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DESIGN AND IMPLEMENTATION OF A MOBILE FINGERPRINT ATTENDANCE SYSTEM FOR STUDENT AND LECTURERS

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ABSTRACT

This study addresses the inefficiencies of traditional attendance tracking methods in educational institutions by developing a mobile fingerprint-based attendance system. Built with Android Studio, Java, and Firebase, the system automates attendance verification during examinations, providing improved accuracy and security. Students register their fingerprints, which are securely stored, and use the mobile app to authenticate their attendance in real-time. This reduces administrative workload, minimizes errors, and enhances overall efficiency. The system's object-oriented design ensures scalability and maintainability, offering a comprehensive solution to streamline attendance tracking at the University of Benin.

Keywords: Attendance, Fingerprint, Mobile, Scalability, Accuracy

INTRODUCTION

Biometric authentication systems have become increasingly important in modern technology, with fingerprint recognition emerging as one of the most reliable and secure methods for various applications, including attendance management Lee et al (2021). The use of fingerprints for identification dates back to the 1800s, when a French policeman and biometric researcher, Alphonso Bertillon (1893), developed a technique to identify criminals using their biological characteristics. Over the years, fingerprint technology has evolved from criminal identification to everyday uses such as signatures and smartphone authentication. Given the growing demand for secure and reliable systems in educational institutions, fingerprint recognition offers a promising solution for managing student and lecturer attendance Jain et al (2004). This project focuses on developing a mobile fingerprint-based attendance system designed to streamline the process and ensure accuracy and security.

Traditional attendance methods, such as paper-based rosters and seating plans, often lead to errors and are vulnerable to forgery Kumar et al (2014). As the student population increases, it becomes more challenging to manage attendance efficiently using these manual methods. For example, students may sign in for their absent peers, compromising the integrity of attendance records. A fingerprint Authentication system addresses these issues by providing an accurate and tamper-proof method for tracking attendance. This system ensures that each student's presence is verified through their unique biometric data, thereby preventing manipulation of records.

The main goal of this paper is to develop a user-friendly mobile attendance system that leverages fingerprint recognition technology. The objectives include designing the system based on user requirements, implementing the application, and conducting thorough testing to ensure its reliability. The system is developed using Android Studio for the mobile interface, Java for application logic, and Firebase for backend services. These technologies work together to create a seamless and efficient process for managing attendance in educational settings.

The development of this fingerprint attendance system follows a systematic methodology. First, requirement gathering is conducted to understand the needs of stakeholders, such as students, lecturers, and administrators. Afterward, the system architecture is designed with scalability, security, and performance in mind. The implementation phase focuses on developing the mobile application, integrating fingerprint scanning features, and ensuring that the system meets all functional requirements. Once the system is implemented, rigorous testing is performed to validate the accuracy and efficiency of the application. Finally, the system is deployed, and documentation is prepared to guide users in operating the application.

The significance of this research lies in its ability to replace manual attendance methods with a modern, automated solution. By using biometric fingerprint technology, this system eliminates the risk of data loss, improves accuracy, and significantly reduces administrative workload. Moreover, the system offers enhanced security, as the fingerprint data cannot be easily forged or manipulated. This project aims to provide a comprehensive and reliable solution for educational institutions, streamlining attendance management and ensuring the integrity of attendance records.

Related Works

Biometric authentication, particularly fingerprint recognition, offers a reliable solution for managing attendance. This chapter reviews the system's overview and explores different types of fingerprint patterns. Fingerprint recognition is widely recognized as the most effective biometric identification method due to its accuracy and ease of use. The system operates in two steps: enrollment and authentication. During enrollment, users register their fingerprints, which are stored in a secure database. During authentication, the system verifies the user's fingerprint against the stored data, logging their attendance in real-time.

Fingerprint patterns are categorized into three main types: the arch, the whorl, and the loop. The arch, the rarest pattern, lacks cores and deltas. The whorl, found in 25-35% of the population, has two deltas and is sub-divided into plain and central pocket whorls. The loop is the most common fingerprint pattern, seen in about 70% of the population, with sub-categories like ulnar, radial, and central pocket loops.

Research on biometric attendance systems, particularly those using fingerprint recognition, has been conducted extensively over the years, with different approaches and improvements. Aldonso et al. (2023) explored fingerprint recognition systems using standalone fingerprint readers. Their system, while accurate, faced challenges related to high hardware

costs and deployment complexities. The reliance on dedicated fingerprint hardware made it less accessible for widespread use, particularly in educational institutions.

Md. Shakil et al. (2013) developed a system focusing on industrial workers' attendance, using fingerprint scanners for identification. While effective in industrial settings, their solution required additional hardware, raising concerns about cost and scalability. In contrast, the approach in this project focuses on leveraging fingerprint sensors already integrated into mobile devices, thereby reducing these additional costs.

Sifatnur Rahman (2018) implemented a biometric attendance system aimed at staff management. His project demonstrated how automating attendance with fingerprint recognition could improve efficiency and reduce errors in organizations. However, it primarily focused on managing staff attendance rather than students.

Zakiah Lamin et al. (2021) and Shoewu et al. (2020) researched advanced biometric systems, including real-time computer vision algorithms for facial recognition and embedded smart systems for attendance management. While these systems enhanced security, they presented challenges in terms of accuracy and installation costs, making fingerprint recognition a simpler and more practical choice.

In another study, Mabayoje et al. (2022) developed a university attendance system using fingerprint and SMS technologies. Their approach included real-time updates and notifications but still relied on standalone devices, highlighting the need for a more integrated and mobile-friendly solution like the one proposed in this project.

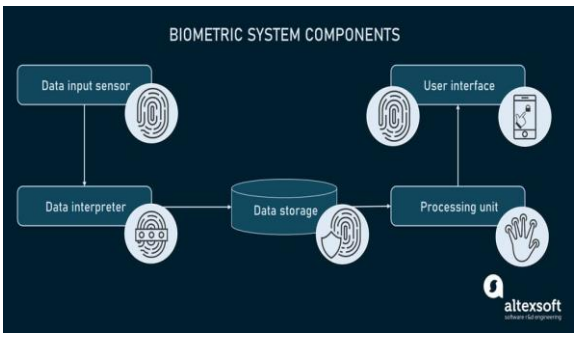

Figure 1: Biometric system components (Souvik et al, 2020)

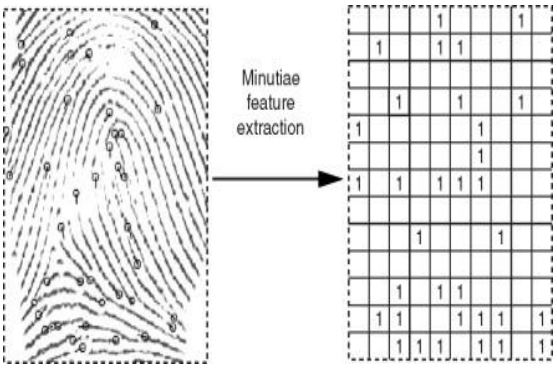

Figure 2: Showing how biometric are interpreted. (Clark, R. A. 2021)

MATERIALS AND METHODS

This project builds on these prior works by focusing on a mobile platform that integrates seamlessly with existing fingerprint sensors in devices, ensuring cost-effectiveness and ease of use while maintaining high accuracy. By leveraging research from earlier projects, this system seeks to address the limitations of hardware reliance and scalability.

The proposed system leverages biometric fingerprint authentication to enhance attendance management. It replaces the manual process with an automated solution that uses fingerprint data for student and lecturer verification. The system operates in identification mode, capturing and securely storing fingerprints during registration, and later verifying them during attendance.

The design goals focus on improving security, accuracy, and user experience. Functional requirements include the generation of attendance reports and seamless operation, while non-functional requirements emphasize system performance and security. The system follows the Waterfall Model, moving from requirement gathering, design, implementation, and testing, to deployment. The project employs Android Studio for frontend development, Java for logic, and Firebase for backend services, ensuring a smooth user experience and secure data handling.

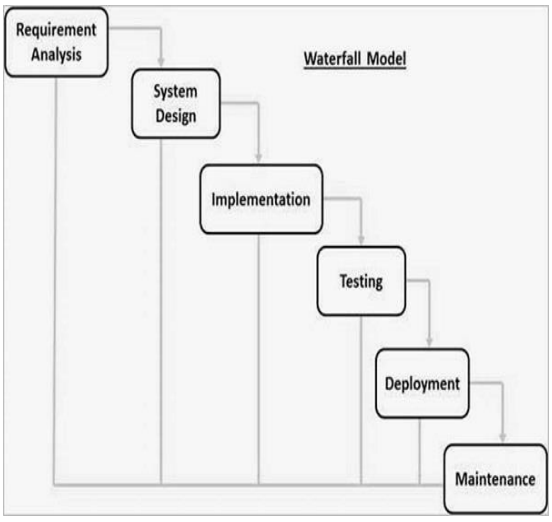

Figure 3: The waterfall Model

In terms of system design, the use of data flow diagrams, entity-relationship models, and flowcharts help illustrate the architecture and processes involved in the attendance system. These diagrams ensure that the system is well-structured, scalable, and capable of handling future enhancements.

System Analysis and Design

The proposed fingerprint-based attendance system replaces traditional manual methods with an automated process that captures and stores fingerprints during registration and verifies them during attendance. This ensures greater accuracy and security, eliminating the errors and forgery risks associated with manual attendance tracking.

The system operates by capturing fingerprints, extracting key features, and securely storing the data. During attendance, the system compares the captured fingerprint to the stored data, ensuring only authorized users are logged. The design goals emphasize security, accuracy, and ease of use, with a focus on generating attendance reports, managing data efficiently, and providing real-time access for administrators.

The system is developed using the Waterfall Model, progressing through requirement gathering, system design, implementation, testing, and deployment. The frontend is built using Android Studio, the application logic in Java, and Firebase for backend services. Rigorous testing ensures that all functional and non-functional requirements are met before the system is made operational.

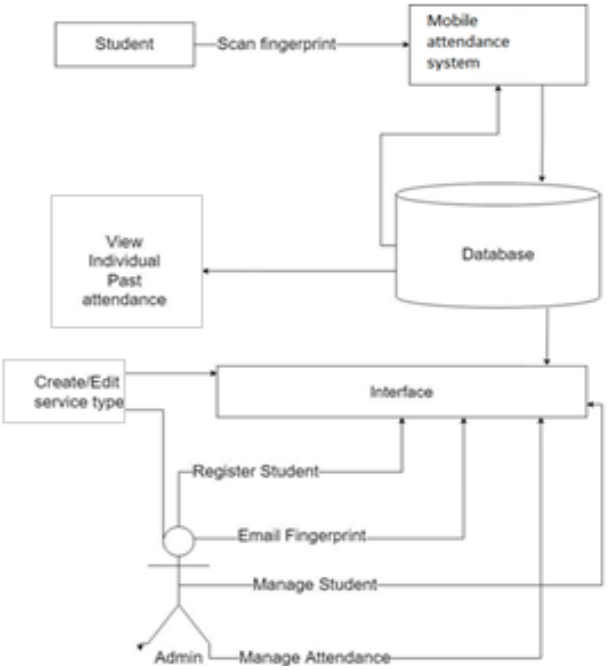

Figure 4: System architectural design

Following the delineation of system requirements, the architectural framework is elucidated, employing software modelling tools to structure these requirements.

Use Case Diagram

The use case diagram visually presents the essential components and actions involved in a system. Actors represent the fundamental elements, while use cases represent the actions or processes. It illustrates the interactions between actors and use cases. Figure 5 displays the depicted use case diagram.

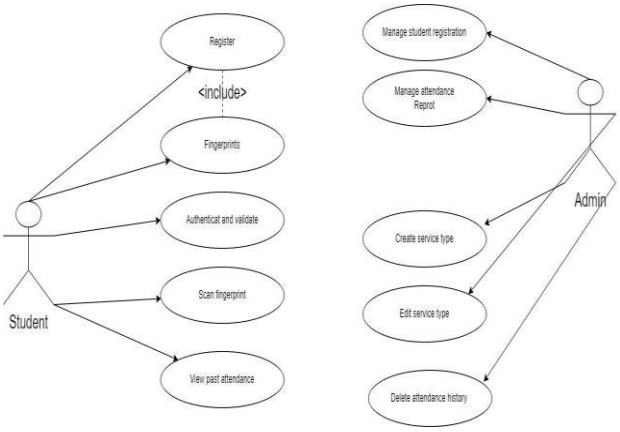

Figure 5: Diagram showing use case of the system

Actor: Student

Registration: This critical function involves students entering their information and fingerprint templates into the system, which are then stored in the database.

Fingerprint Enrollment: Students are required to register their fingerprints, which will be utilized for attendance tracking.

Authenticate and Validate: Fingerprint data is verified for accuracy.

Fingerprint Scanning: Fingerprint verification occurs at designated points, such as entry checkpoints.

View Past Attendance: Students have access to their attendance history for monitoring purposes.

Actor: Admin

The admin oversees the operation of the mobile fingerprint app.

Use Cases:

Manage Student Registration: Admins can edit and register students.

Manage Student Attendance Reports: Admins can view attendance reports for each service.

Create Service Type: Admins can set up service types for attendance tracking.

Edit Service Type: Admins can modify or delete service types.

Delete Past Attendance Admins have the ability to remove outdated attendance records.

Various modeling techniques, such as Data Flow Diagrams (DFDs) and Entity-Relationship Diagrams (ERDs), help represent the system's architecture and data flow. This ensures that the system is well-structured, scalable, and capable of handling future enhancements. By focusing on security, reliability, and user experience, this fingerprint-based system offers a significant improvement over traditional attendance methods.

Implementation

The fingerprint-based attendance system was developed using a combination of Android Studio, Java, and Firebase to ensure it was scalable, efficient, and easy to maintain. Android Studio provided the platform for creating the mobile application, while Java handled the core application logic, such as fingerprint authentication and real-time data processing. Firebase was used for backend services, particularly for storing and retrieving fingerprint data securely, as well as managing user authentication. This combination of tools ensures that the system can operate smoothly and handle large datasets efficiently.

One of the critical aspects of the system's development was the design of the user interface (UI). The UI was created using Android Studio's layout editor and XML, which helped in designing a clean and functional interface that allows students and lecturers to interact with the app easily. The UI features include the login screen, fingerprint verification screen, and the administrator's dashboard for managing attendance.

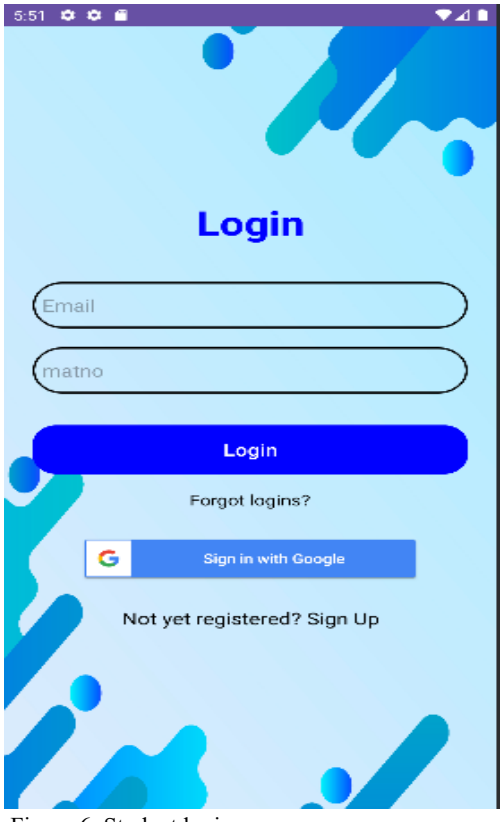

Figure 6: Student login screen

The student login screen is the first interaction point where users enter their credentials, and once authenticated, the system prompts them to scan their fingerprints.

Once the user successfully logs in, the app guides them to the student registration and fingerprint confirmation pages. The registration page collects and stores the student's personal information, while the fingerprint confirmation screen ensures that the fingerprints scanned during login match the data stored in the Firebase database.

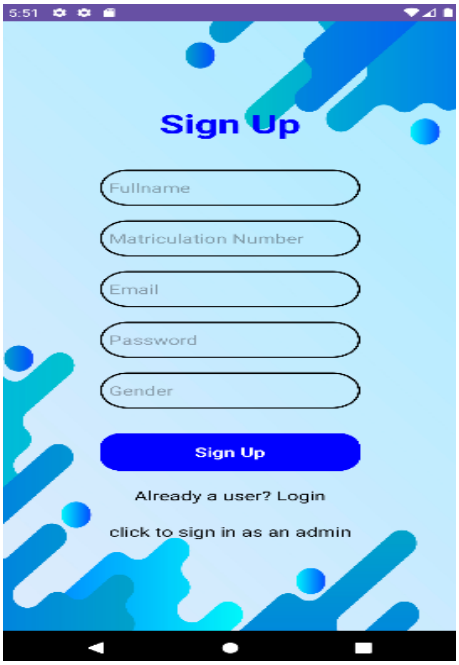

Figure 7: Student signup page

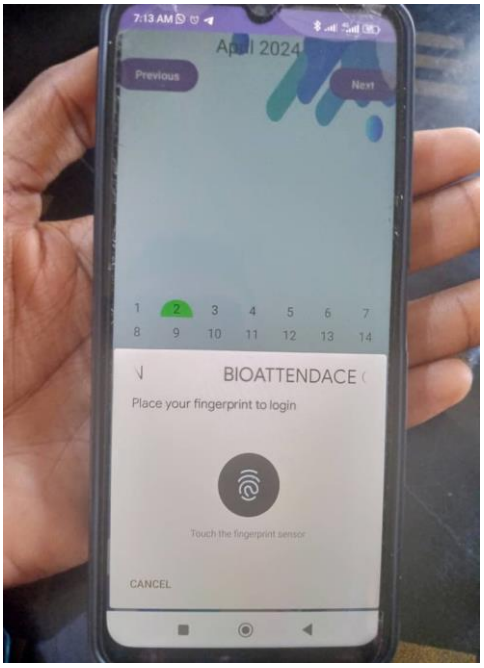

Figure 8: Student finger print confirmation

This step is crucial for confirming the user's identity and logging attendance securely.

From the administrator's perspective, the system offers a dashboard that allows lecturers to manage and track student attendance. The administrator's dashboard contains several functionalities, including adding and removing courses and viewing detailed attendance reports.

Figure 9: Admin dashboard

The dashboard is intuitive, enabling easy navigation through course lists and attendance summaries. Each course has its own attendance list, allowing the administrator to track student participation on a daily, weekly, or monthly basis. The attendance data can be exported as Excel files for record-keeping. When the Authentication fails, the system will quickly alert who ever is using it that there is fraud. That is the person is fake(forgery)

Figure 10: Attendance list

The choice of programming languages was essential for ensuring that the system met the required performance standards. Java was selected for its compatibility with Android, its wide range of libraries, and its efficiency in handling biometric data processing. Android Studio, built on IntelliJ IDEA, provided the necessary tools for UI design and debugging. Firebase was an ideal choice for backend services, as it offers real-time data synchronization, secure authentication, and a scalable database solution that can support multiple users simultaneously.

In terms of system requirements, the app is designed to run on modern Android smartphones equipped with a fingerprint sensor. The minimum hardware specifications include 3 GB of RAM, a quad-core processor, and at least 100 MB of available storage. Additionally, the app requires Android 7.0 (Nougat) or later to ensure compatibility with fingerprint authentication features. The app also relies on an active internet connection for syncing attendance data with the Firebase database and for real-time updates.

System testing was an integral part of the development process to ensure the app functions as intended. Testing included unit testing, where individual components such as fingerprint scanning and user authentication were tested separately. Integration testing followed to ensure that the app's components worked together seamlessly, particularly in syncing data between the mobile front-end and the Firebase backend. Finally, acceptance testing was conducted to validate that the app met all the functional requirements and worked smoothly in real-world scenarios.

The results of the system's development demonstrated its effectiveness in managing attendance securely and efficiently. The fingerprint authentication system eliminates the need for manual attendance processes, reduces the chances of errors, and ensures data integrity. Additionally, the user-friendly interface allows both students and lecturers to use the app with minimal training, making it a practical solution for educational institutions.

The fingerprint-based attendance system provides a modern solution to the challenges of managing attendance. By leveraging mobile fingerprint authentication, real-time data processing, and cloud storage, the system ensures secure, efficient, and scalable attendance management. The app's ability to track attendance, generate reports, and export data makes it an ideal tool for educational institutions looking to modernize their attendance tracking processes

CONCLUSION

The fingerprint-based system provides an innovative solution to traditional attendance management issues. By eliminating the manual recording process, the system significantly reduces errors, prevents forgery, and saves time. The use of biometric authentication ensures that only verified individuals can register their attendance, enhancing the integrity of attendance records. This system has shown to be more reliable and efficient compared to paper-based methods.

In conclusion, the fingerprint attendance system is a secure and scalable solution that streamlines the attendance process for educational institutions. It enhances productivity by automating attendance tracking and offers administrators the ability to monitor attendance in real-time. The use of Firebase as a backend ensures that data is stored securely and that records are updated instantly.

For future development, it is recommended to integrate this system with existing school management systems for broader functionality, such as grade tracking and student performance monitoring. Additionally, adding more biometric features, such as facial recognition, could further enhance security and provide more flexibility in identification methods.

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