

Implementation Of Teacher Presence System Using Mobile-Based Geofencing & Haversine Formula Methods

Muhammad Dawamul Mughni^{1*}, Putri Aisyiyah Rakhma Devi²

^{1,2}Muhammadiyah Gresik University, Indonesia

Jl. Sumatera No.101, Gn. Malang, Randuagung, Kec. Kebomas, Gresik

^{1*}mdawam24@outlook.com, ²deviaisyiyah@umg.ac.id

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Abstract

Implementing a teacher presence system using geofencing and the Haversine Formula mobile-based method provides a modern solution for accurately monitoring teacher attendance. This system utilizes geofencing technology to set virtual boundaries around specific locations and the Haversine formula to calculate the distance between the teacher's current location and the school's location. If the teacher's location is within the area's boundaries, the system assumes the teacher is present, and if outside, the system considers the teacher absent. Attendance status is regularly updated and stored in the database, providing an efficient method for administrators to monitor teacher attendance and increase accountability. The use of this system reduces the possibility of manual errors, making it a valuable tool in education. Two tests were carried out, namely testing the accuracy of the system, and testing black box testing. Accuracy testing was carried out under three conditions, namely inside the presence area, at the border of the presence area, and outside the presence area. The test was carried out 30 times and resulted in 100% accuracy. Then, black box testing also concludes that the application works in accordance with the testing that has been done. The conclusion from this research is that the higher the device and network used, the more accurate it will be.



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I. INTRODUCTION

Mobile technology, which has developed in the industrial era 4.0, especially in the education sector, is expected to solve problems of access, quality, and social justice in the education sector. The field of education has many activities, including attendance activities; attendance is an activity or routine carried out by lecturers, teachers, and students to prove themselves present or not present in an institution and carry out teaching and learning activities. The manual attendance method is done by signing proof of attendance on the attendance register book.

The manual attendance method is less efficient to apply, because it has several drawbacks such as time inefficiency in the implementation process and provides a high possibility for errors in the data collection process caused by the large number of files that must be checked each semester. The introductory section

Corresponding Author

contains background information such as theory, previous work, and hypotheses. This is followed by a statement of purpose for the research issue or problem and a series of questions you wish to answer in your research.

The solution to overcome the problems caused by the manual attendance method, this research was conducted with the aim of designing a teacher attendance information system using the Mobile-based Geofencing and Haversine Formula methods to overcome the problem of inefficient manual attendance. This system runs after getting latitude and longitude using Geofencing, both information will be calculated using the Haversine Formula method which is one of the most accurate equations for determining the distance between two points on the earth because it has taken into account that the earth is not a flat plane but is a flat plane. has a certain degree of curvature.

II. RELATED WORKS

Geofencing is a technology that defines virtual boundaries around geographic areas of the world. Reducing radius which can reduce triggering actions on telephones or other portable electronic devices. The function of a geofence that is made with the current location of a mobile device is: when the user enters or leaves the geographical area that has been created it can be detected automatically, then from the results of this detection the desired output can be produced[1]. Geofencing allows automatic alerts to be generated based on the coordinates entered in a geographically defined area used to monitor moving objects such as smartphones, vehicles and others using the Global Positioning System (GPS) satellite network. Geofencing describes an area (geofence) which has the geographical boundaries of a map[2]. Then the Haversine Formula is a method used to calculate the distance from a place to a destination [3]. Research - Research that uses the Geofencing method and the haversine formula has been used frequently as previously made by Shandy Tresnawati & Alfian Pratama in 2021 to create a presence system using the web-based geolocation method with case studies: PT. Codepolitan Integration Indonesia using PHP and MySQL technology [4]. Anggita Arfina Arfah and Untung Suwardoyono in 2022 will create an employee attendance system using geolocation and fingerprint based on Android where the system to be built is capable of monitoring the location of employees who have been absent, so the company can find out if employees leave the company's location during working hours without confirmation [5]. Nyoman Eddy Indrayana et al in 2020 created a Virtual Area restriction system to monitor children's activities using Smartphones and smartwatches using the help of Geolocation and Haversine Formula. This application can detect smartwatch user coordinates which can be monitored via a smartphone [6]. Virgian Fajaryantoro et al in 2020 created a system for finding the nearest kiosk providing agricultural products using the radius method, a web-based haversine formula [7]. Mulyanti in 2020 created an employee attendance application design system using the Geofencing method and calculating distances at the Inuman Health Center to overcome problems such as damage to books or loss of attendance books which should be used as monthly absence reports, so an attendance application was created using Android and the geofencing method [8]. Syarifudin A. in 2019 created a system for designing an information system for submitting and reporting the payment of performance allowances for the ministry of finance using the Prototype method. One of the efforts to improve good governance within government agencies is to utilize information technology [9]. Syafar A., Kambau R., Mulaya N in 2021 will create a search system for Al-Qur'an teachers using the haversine formula method by utilizing smartphones as a tool in addition to teaching, the teacher will also evaluate any progress in learning material achieved by students. This of course will make it easier for parents to monitor their child's learning progress without having to participate in the learning process [10]. Hermawan

& Rosyid in 2020 created an information system for Gresik regency tourist locations using the Item-based collaborative filtering method, the feature of this application is the navigation of tourist locations, there is a list of tourist attractions in Gresik Regency, after selecting one of the tourist attractions it will automatically enter google map and direct tourist users to the intended tourist location. This feature will really help tourists who don't know the direction of their destination when they are going to visit a location [11]. Mukhlisin et al in 2019 created a Web-based Tracer study alumni information system for informatics engineering study program at Muhammadiyah University of Gresik[12]. Based on this, several researchers have used Geofencing and haversine formulas for the purpose of making an online presence system[13]. So that in this study the geofencing and haversine formula methods were used which aimed at making attendance systems using the geofencing method and mobile-based haversine formulas for the MINU Lumpur school. And later it can be useful for administrative officers in minimizing errors in teacher attendance data collection to improve school performance so that it is more efficient and accurate.

III. METHODS

The type of research method used in this study is a qualitative descriptive research method. The qualitative descriptive approach aims to describe systematically and accurately facts and characteristics regarding specific areas under pressure analysis on processed data [14]. The research stages contain steps to carry out research that is structured and planned to achieve research objectives. The study uses the prototype method, which is a version of the system or part of the system and is developed quickly to validate the requirements or feasibility of several design decisions required by the customer[15]. The stages of research on the implementation of the prototype methodology in the presence's system can be seen in Figure 1.

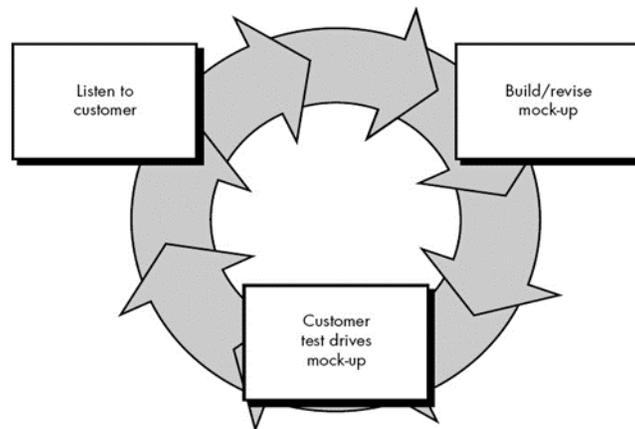


Figure 1. Research Stages

A. Method of collecting data

Data collection aims to find information related to research needs. Some of the systems used for data collection include:

1. Observation
Researchers made direct observations to find problems related to attendance recording activities.
2. Interview
This technical interview is carried out through a question-and-answer process with administrative officers about what are the obstacles in attendance activities carried out at school.
3. Literature Study

Literature Study Reference Method This information retrieval technique is used to gather appropriate and relevant reference sources to support research needs.

B. System Requirements Analysis

This requirement specification includes the elements or components needed. This system consists of two interconnected applications, namely, a website-based application to manage presence data as a web server, and an Android-based application which provides usability as a presence location that will be used by the user.

C. Implementation of the haversine formula

The Haversine formula provides the great circle distance between two points on the spherical surface (earth) based on longitude and latitude by accommodating the radius R 6.367.45 km, and the locations of the 2 points in spherical coordinates (latitude and longitude) respectively lon1, lat1, and lon2, lat2[16].

Calculations on haversine formula [3] use the difference or magnitude of changes in latitude (Δlat) and longitude ($\Delta long$) two coordinate points in radians.

$$\Delta lat = latitude2 - latitude1 \quad (1)$$

$$\Delta long = longitude2 - longitude1 \quad (2)$$

From the two equations above, we calculate the distance between two points using the formula in Equation (3).

$$distance = 2.R.arcsin\left(\sqrt{\sin^2\left(\frac{\Delta lat}{2}\right) + \cos(latitude2) \cdot \cos(latitude1) \cdot \sin^2\left(\frac{\Delta long}{2}\right)}\right) \quad (3)$$

D. System planning

Based on the analysis carried out, the process of designing a teacher attendance system will be continued. System design is described in Use case diagrams, Activity diagrams, Class diagrams. System design is made using UML (Unified Modeling Language).

E. System Implementation

The teacher attendance system is built on a mobile basis, so that the programming language Dart and the Flutter Framework are used in the coding process through the Visual Studio Code text editor and for data storage using Firebase.

F. System Testing

Testing aims to ensure that the software built has tested criteria and can run properly without experiencing interruptions or errors. This test is carried out especially in testing system functionality and system performance that has been built. There are two testing systems in this research:

1. Testing the accuracy

Testing the accuracy of the system Testing is carried out by testing techniques by trying on 10 different devices and carried out several times with 3 situations inside the presence location, on the border of the presence location, and outside the presence location area to find out how accurate this application is.

2. Blackbox testing

Blackbox testing is based on the details of the application, the functions that exist in the application and the suitability of the function flow with the process desired by the user or users. This test does not look at and test program logic. Blackbox testing is testing that is carried out only by observing the results of execution through test data and checking the functionality of the software. Blackbox testing evaluates only from its external appearance (interface), functionality without knowing what happens in the detailed process (only knowing input and output).

IV. RESULTS AND DISCUSSIONS

The main challenge in this research is how to produce an effective teacher attendance recording system using the Geofencing method and the Haversine formula, so that the right solution and according to needs can be found. After finding the main challenges, the next step is to develop functional requirements. Functional requirements of the attendance system:

1. The system can manage data criteria, such as adding, deleting, and changing teacher data.
2. The system can make presence and return attendance.
3. The system can calculate the distance between the user coordinates and the school coordinates using the haversine formula method.
4. The system can display attendance data recapitulation results.

Next, system design is carried out based on predetermined functional requirements by utilizing use case diagrams. The use case diagram of the system created is shown in Figure 2.

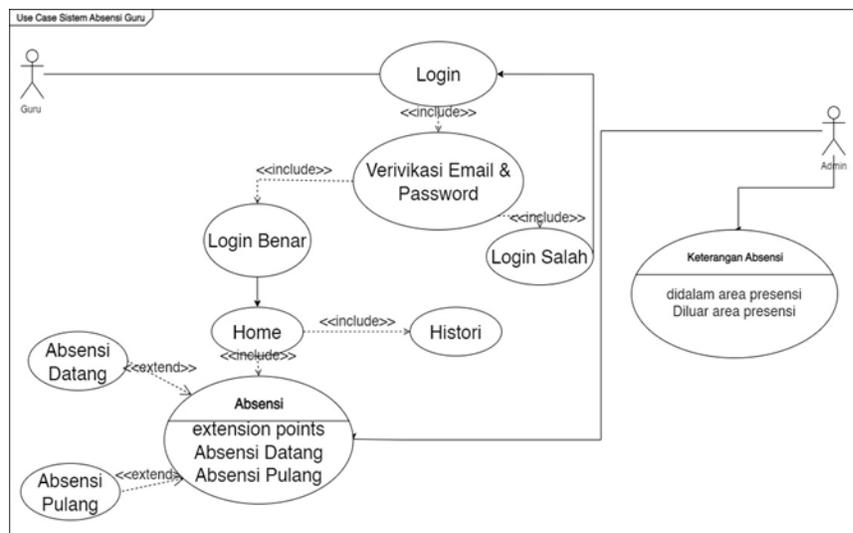


Figure 2. Use Case Diagram teacher presence system.

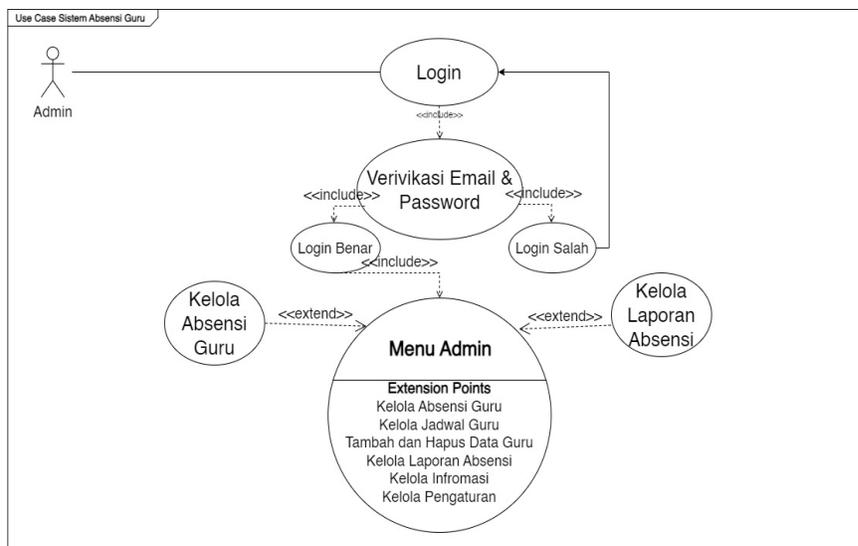


Figure 3. Use Case Diagram admin presence system.

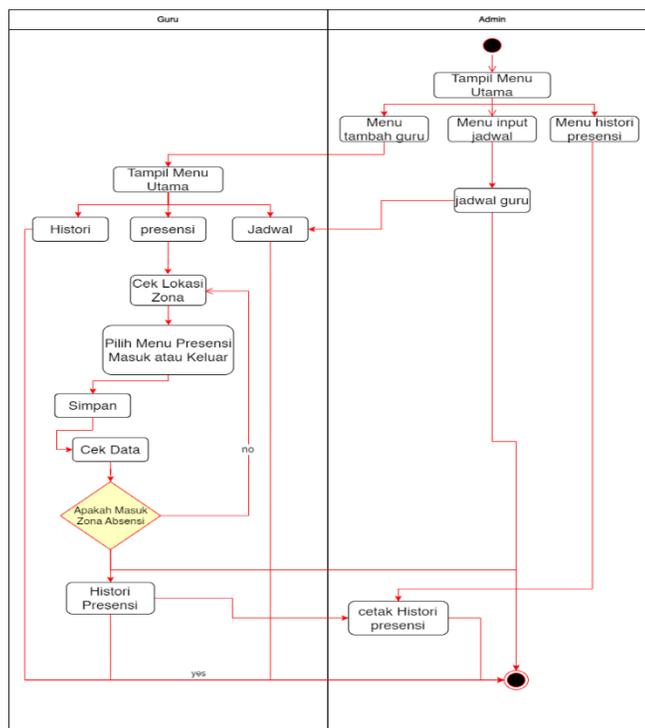


Figure 4. Activity Diagram admin and teacher presence system

After the design is carried out, the implementation is carried out, implementation is the stage of implementing the system that has been designed in the form of program code according to the needs of the system so that it can run properly. Implementation of the teacher presence system using the mobile-based geofencing & haversine formula method using the Dart programming language and assisted by the Flutter framework. The software used in system development is the "Visual Studio Code" text editor, the "Android

Studio" emulator and the "Firebase" database. Home page interface implementation can be seen in Figure 5.

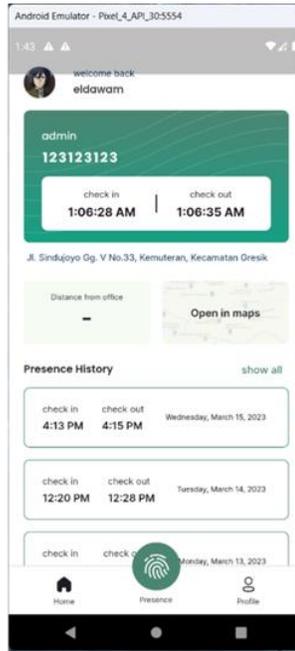


Figure 5. Home Page Interface Implementation

All presence page interface implementation can be seen in Figure 6.

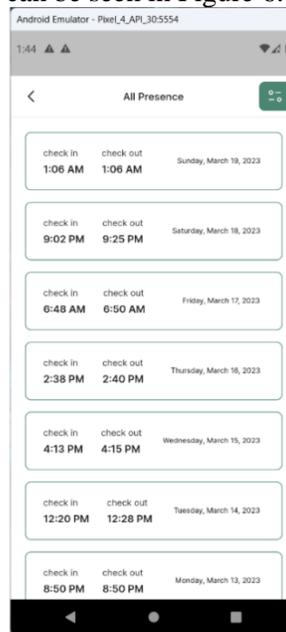


Figure 6. All presence page Interface Implementation

Detail presence page interface implementation can be seen in Figure 7.

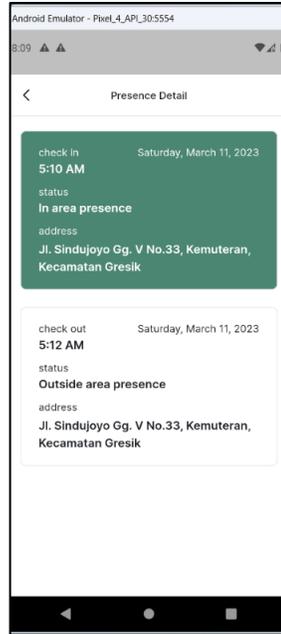


Figure 7. Detail presence page Interface Implementation

After the system requests permission to use the location, the Haversine formula method will be calculated. which will be displayed on the distance from office widget on the home page which will be presented in Figure 8.

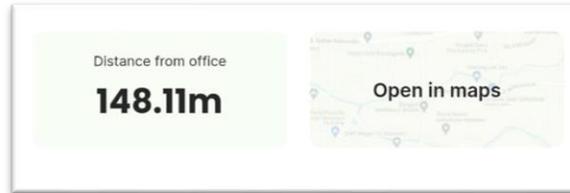


Figure 8. Widget distance from office Interface Implementation

After the implementation is complete, the main process is tested, namely the process of accuracy using the geofencing method and the haversine formula to determine the accuracy of the resulting presentation. The following table 1 results of testing the accuracy process.

Table 1. Results of Testing The Accuracy Process

NO	Device	condition 1	condition 2	condition 3	Total
1	Device 1	1	1	1	3
2	Device 2	1	1	1	3
3	Device 3	1	1	1	3
4	Device 4	1	1	1	3
5	Device 5	1	1	1	3
6	Device 6	1	1	1	3
7	Device 7	1	1	1	3
8	Device 8	1	1	1	3

9	Device 9	1	1	1	3
10	Device 10	1	1	1	3
					30

Table 2. Condition

No	Condition	Information
1.	Condition 1	The user is in the presence area
2.	Condition 2	The user is in the presence border area
3.	Condition 3	The user is outside the presence area

After that, the system that has been made is tested to ensure that the system is functioning properly and there are no errors using the black box testing method. Testing is done by running the system features that have been developed. Table 3 below are the results of the tests carried out.

Table 3. Black Box Testing Results

NO	Testcase	Functionality	Result
1	Login in system	Users enter the username and password to enter the system and can enter the system by entering the username and password	Valid
2	Presence Menu Feature Coming	Users can make attendance with notes in the attendance area and connected to the internet	Valid
3	The Presence feature back	users can make attendance with notes in the attendance area and connected to the internet	Valid
4	Menu feature added teacher	Admin adds user data in the form of nip, name, job, email with a note that all fields are filled in	Valid
5	Feature Menu update profile	Admin and user update the data with a note that all fields are filled	Valid
6	Fitur change password	Admins and users can change passwords with a note that all fields must be filled in	Valid
7	Fitur Menu <i>all</i> presensi	Admin and user can see the data of all presence that has been done	Valid
8	Fitur Detail Presensi	Admin and user can see details of presence that has been done	Valid
9	Fitur <i>Report</i> Presensi	Admin can see the results of attendance data recap that has been done by all users	Valid

From the test results in Table 3 it can be seen that all the test features run smoothly and have a "Valid" test case status. This indicates that the system has been operating successfully.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and testing carried out, the conclusions that can be drawn are the methodology and implementation of the teacher attendance system using the mobile-based geofencing & haversine formula method starting with system analysis, system design, database design, interface design, implementation, and system testing. The test is carried out with three presence conditions, namely conditions within the presence area and conditions at the border of the presence area and conditions outside the presence area. Based on the test results, it can be concluded that the accuracy of this application is 100% dependent on the device and GPS network. The higher the processor and cellular network used, the faster the device will display the application display. Based on system testing, it is also concluded that the system runs smoothly and according to needs.

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