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Designing An Android Application For Student Attendance Management Using Geolocation Technology

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Abstract

The development of information technology has encouraged innovations in student attendance management, one of which is through a geolocation-based attendance system. This study aims to design and develop an Android application capable of automatically recording student attendance based on their physical location. The system was developed using *Android Studio, Google Maps API, and Firebase*, and tested in the STMIK TIME Medan campus environment. The implementation results show that the application can record attendance with high accuracy, provide real-time reports, and improve the efficiency of the attendance process. This research is expected to contribute to a more modern and efficient academic system.

Keywords: *Attendance, Geolocation, Android, Firebase, Google Maps API*

1. Introduction

Student attendance in lecture activities is an important indicator in supporting academic success and discipline assessment. However, the manual attendance system still used in many educational institutions tends to be inefficient, prone to manipulation, and requires slow and error-prone verification processes [1], [2]. This situation demands a more accurate, efficient, and automated attendance system.

Geolocation technology offers a solution to improve the accuracy of recording student attendance. By utilizing the Global Positioning System (GPS) and integration through an Android application, attendance can be recorded automatically only if students are within a predetermined campus area [3]. The implementation of this system also allows real-time monitoring of attendance data by lecturers and academic administrators [4].

Several previous studies have shown that integrating geolocation technology into attendance systems is effective in reducing fraud, simplifying the recording process, and increasing transparency and accountability [1], [4], [5]. With an Android-based attendance application connected to Firebase and Google Maps API, users can perform clock-in and clock-out without manual verification, while lecturers can access attendance reports directly.

A. Attendance

Attendance is the process of recording a person's presence in an activity or event. In an educational context, attendance refers to recording the presence of students in class to ensure they are physically present during learning activities. Student presence in class is not only a physical indicator but also reflects their level of engagement and commitment to the learning process [6].

B. Attendance Management in Education

Attendance management is the process of systematically managing and recording student attendance by educational institutions. This system plays an important role in ensuring the accuracy of attendance data and supports academic and administrative decision-making, such as performance evaluation, scholarship awards, and discipline monitoring [9].
Good attendance records can serve as the basis for academic recognition, while low attendance often requires special evaluation [10]. Therefore, effective attendance management contributes to improving the quality of education and supports adaptation towards digital and hybrid learning systems.

The manual attendance system is a traditional method of recording attendance that is still commonly used in educational institutions. Students sign an attendance sheet, which is then collected by the administration. Although simple, this system has several weaknesses, such as vulnerability to fraud (e.g., proxy sign-ins) [8], time consumption [6], susceptibility to recording errors [9], and slow verification processes [7].
These limitations make manual systems less effective in meeting the efficiency and accuracy needs of attendance in today's digital education era.

Geolocation is a technology that enables devices to determine a user's physical location through GPS, Wi-Fi networks, or cellular towers [10]. In attendance systems, geolocation offers several advantages, such as accurate location verification to ensure students are truly within the lecture area [10], automatic attendance recording without manual intervention [9], and real-time data access that allows lecturers and administrators to monitor attendance directly [4].
With these capabilities, geolocation becomes an effective solution to address the weaknesses of manual attendance systems, especially in terms of accuracy and potential fraud.

1. Supporting Technologies for Designing a Geolocation-Based Android Attendance Application.
   To develop a geolocation-based attendance application, several technologies are required to support the design process. The following are the technologies used:
   a. Android Studio as the IDE for Application Design - Android Studio is the official Integrated Development Environment (IDE) used to develop Android applications. In the context of designing a geolocation-based attendance application, Android Studio provides various features that facilitate designers in integrating geolocation technology and maps into the application [7].
   b. Firebase for User Authentication and Real-Time Database - Firebase is an application development platform from Google that offers various backend services to make it easier for developers to build and manage applications without having to handle servers manually. In the development of a geolocation-based attendance application, Firebase is used for two main functions: Firebase Authentication for user authentication, and Cloud Firestore as a real-time database to record and store attendance data directly.
   c. Figma for User Interface (UI/UX) Design - User Interface (UI) and User Experience (UX) design play an important role in ensuring that the application is not only functional but also easy and comfortable to use. In a geolocation-based attendance application, good UI/UX allows users to perform attendance and monitor their attendance status more easily. One design tool used is Figma, which enables efficient and collaborative UI/UX prototyping.
   d. Flutter for Attendance Application Design - Flutter is an open-source framework developed by Google for building cross-platform applications, enabling a single codebase to run on both Android and iOS. Using the Dart programming language, Flutter offers several advantages in developing a geolocation-based attendance application, such as location integration through the Geolocator plugin, real-time data management using Firebase via cloud_firestore and firebase_auth, as well as responsive and attractive interfaces with support from various widgets.
2. Data Collection Methods in Attendance System Design
   In designing this geolocation-based attendance system, data collection is essential to ensure that the developed application can function as expected. Therefore, the data collection methods used in this study involve two main approaches: observation of geolocation attendance system usage and user testing. These two methods have different purposes and focuses but complement each other in obtaining the necessary data to evaluate the performance and user experience of the application.
   a. Observation of Geolocation Attendance System Usage - Observation was conducted by directly monitoring the application's performance in the classroom environment to evaluate geolocation accuracy and the attendance recording process. The observation focused on location detection accuracy based on predetermined coordinates, the speed of recording attendance after location detection, as well as technical issues such as detection errors, slow connections, and recording delays. The observation results form the basis for evaluating and optimizing the technical performance of the application to make it more accurate and efficient in field use.
   b. User Testing for Mobile Applications - User testing is an evaluation method that directly involves users to assess the application's functionality and user experience. In the context of a geolocation-based attendance application, students were asked to try the application during class attendance and provide feedback regarding ease of use, location accuracy, system speed, and comfort. The results of this testing provide a subjective yet important overview of user acceptance as well as UI, UX, and functionality aspects that need improvement.
   c. Conclusion from Literature Review - Based on the literature review, it can be concluded that designing a geolocation-based attendance application has great potential to improve the efficiency and accuracy of attendance systems in educational institutions. Technologies such as GPS, Wi-Fi, and Google Maps API allow attendance to be performed automatically and only by users who are in a valid location. In addition, the use of platforms such as Android Studio, Firebase, and Figma supports the application development process effectively. This research will proceed with the design of a geolocation-based attendance system as a solution to the limitations of manual attendance systems.

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2. Main Body

A. System Analysis

Analysis is the initial step in system development aimed at gathering information and determining the requirements of the system to be created. In the project of developing an attendance application for STMIK TIME, this analysis stage is essential to identify key features that need to be integrated into the application. Through an iterative analysis process, the authors ensure that all system requirements are effectively identified and met.

1. Design Stages with Geolocation Technology – Geolocation technology enables the automatic recording of student attendance based on their physical location. The design stages of this application include: (1) initial planning by identifying required features such as automatic attendance, user authentication, location validation, and attendance reporting; (2) requirements analysis through observation and literature review; (3) interface and technical system design; (4) implementation using Android Studio, integration of Google Maps API for location detection, and Firebase for authentication and data storage; and (5) functionality testing and geolocation accuracy testing according to the specified location radius.

2. Analysis of Similar Systems – Analysis of geolocation-based attendance systems was conducted to identify common features and potential for further development. It was found that such systems generally have a login feature for user authentication, location validation based on a certain radius, and real-time attendance reporting via the lecturer's dashboard. Based on these findings, the developed application is directed towards improvements in location radius flexibility, a more user-friendly interface, and optimal data security.
3. Application Feature Analysis – Based on the results of similar system analysis, several main features were designed to improve the effectiveness and accuracy of attendance recording in the Android geolocation-based application. These features include login and registration for user authentication, geolocation-based attendance using Google Maps API, location validation based on GPS coordinates, real-time reporting for lecturers, and data management through the admin dashboard. In addition, the application also features user profiles, automatic attendance notifications, and adjustable location radius settings. All these features are designed with considerations of ease of use, data security, and efficiency in supporting digital attendance management in the campus environment

B. System Design

The design stage in developing an Android application for student attendance management includes several important aspects to ensure that the system functions according to user needs and technical specifications. This stage involves the design of the flowchart and the application interface. Each part of this design process plays a crucial role in building a system that is efficient and easy to use.

1. Flowchart Design of the Attendance Process - The attendance process in a geolocation-based Android application requires a structured workflow so that each function operates optimally. The flowchart is designed to visualize the main steps, starting from user authentication to recording data on the Firebase server. Each stage is arranged to minimize errors, provide feedback to users, and ensure location validity through a geolocation validation process.

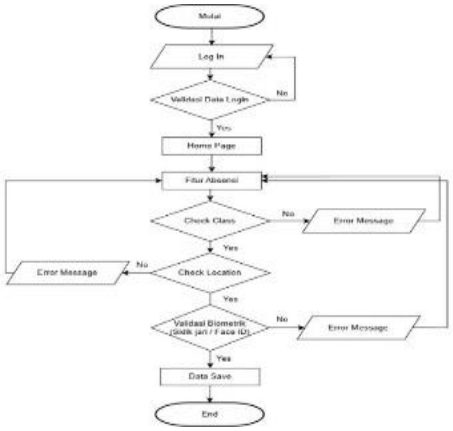

Fig. 1: Attendance Process Flowchart

2. Step-by-Step Design - The stages of the student attendance process in a geolocation-based Android application begin when the user opens the application and enters their email, student ID (NIM), and password on the login interface. After the data is verified, the user is directed to the main page and selects the attendance feature via the dashboard. The system then validates the active class schedule and performs biometric verification using a fingerprint or Face ID. Next, the user's location is verified in real time using geolocation, and only if within the allowed radius will the attendance be recorded. Data such as time, location coordinates, and biometric status are sent to Firebase in real time. After that, the system displays a success notification, and the process is considered complete, with attendance data accessible to lecturers or admins for monitoring purposes.
3. Entity Relationship Diagram (ERD) Design - The Entity Relationship Diagram (ERD) is used to model the database structure in the biometric-based attendance system. The ERD defines the main entities such as students, attendance, biometrics, classes, and schedules, along with the relationships between them. This diagram ensures that the data is stored in a structured and efficient manner, supports attendance validation using fingerprints and Face ID, and facilitates data retrieval for reporting and attendance management purposes.

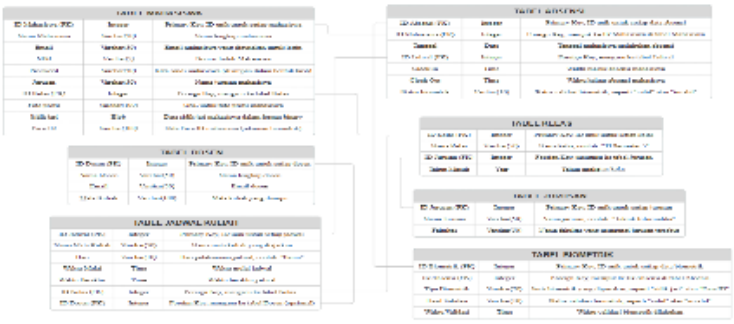

Fig. 2: ERD Design for Student Attendance Application

4. Campus Attendance System Interface Design - The interface design of the attendance system is carried out using Figma to produce an intuitive, modern, and responsive interface. The process begins with creating wireframes of the user flow, such as login, attendance recording, and attendance reporting, which are then developed into complete visual designs. With cloud-based features, Figma

supports real-time team collaboration and interactive prototype testing to ensure smooth navigation and compatibility on Android devices.

C. Results

This Android-based student attendance management application was developed using Flutter, supported by Firebase, Google Maps API, and Network Time Protocol (NTP). The application is intended to address issues in conventional attendance systems such as slow recording, time manipulation, and inaccurate locations. By utilizing geolocation technology and cloud computing, the system provides a more accurate, efficient, and transparent solution.

The application supports two types of users: students, who perform clock-in and clock-out with location and time validation from the NTP server, and lecturers, who manage attendance and account security. All processes take place in real time via Firestore, with Firebase Authentication ensuring account authenticity.

The login page provides fields for email, password, and student ID (NIM) (for students), as well as a "Remember Me" button, and will direct users to the main page according to their role after successful login.

1. Interface Results

   Several interface results of the Student Attendance Application are presented as follows:

   a. Main Page Display (Students and Lecturers)

   The main page is customized according to the user's role. For students, it displays real-time attendance information, user identity (name, NIM, study program, class), and the Live Attendance feature showing time, date, start time, end time, and clock-in/clock-out buttons active only during the allowed time. Class schedules are displayed based on the day and lecturer's name, with a "No Class" notification if no schedule exists.

   For lecturers, the main page displays the lecture schedule list by date along with the list of students and their attendance times. Lecturers can monitor attendance status using specific icons, such as an orange cross icon for absent students and a lock icon to grant re-attendance permission. This display supports efficient and interactive attendance monitoring according to user roles.

Fig. 3: Login Page (Students and Lecturers)

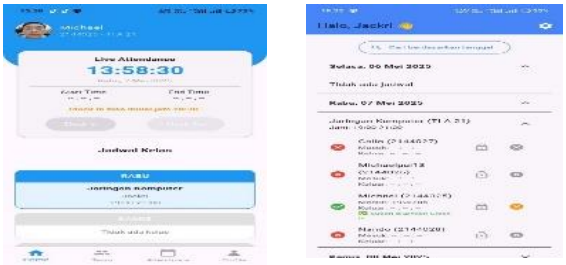

Fig. 4: Main Page (Students and Lecturers)

   b. Team Page Display (Students)

   This page displays the list of classmates or team members registered in the system. Each entry includes a profile photo, full name, NIM, study program, and class. A search bar is provided at the top to facilitate searches by name or NIM. The design is kept simple and clean to support comfortable and efficient navigation for users.

Fig. 5: Team Page (Students)

   c. Attendance Page Display (Students)

   The Attendance page presents complete student attendance information, starting from user identity such as profile photo, name, and NIM, along with the Live Attendance feature displaying the current time and date in real time. Displayed information includes

start and end times, as well as attendance history sorted by the most recent date. If a student fails to perform clock-out, the system will display a “No Clock Out” note with a specific color indicator to distinguish incomplete attendance status, ensuring transparency and easy monitoring

Fig. 6: Attendance Page (Students)

d. Profile and Settings Page Display (Students)
The Profile and Settings pages allow students to manage their personal data and accounts independently. The Profile page displays basic information such as name, date of birth, gender, contact, major, and campus, with an Edit Profile option for data updates. The Settings page provides features for changing PIN, changing password, viewing Face ID, and logging out. These pages are designed to enhance user convenience and maintain information security in the application.

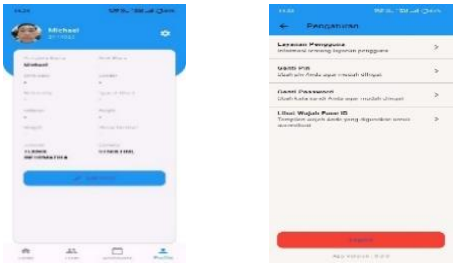

Fig. 7: Profile and Settings Page (Students)

e. Location Validation Page Display (Clock In and Clock Out)
This page validates the user’s location when performing clock-in and clock-out. The system displays a map based on predetermined coordinates and automatically calculates the user’s distance from the allowed location. If the user is within the set radius, the clock-in or clock-out button becomes active and usable.

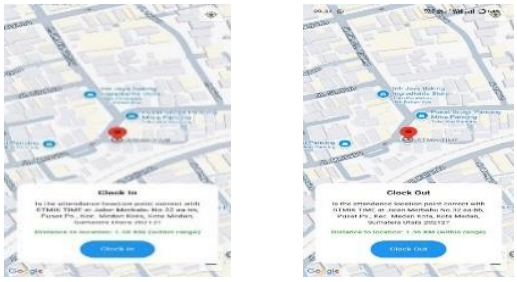

Fig. 8: Location Validation Page (Clock In and Clock Out)

f. Face ID Verification Page Display (Students)
This page verifies student identity via Face ID. Users are asked to align their face according to the guide, after which the system automatically validates the face to ensure identity authenticity.

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Fig. 9: Face ID Verification Page (Students)

2. Discussion
   a. Advantages of the System

The application has several main advantages, including geolocation integration through GPS and Google Maps API to ensure attendance can only be performed in authorized locations, and facial validation (Face ID) that adds a layer of identity security. The interface is user-friendly, intuitive, and responsive across devices. Attendance data is stored in real time using Cloud Firestore and can be accessed anytime. Additionally, lecturers have direct control over the attendance process, including granting re-attendance permission and blocking students not in class to maintain discipline.

b. System Weaknesses
Several weaknesses remain to be addressed, such as dependence on internet connection and GPS signal, which can disrupt attendance processes, and unstable location accuracy due to external factors such as weather and tall buildings. The Face ID feature is still simple and not supported by machine learning, making it sensitive to lighting and facial angles. Furthermore, the application does not yet have real-time notifications, requiring lecturers to refresh the application manually. The system is also limited by Firebase's free tier capacity and does not yet implement two-factor authentication (2FA) for added security.

3. Conclusion

The Android application for student attendance management was successfully developed with the integration of geolocation and Face ID technology. The system only allows clock-in and clock-out if students are within the predetermined campus radius. Attendance is recorded in real time via Firebase, and facial verification increases security. User feedback indicates that the application facilitates the attendance process, although limitations remain, such as dependence on GPS and camera quality.

For future development, it is recommended that the application overcome indoor location limitations by integrating technologies such as Wi-Fi positioning systems or Bluetooth beacons. Facial verification can be enhanced using machine learning algorithms such as TensorFlow Lite to be more adaptive to lighting and facial angles. Adding real-time notifications via Firebase Cloud Messaging (FCM) would also improve lecturer responsiveness. Moreover, security features such as two-factor authentication (2FA) should be implemented, especially for lecturers and admins. Strategies for optimizing Firebase usage, such as automatic archiving or migrating to paid services, are also important to accommodate the growing number of users.

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