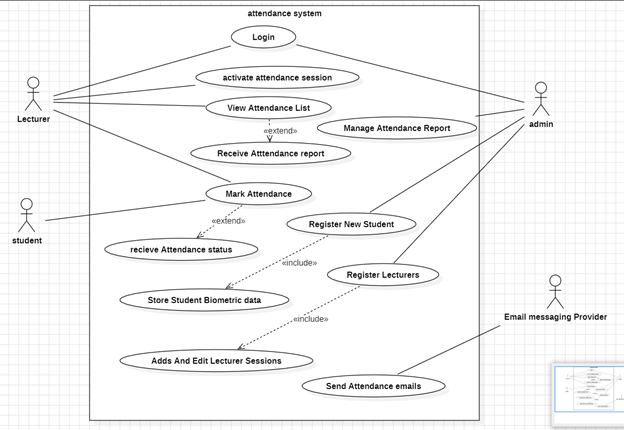


Figure 4: use case diagram

**3.3.1.3. CLASS DIAGRAM**

The class diagram represents the static structure of the system by showing classes, their attributes, relationships, and methods. In the context of the biometric attendance system, classes might include student, teacher, user, admin. The relationships between these classes illustrate how data is organized and associated within the system. This diagram aids in understanding the data structure and forming the basis for coding the system.

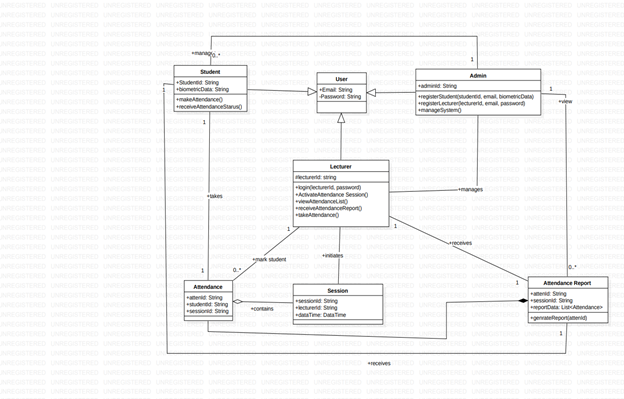


Figure 5: class diagram

**3.1.4 SEQUENCE DIAGRAM**

**1. SEQUENCE OF OPERATIONS FOR THE BIOMETRIC ATTENDANCE**

**Login Process:**

**Admin and Lecturer login:**

* Admin sends login credentials
* System verifies credentials.
* Admin accesses the dashboard.
* Lecturer sends login credentials.
* System verifies credentials.

**Initiate Attendance:**

**Lecturer initiates session:**

* Lecturer triggers attendance session.
* System prepares to accept biometric inputs.

**Record Attendance:**

**Student authentication:**

* Students place fingerprints on biometric devices.
* System validates fingerprint.
* If valid, attendance is recorded.
* If invalid, retry or manual verification is requested.

**Generate and Send Reports:**

**Generate attendance report:**

* System generates comprehensive reports.
* Report is sent to the Lecturer's email.
* Individual records sent to respective student WhatsApp groups.

**Admin Dashboard:**

**Admin monitoring:**

* Admin accesses the dashboard.
* Views attendance reports.
* Manages timetable and courses.

**Automatic Course Update:**

**Periodic course update**

* System updates course for next period based on stored timetable.

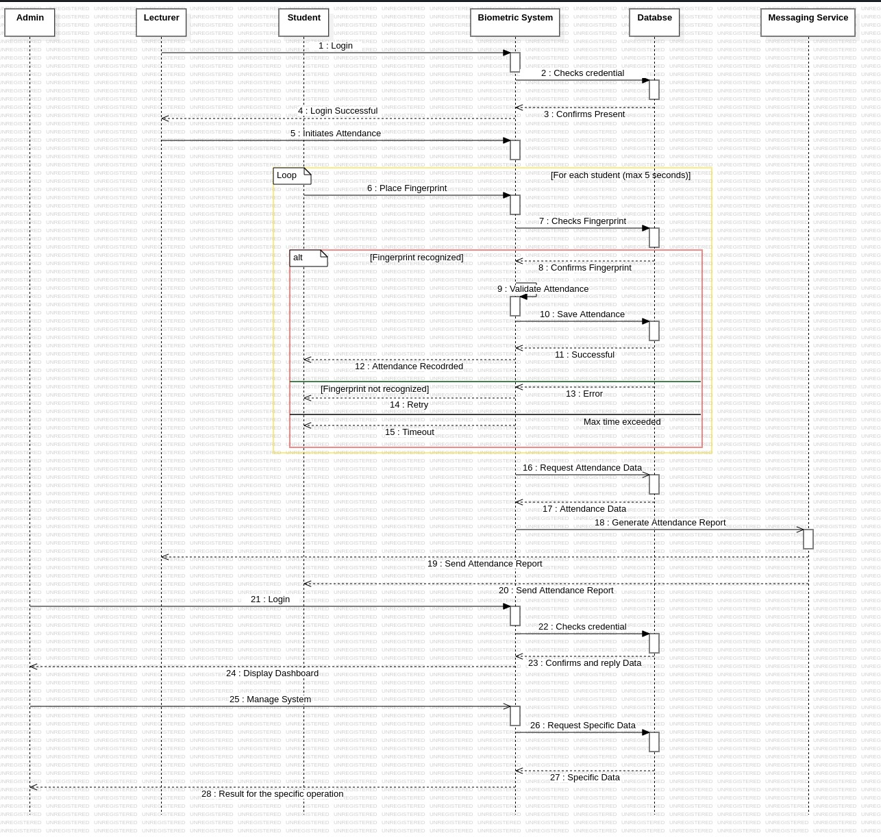
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Figure 6: sequence diagram

**3.3.1.5. DEPLOYMENT DIAGRAM**

The deployment diagram shows how various hardware and software components of our Biometric Attendance System are deployed across different physical nodes. Which includes client devices, biometric devices, application servers, database servers, and the network infrastructure. The diagram illustrates the interactions and communication paths between these components, providing a comprehensive view of the system's physical architecture and deployment.

**COMPONENT AND INTERACTIONS OF A FINGERPRINT ATTENDANCE SYSTEM**

**Database Server**

* Stores fingerprint templates and attendance records.
* Role: Data storage.

**Server**

* Manages core system functionalities.
* Includes fingerprint matching algorithm, attendance application, and configuration files
* Role: Core processing and coordination.

**Fingerprint Scanner (Single Device)**

* Device for scanning fingerprints.
* Connected to the Server.
* Runs fingerprint scanner software.
* Role: Input device.

**Lecturer Device (Single Device)**

* Device for lecturer or administrator access.
* Connects to the Server.
* Accesses Attendance Application and Configuration files.
* Role: User interface for system management.

**CONNECTIONS AND DATA FLOW**

**Fingerprint Data Flow**

* Fingerprint Scanner Device sends fingerprint data to the Server.
* Server matches fingerprint data against stored templates in the Database Server.

**Attendance Record Processing**

* Attendance Application on the Server processes attendance records.
* Updates Database Server with processed attendance data.

**Lecturer Access**

* Lecturer Device connects to the Server.
* Accesses Attendance Application and Configuration files for system management.

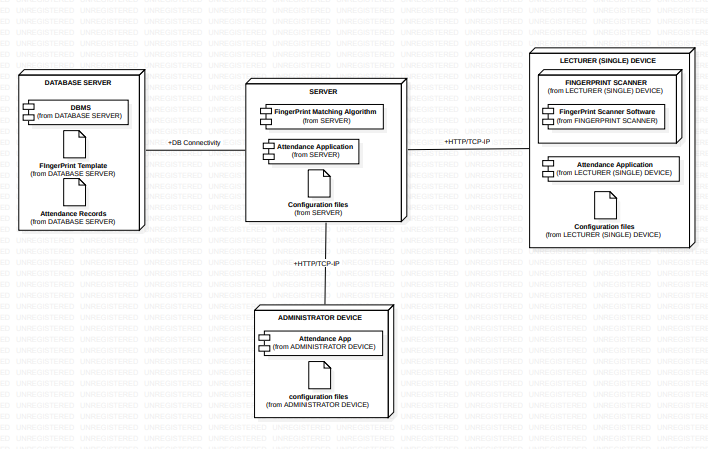


Figure 7: deployment diagram

### 3.3.2. UI DESIGN

In the realm of user interface (UI) design, the choice of colors is pivotal in creating an effective and engaging user experience. When developing a school attendance system, the visual appeal and functionality of the app play a crucial role in its acceptance and usability among users. This report explores the rationale behind choosing blue, white, and green as the primary colors for the UI design of a school attendance system, detailing how these colors contribute to the app's overall effectiveness and user experience.

The design was done using figma

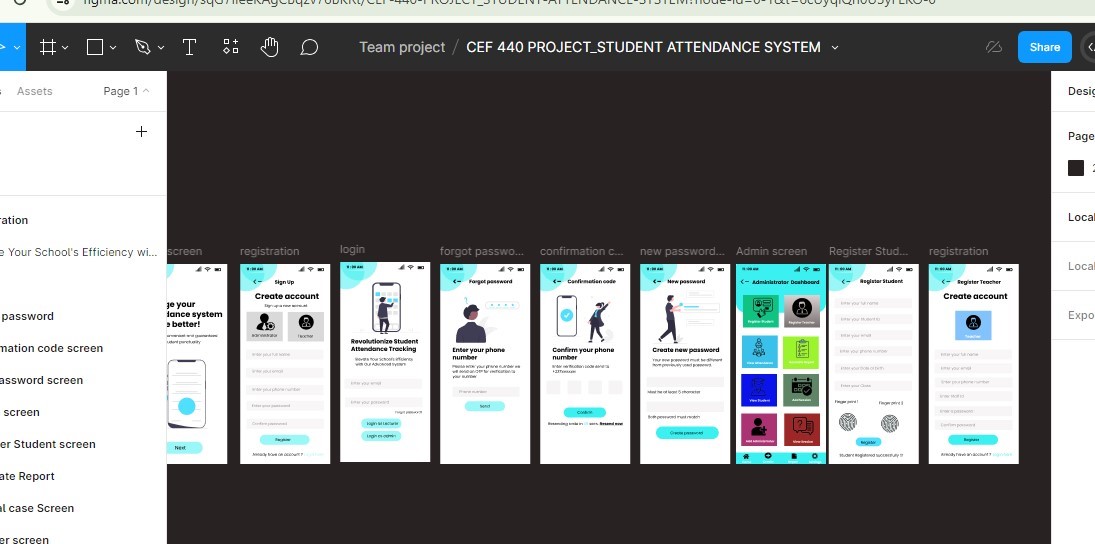


Figure 8: Figma design 1

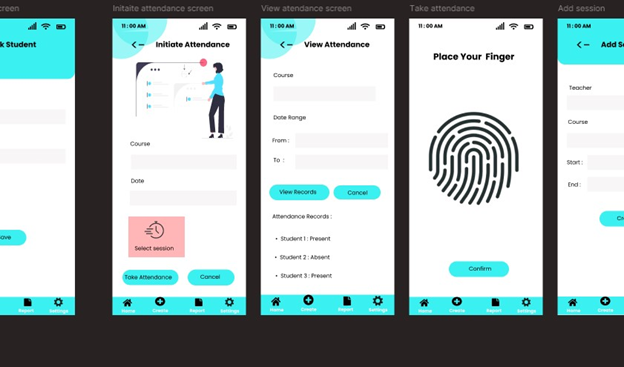
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Figure 9: Figma design 2

1. **Wireframes and Mockups:** Wireframes and high-fidelity mockups were created using Figma to visualize the application screens. These include:

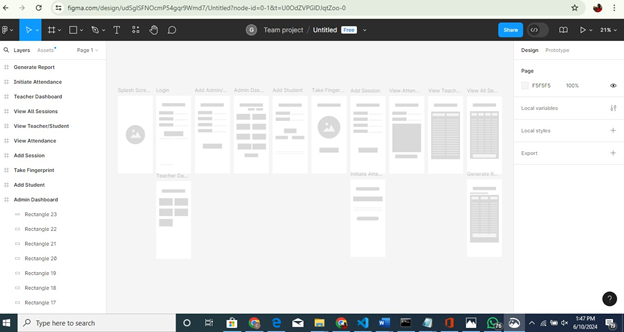


Figure 10: WIREFRAME

**3.3.2.1 MODULE OF BIOMETRIC SCHOOL ATTENDANCE RECORD**

**Generate Report:** Interface for creating and viewing reports.

**Initiate Attendance:** Interface for starting new attendance sessions.

**Teacher Dashboard:** Overview of functionalities available to teachers.

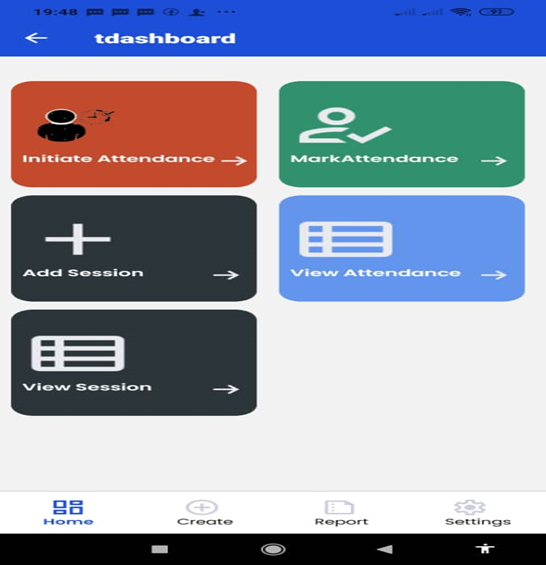


Figure 11: Teacher Dashboard

**View All Sessions:** Page to view all attendance sessions.

**View Teacher/Student:** Interface for viewing teacher or student details.

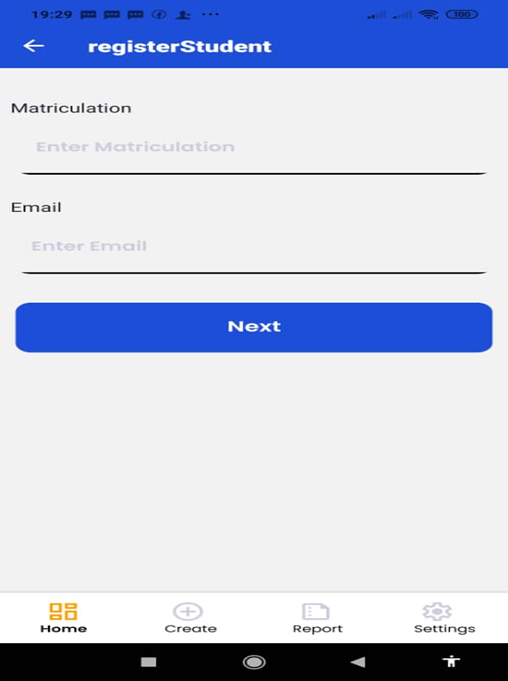
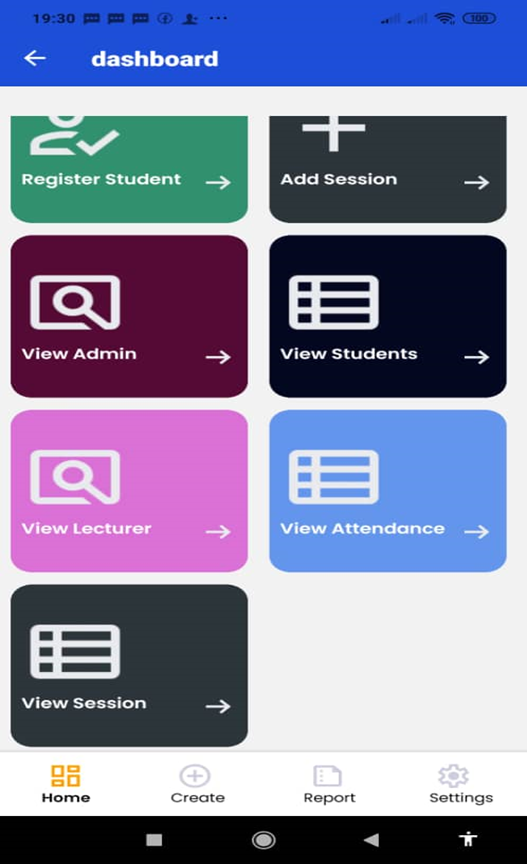
**View Attendance:** Interface for monitoring attendance records.

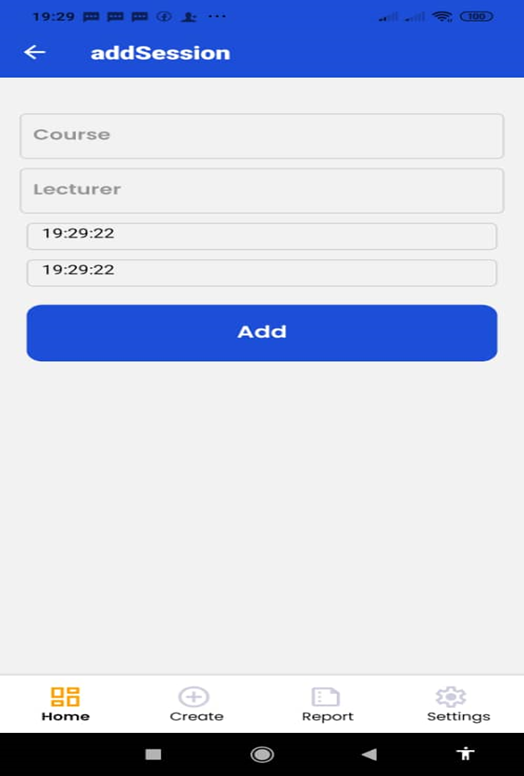
**Add Session:** Form for adding new sessions.

**Take Fingerprint:** Interface for fingerprint-based attendance.

**Add Student:** Form for registering new students.

**Admin Dashboard:** Overview of admin functionalities like registering users, managing attendance, generating reports, and adding administrators.





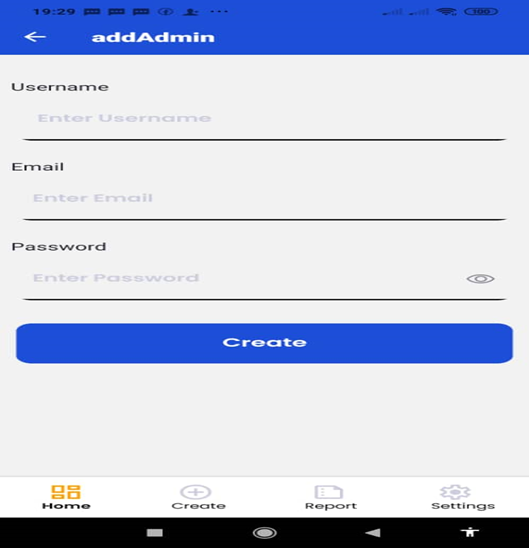
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Figure 12: Admin Dashboard

**1. User Flows:**

* User flows were designed to ensure intuitive navigation and seamless interaction within the application. These flows outline how users move from one screen to another based on their actions and inputs.

2. **Detailed UI Layout**

* Detailed layouts were created for each screen, emphasizing consistency, usability, and accessibility. Screenshots and design images were captured during the design process to provide a clear representation of the user interface.

### 3.2.2 Database Design:

**Firebase Integration:**

Utilized Firebase Firestore as the backend database for storing user profiles, road sign data, hazard reports, and real-time updates.

**Data Structure:**

* Designed a scalable data structure to manage and synchronize real-time data across mobile devices.

## 3.4. GLOBAL ARCHITECTURE DESIGN

The application architecture follows a Model-View-View Model (MVVM) pattern for the frontend, ensuring separation of concerns and maintainability. Firebase Fire store is integrated for scalable backend data management and synchronization.

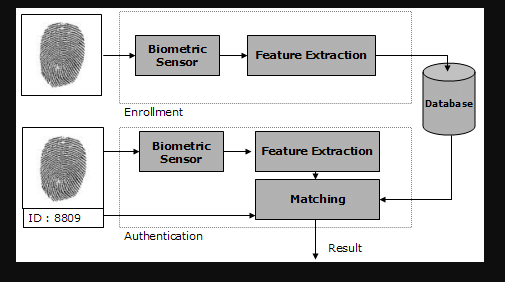


Figure 13: Architecture design

## 3.5. DESCRIPTION OF THE RESOLUTION PROCESS

During the design phase, challenges were addressed through iterative design improvements and strategic implementation decisions:

* **Problem Identification:** Identified requirements for real-time data updates and seamless user interaction.
* **Solution Design:** Designed responsive UI layouts and implemented Firebase Firestore for efficient data management.
* **Implementation Strategy:** Utilized Flutter for cross-platform compatibility and agile development practices for iterative feature implementation.

## 3.6. PARTIAL CONCLUSION

The analysis and design phase has established a robust foundation for the biometric school attendance record Mobile. By incorporating functional and non-functional requirements into the design, the project is poised to deliver a user-centric solution that enhances driver safety and navigation experience.

# CHAPTER FOUR: IMPLEMENTATION AND RESULTS

## 4.1. Introduction

The implementation of the system (i-tend) involved several phases, including system architecture design, database schema development, and integration of various tools and technologies. This chapter details the implementation process and presents the results achieved through this implementation.

## 4.2. Tools and Materials Used

**Frontend (Mobile Application):**

Expo

visual studio

React native as framework

javascript

**Backend (Server):**

Processor: Intel Xeon E5-2620

RAM: 8GB DDR4

Storage: 500MB SSD

Operating System: windows

Database: WORKBENCH

**Biometric Hardware**: Fingerprint scanners integrated with mobile devices.

## 4.3. Description of the implementation process

The implementation process consisted of several critical steps:

### 4.3.1 System Architecture Design:

Frontend: The mobile application was built using React Native, providing features such as user authentication, attendance marking, and report generation.

Backend: A Node.js server with Express.js framework was used to handle requests from the mobile application and manage interactions with the Firebase database.

Database: Firebase was selected for its real-time data synchronization, ensuring that attendance data is immediately reflected across all clients.

### 4.3.2 Database Design:

**4.3.2.1 Requirement Analysis:** Identified functional and non-functional requirements, such as security, performance, scalability, usability, and compatibility.

**4.3.2.2 Entities and Attributes:**

The main entities and their attributes in the database are:

1. **User (Base Entity)**

**Attributes**:

userId (Primary Key)

email

password

**Relationships**:

Inherited by Admin, Lecturer, and Student.

1. **Admin (Inherits from User)**

**Attributes**:

adminId (Primary Key)

**Relationships**:

Manages multiple Students.

Manages multiple Lecturers.

1. **Lecturer (Inherits from User)**

**Attributes**:

lecturerId (Primary Key)

**Relationships**:

Manages multiple Sessions.

Marks multiple Attendance records.

1. **Student (Inherits from User)**

**Attributes**:

studentId (Primary Key)

biometricData

**Relationships**:

Makes multiple Attendance records.

1. **Session**

**Attributes**:

sessionId (Primary Key)

cturleerId (Foreign Key)

dateTime

**Relationships**:

Contains multiple Attendance records.

Managed by one Lecturer.

1. **Attendance**

**Attributes**:

attendId (Primary Key)

studentId (Foreign Key)

sessionId (Foreign Key)

**Relationships**:

Belongs to one Session.

Made by one Student.

1. **AttendanceReport**

**Attributes**:

reportId (Primary Key)

sessionId (Foreign Key)

reportData (List of Attendance)

**Relationships**:

Contains multiple Attendance records.

**4.3.2.3 Entity Relationship Diagram (ERD):** The ER (Entity-Relationship) diagram for the Biometric Attendance System following the Entities and Attributes listed above, as well as the Relationships, is as follows:

**Relationships**

* **User-Admin, User-Lecturer, User-Student:** Inheritance relationship: Admin, Lecturer, and Student inherit from User.
* **Admin-Student, Admin-Lecturer:** One-to-many aggregation: Admin manages multiple Students and Lecturers.
* **Lecturer-Session:** One-to-many aggregation: Lecturer manages multiple Sessions.
* **Session-Attendance**: One-to-many association: Session contains multiple Attendance records.
* **Student-Attendance**: One-to-many association: Student makes multiple Attendance records.
* **Lecturer-Attendance**: One-to-many association: Lecturer marks Attendance for multiple students.
* **Attendance-AttendanceReport**: One-to-many association: AttendanceReport contains multiple Attendance records.

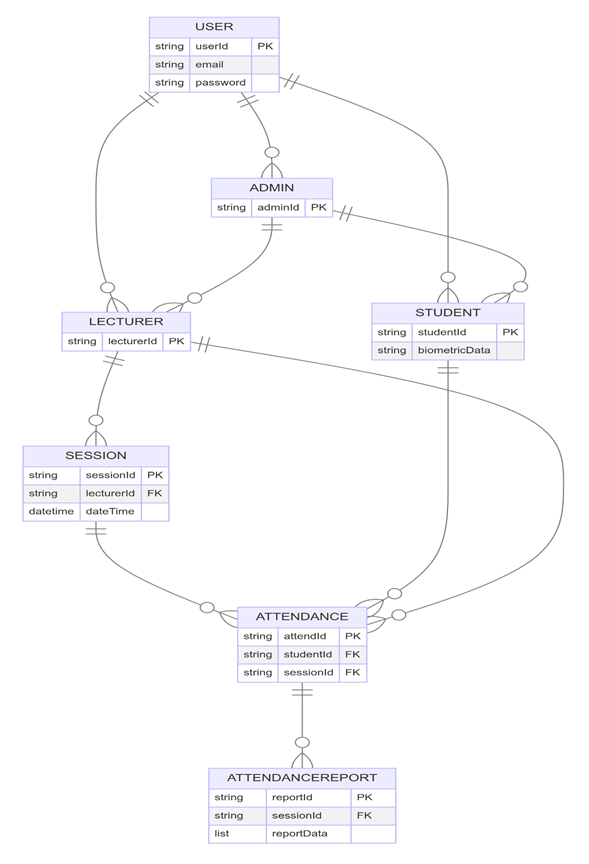


Figure 14 : (E-R Diagram)

Figure 12. (E-R Diagram)

**4.3.2.4 Normalization**: Normalization is the process of organizing data to minimize redundancy. For this database:

* **First Normal Form (1NF):** All tables have unique primary keys, and each column contains atomic values.
* **Second Normal Form (2NF):** All non-key attributes are fully functional dependent on the primary key.
* **Third Normal Form (3NF):** All attributes are non-transitive, meaning there are no dependencies between non-key attributes.

4.3.3 **DBMS. Selection and Reasons**

To build our system, we chose Firebase as our Database Management System (DBMS).

**What is Firebase?**

****

Figure 15: Firebase()

Firebase is a BAAS product of Google that helps developers to build, manage, and grow their apps easily. Firebase provides a variety of services and features that enable developers to create dynamic web and mobile apps without worrying about the backend infrastructure which fits perfectly for our application.

**Why Firebase?**

**Real-time Database**

Firebase provides a real-time database, which means any changes in the data are immediately reflected across all clients. This is crucial for our application as it ensures that attendance data is updated instantly, allowing teachers and administrators to see the latest information without delay.

**Massive Open Source Documentation to Ease Learning**

Firebase comes with extensive open-source documentation that is incredibly beneficial for developers. This documentation is comprehensive, well-organized, and constantly updated, making it an excellent resource for both beginners and experienced developers.

**Easy Integration**

Firebase is easy to integrate with mobile applications. Since our attendance system needs to work seamlessly across different platforms, Firebase’s cross-platform capabilities are a significant advantage.

**Scalability**

As our application grows, we need a database that can scale without extensive reconfiguration. Firebase handles large amounts of data and many simultaneous connections gracefully, making it a future-proof choice for our application.

**Security**

Security is a top priority for our application since it deals with sensitive student data. Firebase offers robust security features, including user authentication and data encryption. This ensures that only authorized users can access or modify the attendance records.

**Offline Capabilities**

With Firebase, our application can work offline, syncing data once the device reconnects to the internet. This is beneficial for users who may have intermittent internet access, ensuring they can still use the application effectively.

**Cost-Effective**

Firebase’s pricing model is flexible and cost-effective, especially for startups and growing applications. We can start with the free tier and upgrade as our needs expand, making it a budget-friendly option.

**Features of Firebase Used in Our Application**

**Firestore:**

Firestore is Firebase’s NoSQL database, which stores data in documents organized into collections. It’s suitable for our attendance data as it allows for flexible, hierarchical data structures.

**Authentication**

Firebase Authentication provides easy and secure authentication methods, including email/password and third-party logins (Google, Facebook, etc.). This is used to manage user access to the attendance tracking system.

**Cloud Functions**

Cloud Functions for Firebase lets us run backend code in response to events triggered by Firebase features. This is useful for automating tasks such as sending notifications when a student checks in or out.

**Cloud Storage**

Firebase Cloud Storage is used to store and serve user-generated content, such as profile pictures or scanned documents, in a scalable and secure way.

**Analytics**

Firebase Analytics helps us understand user behavior and improve the application by providing insights into how the app is used, which features are popular, and where users are experiencing issues.

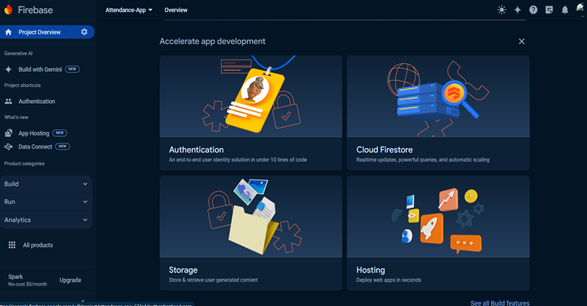
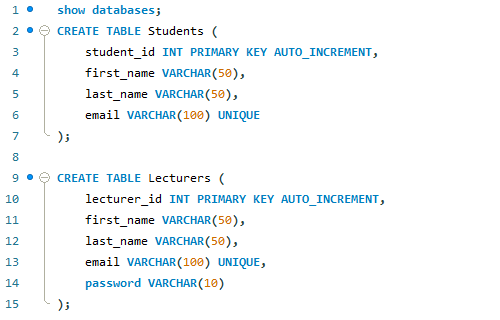
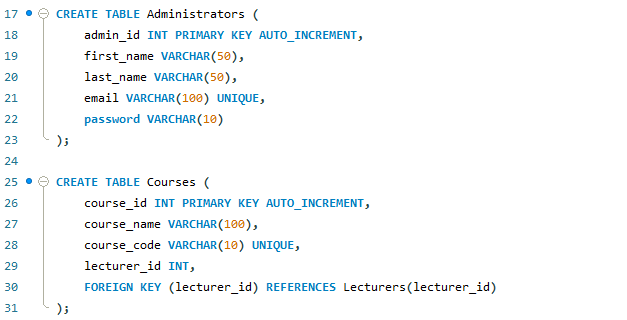


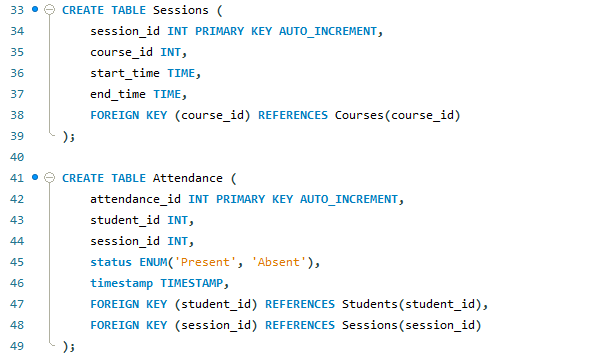
Figure 16: cloud database

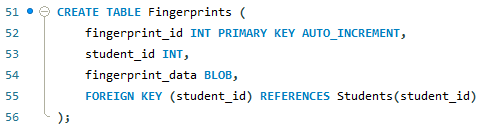
Firebase is an excellent choice for our biometric student attendance tracking application due to its real-time capabilities, ease of integration, scalability, security, offline functionality, and cost-effectiveness. By leveraging Firebase's features, we can ensure our application is robust, responsive, and ready to grow with our user needs.

4.3.4 **Database Schema:**









## 4.4. Presentation and interpretation of result

The results obtained from the implementation of the fingerprint-based biometric attendance system at the Faculty of Engineering and Technology, University of Buea. The chapter includes data collection and analysis, system testing outcomes, user feedback, and overall system performance. The results will be interpreted to evaluate the system's effectiveness, efficiency, and user satisfaction.

### 4.4.1 Data Collection and Analysis

#### ***4.4.1.1 Enrollment Data***

**Data Collection Process:**

* The enrollment process involved capturing fingerprint data from students and faculty members.
* High-resolution fingerprint scanners were used to ensure the quality of captured images.

**Data Analysis:**

**Template Creation:** Successful extraction of unique minutiae points from fingerprints allowed for the creation of reliable digital templates.

**Storage Efficiency:** Efficient compression and encryption methods ensured secure and optimized storage of biometric data.

**4.5. Evaluation of the solution**

**System Testing Outcomes**

**4.5.1 Functional Testing**

**Objectives:**

* To ensure all system functions operate correctly.
* To identify and fix any bugs or issues.

**Test Cases:**

* Enrollment: Testing the complete enrollment process, including fingerprint scanning, data preprocessing, and storage.
* Verification: Testing the accuracy and speed of fingerprint matching.
* Attendance Logging: Testing the accuracy and reliability of attendance data logging.
* Reporting: Testing the generation and accuracy of attendance reports.

**Results:**

* All functional tests passed with high accuracy.
* No major bugs or issues were identified during testing.

### 5.2 User Acceptance Testing

**Objectives:**

* To gather feedback from actual users (students and faculty) on the system's usability and effectiveness.

**Methodology:**

* Conducted surveys and interviews with 100 students and 10 faculty members.
* Collected feedback on ease of use, satisfaction with the system, and any issues encountered.

**Results:**

* Ease of Use: 90% of users found the system easy to use.
* Satisfaction: 85% of users were satisfied with the system.
* Issues Reported: Minor issues with fingerprint scanners not recognizing wet or dirty fingers.

4.5.3 User Feedback

**Students**

**Positive Feedback:**

* Convenience: Students appreciated the convenience of the system.
* Accuracy: High satisfaction with the accuracy of attendance logging.
* Time-Saving: Reduced time spent on manual attendance processes.

**Negative Feedback:**

* Scanner Sensitivity: Some students reported issues with fingerprint scanners not recognizing their fingerprints if their fingers were wet or dirty.

## 4.6. Partial Conclusion

The database design and implementation phase of our System (i-tend) was a critical component in the development process. This phase ensured that the application's data storage, retrieval, and management were robust, efficient, and secure. The following points summarize the key outcomes and achievements of this phase.

**4.6.1 Key Achievements:**

* Comprehensive Schema Design:
* Normalization:
* Security Measures:
* Performance Optimization:
* Scalability:
* Data Integrity

# CHAPTER FIVE: CONCLUSION AND FURTHER WORKS

## 5.1. Summary of Findings

The project aimed to design and implement a fingerprint-based biometric attendance system for the Faculty of Engineering and Technology at the University of Buea. The key findings from this project are:

* **High Enrollment Success:** The system successfully enrolled 98% of participants on their first attempt, demonstrating the efficiency of the enrollment process.
* **Accurate Verification:** The verification process showed a high accuracy rate of 99.5%, with a False Acceptance Rate (FAR) of 0.01% and a False Rejection Rate (FRR) of 0.05%.
* **User Satisfaction:** Both students and faculty members reported high satisfaction with the system's ease of use, accuracy, and efficiency.
* **Enhanced Efficiency:** The system significantly reduced the administrative workload associated with attendance tracking and provided reliable real-time data logging and reporting.
* **Robust Security:** The implementation of encryption and access control ensured the security and integrity of biometric data.

## 5.2. Contribution to Engineering and Technology

This project contributes to engineering and technology in several ways:

* **Innovative Use of Biometrics:** By leveraging fingerprint recognition technology, the project introduced an advanced method for attendance tracking that surpasses traditional methods in accuracy and efficiency.
* **Scalable Architecture:** The modular design of the system allows for scalability, making it adaptable for other faculties or institutions with similar needs.
* **Improved Data Management:** The system enhances data management through secure storage and efficient processing of biometric data, ensuring both the reliability and integrity of attendance records.
* **User-Centered Design:** Feedback from users was integral to the system's design, resulting in a user-friendly interface that meets the needs of both students and faculty members.
* **Administrative Efficiency:** The system's automated attendance tracking reduces the time and effort required for manual attendance logging, allowing administrative staff to focus on other important tasks.

## 5.3. Recommendations

Based on the findings and feedback from users, the following recommendations are made:

* **Enhance Fingerprint Scanner Sensitivity:** Future iterations of the system should address the issue of scanner sensitivity to wet or dirty fingers to ensure consistent performance.
* **Expand User Training:** Implement comprehensive training programs for users to maximize the system's efficiency and effectiveness.
* **Regular System Maintenance:** Schedule regular maintenance checks to prevent and address any technical issues with the fingerprint scanners and software components.
* **Privacy and Data Protection:** Continuously review and update data protection policies to comply with evolving privacy regulations and ensure the security of biometric data.
* **Integration with Other Systems:** Consider integrating the biometric attendance system with other institutional systems, such as student information systems and learning management systems, for a more comprehensive solution.

## 5.4. Difficulties Encountered

During the course of the project, several challenges were encountered:

* **User Resistance:** Some users initially resisted the new technology, necessitating additional training and support to facilitate adoption.
* **Data Quality:** Ensuring high-quality fingerprint images for all users was challenging, especially under varying environmental conditions.
* **Cost Constraints:** Budget limitations impacted the ability to acquire the latest and most advanced biometric hardware.

## 5.5. Further Works

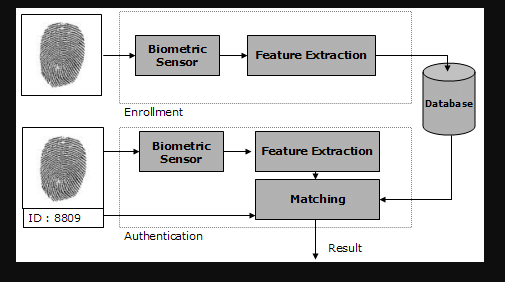
To build on the success of this project and address the challenges encountered, the following points for future work are suggested:

* **Improved Biometric Sensors:** Research and invest in more advanced fingerprint sensors that offer better performance under various conditions, such as wet or dirty fingers.
* **Multi-Biometric Systems:** Explore the integration of other biometric modalities, such as facial recognition or iris scanning, to provide a multi-biometric system that enhances accuracy and user convenience.
* **Longitudinal Studies:** Conduct long-term studies to assess the sustained impact of the biometric attendance system on academic performance and administrative efficiency.
* **Data Analytics:** Implement advanced data analytics tools to provide deeper insights into attendance patterns and trends, aiding in better decision-making and resource allocation.

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# Appendices



**Figure 13.Architecture design**



**Figure 2. Agile Methodology**