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Optimization of Mobile Attendance System with Haversine Formula Method for Field Work Practice Students

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Abstract

Conventional attendance of Field Work Practice (PKL) students still has various obstacles, such as manipulation of attendance, late recording, and difficulties in validating accurate attendance. In today's digital era, the use of location-based technology is a solution to overcome these problems. Therefore, this study aims to develop and optimize a location-based mobile attendance system by implementing the Haversine Formula Method. This method is used to calculate the distance between the student's GPS coordinates and the predetermined PKL location, so that the system only allows attendance if the student is within a certain radius.With implementation on the Android platform. The main features of this system include real-time location recording, automatic validation based on GPS coordinates, and encrypted data security. Accuracy measurement uses a comparison of the Haversine distance calculation results with a mapping application. The results of the study show that the Haversine Formula method is able to calculate distances with high accuracy, and the system developed can prevent cheating in attendance. Thus, the application of this method can improve transparency, efficiency, and accuracy of recording the attendance of PKL students in real-time, provide convenience for institutions in monitoring the presence of coordinates laboratory location accurately with a distance of ≤ 50 meters, so that the system can determine whether students are within the radius permitted to take attendance at Latitude: -2.123900 and Longitude: 106.788800. at the location of the PKL institution, namely in the ISB Atma Luhur computer laboratory.

***Keywords**: Mobile Attendance, Haversine Formula, GPS, Field Work Practice, Android.*

1. Introduction

Internship (PKL) is one of the programs aimed at providing direct work experience to students in the industrial world, government agencies, or other sectors related to their field of study. In its implementation, recording attendance for the internship activity is the starting point before carrying out the internship tasks and ensures the discipline and accountability of the students' activities at the internship site. However, conventional attendance methods, such as manual recording or signature-based attendance, often face various challenges, such as the possibility of fraud, recording errors, and delays in reporting attendance data [1].

With the development of technology, the use of mobile-based attendance systems has become an innovative solution to address these issues. One of the technologies that can be applied is a GPS-based attendance system, where the Haversine Formula is used to calculate the distance between two coordinate points based on latitude and longitude, ensuring that students can only record their attendance when within a predetermined

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radius [2]. By implementing this method in an Android-based mobile application, the accuracy and security of the attendance system can be significantly improved [3].

GPS-based digital attendance systems have been widely developed in various sectors, including educational institutions and the industrial world. Previous studies have shown that the implementation of digital attendance systems can reduce data manipulation and improve the efficiency of attendance management [4]. Additionally, Android-based mobile technology combined with cloud computing systems accelerates data processing and simplifies information access for the relevant parties [5].

The implementation of a mobile attendance system with the Haversine Formula method offers several advantages, such as increased accuracy, automated attendance recording, and ease of monitoring by both the school and industry mentors [6]. Therefore, this research aims to optimize the Android-based mobile attendance system using the Haversine Formula method to improve the accuracy and efficiency of recording the attendance of PKL students at the ISB Atma Luhur Computer Laboratory. Through this system, schools can easily monitor student attendance in real-time, minimize fraud, and enhance the efficiency of attendance data management. Thus, the implementation of this technology is expected to become an effective solution for a more accurate and reliable modern attendance system.

2. Research Methodology

Data collection is essential in various fields, including academic research, business, government, and industry, because the data obtained will be used to analyze trends, identify problems, and design appropriate solutions. To ensure the results are valid and reliable, the following data collection techniques are used:

a. Primary Data

1) Interviews
   Interviews are a data collection technique through direct questioning from the researcher to the laboratory technician at the ISB Atma Luhur Computer Laboratory, as well as to the PKL students, with the answers being stored or recorded.
2) Observation
   Observation is a data collection technique that involves direct monitoring of the PKL student attendance system based on Android.

b. Secondary Data

1) Literature Review
   The literature review is conducted to gain knowledge about the various concepts underlying the research process. This data collection technique is used to gather information found in articles, newspapers, books, research papers, and previous scientific publications.
2) Data Analysis Techniques
   The systematic search and compilation of information received from interviews, notes, and other materials.

c. System Design

The research process involves system development using UML (Unified Modeling Language), consisting of:

1) Use Case Diagram
   Describes the interaction between users (actors) and the system in an application or software [7].
2) Activity Diagram
   Describes the activities or functions of a system or business process in software.
3) Class Diagram
   A type of diagram in UML used to model the system's structure by representing classes, attributes, methods, and the relationships between classes in software.

4) Sequence Diagram
A UML diagram that describes the relationships between objects in and around the system, including users, displays, and so on.

d. Formula Used in GPS

In this study, the researcher uses the Haversine formula to calculate the radius distance from coordinate points in the PKL student attendance system at ISB Atma Luhur campus. This formula calculates the great-circle distance between two points, i.e., the shortest distance over the Earth's surface, providing a "as-the-crow-flies" distance between points (ignoring any hills or valleys they may fly over) [8][9]. The Haversine formula provides accurate calculations because it does not account for hills and valleys on the Earth's surface [10].

Rumus Haversine :

$$a = \sin^2(\Delta\varphi/2) + \cos\varphi 1 \cdot \cos\varphi 2 \cdot \sin^2(\Delta\lambda/2)$$
$$c = 2 \cdot \text{atan2}(\sqrt{a}, \sqrt{(1-a)})$$
$$d = R \cdot c \quad (1)$$

Explanation:
Δ : delta
φ : latitude
λ : longitude
R : radius of the Earth (average radius = 6,371 km)

Based on the research framework, as shown in Figure 1, the following application model is obtained:

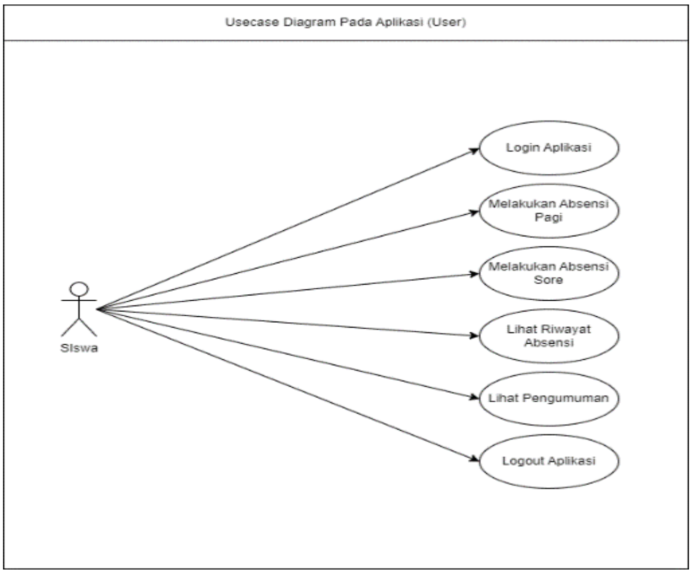

Figure 1. Application model

Figure 1. Application Model The Use Case Diagram stage in this application explains the job description activities of PKL students in using the application to perform PKL attendance.

3. Results and Discussion

a. Interface

The implementation of the PKL student attendance system is accessed on the PKL student's mobile phone. The application is developed using Java programming language in Android Studio, which is an IDE for developing software and can run on all platforms. The server is placed in the laboratory room.

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1) Interface Implementation

The following is a screenshot of the drawer menu shown in Figure 2, which contains the home menu, morning attendance, afternoon attendance, history, and logout.

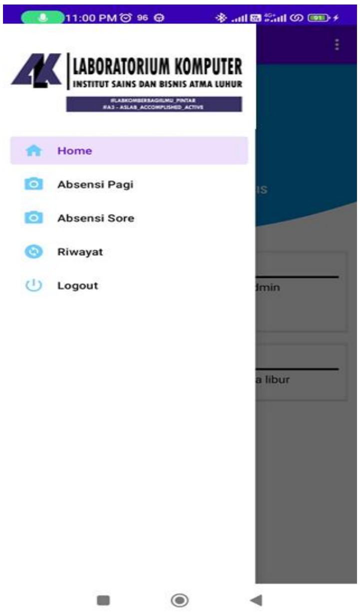

Figure 2. Drawer Menu Screen (User)

2) Screenshot of the Dashboard Page (Admin)

This screenshot shows the display after the admin successfully logs into their account on the web and is directed to the dashboard page. Below is the screenshot of the dashboard page shown in Figure 3.

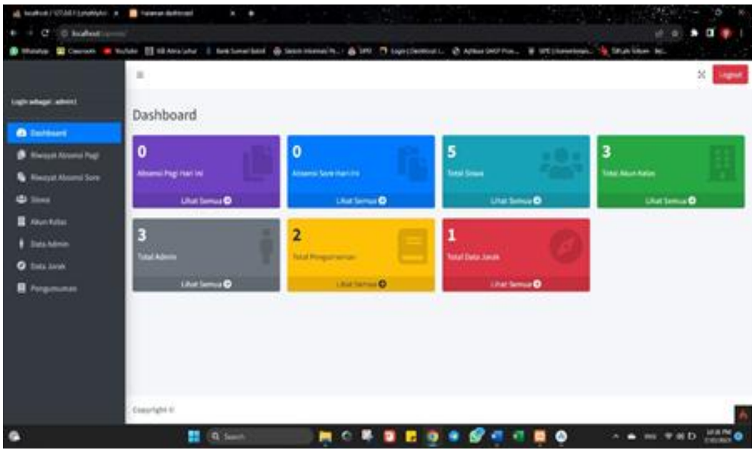

Figure 3. Screenshot of the Dashboard Page (Admin)

3) Screenshot of Morning Attendance History (Admin)

This screenshot shows the display when the admin wants to view the morning attendance history on the web application. Below is the screenshot of the morning attendance history shown in Figure 4.

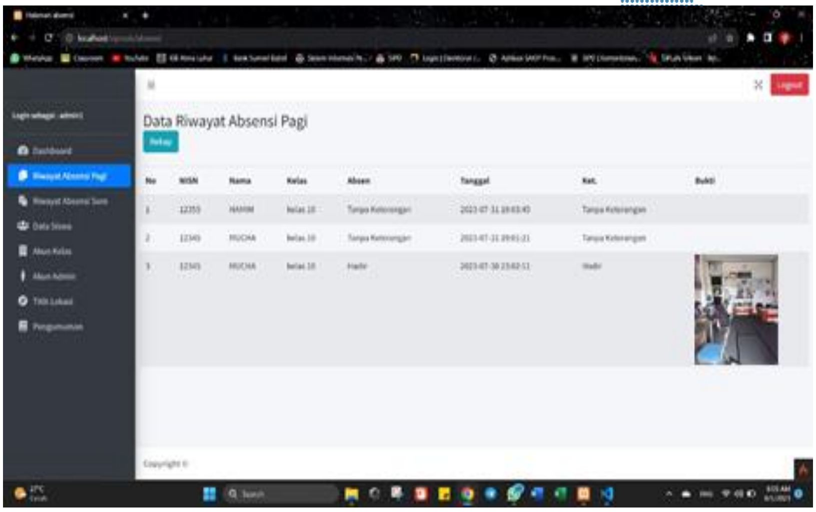

Figure 4. Screenshot of Morning Attendance History (Admin)

The Haversine Formula method is used to calculate the distance between two points based on geographic coordinates (latitude and longitude). In this study, the method is applied to determine whether the PKL students are within the allowed radius before the system records their attendance.

b. How the Haversine Formula-Based Attendance System Works

1) GPS Location Retrieval

When a student opens the attendance application, the system will:

a) Access the device's GPS to obtain the student's location coordinates (latitude & longitude).

b) Retrieve the coordinates of the ISB Atma Luhur Computer Laboratory as the reference point.

c) Distance Calculation Using the Haversine Formula

The system calculates the distance between the student's location and the laboratory using the Haversine Formula, which is formulated as follows:

$$a = \sin^2\left(\frac{\Delta\varphi}{2}\right) + \cos(\varphi_1)\cdot\cos(\varphi_2)\cdot\sin^2\left(\frac{\Delta\lambda}{2}\right)$$

$$c = 2\cdot \text{atan2}\left(\sqrt{a}, \sqrt{1-a}\right)$$

$$d = R\cdot c \qquad (2)$$

Here’s the continuation of the explanation:

$\varphi 1$, $\varphi 2$ are the latitudes of the two points.

$\lambda 1$, $\lambda 2$ are the longitudes of the two points.

$\Delta\varphi = \varphi 2 - \varphi 1$ is the difference in latitudes between the two points.

$\Delta\lambda = \lambda 2 - \lambda 1$ is the difference in longitudes between the two points.

R is the radius of the Earth (6371 km).

d) Attendance Validation Based on Radius

If the distance $d \leq 50$ meters $\rightarrow$ The attendance is accepted and recorded into the system.

If the distance $d > 50$ meters $\rightarrow$ The attendance is rejected, and the student receives a notification that they are not at the specified PKL location.

Case Study

Location of ISB Atma Luhur Laboratory

1. Latitude: -2.123456
2. Longitude: 106.789012

PKL Student's Location during Attendance

1. Latitude: -2.123900
2. Longitude: 106.788800

Maximum Distance for Attendance: 50 meters

e) The following code is used to calculate the distance between the PKL student and the ISB Atma Luhur Computer Laboratory:

```python
import math

# Fungsi untuk menghitung jarak menggunakan Haversine Formula
def haversine(lat1, lon1, lat2, lon2):
    R = 6371  # Radius bumi dalam km

    # Konversi derajat ke radian
    lat1, lon1, lat2, lon2 = map(math.radians, [lat1, lon1, lat2, lon2])

    # Perbedaan koordinat
    dlat = lat2 - lat1
    dlon = lon2 - lon1

    # Rumus Haversine
    a = math.sin(dlat / 2)**2 + math.cos(lat1) * math.cos(lat2) * math.sin(dlon / 2)**2
    c = 2 * math.atan2(math.sqrt(a), math.sqrt(1 - a))

    # Jarak dalam meter
    distance = R * c * 1000
    return distance

# Lokasi laboratorium ISB Atma Luhur
lab_lat = -2.123456
lab_lon = 106.789012

# Lokasi siswa PKL saat absensi
siswa_lat = -2.123900
siswa_lon = 106.788800

# Hitung jarak
jarak = haversine(lab_lat, lab_lon, siswa_lat, siswa_lon)

# Menampilkan hasil
print(f"Jarak antara siswa dan laboratorium: {jarak:.2f} meter")

# Validasi absensi
if jarak <= 50:
    print("Absensi BERHASIL! Anda berada dalam radius yang diperbolehkan dilingkungan Kampus ISB Atma Luhur.")
else:
    print("Absensi DITOLAK! Anda berada di luar radius yang diperbolehkan.")
```

Figure 5. Source Code to Calculate Distance

c. System Testing and Evaluation

The attendance system was tested with several scenarios to ensure its accuracy:

1) Accuracy Testing of Distance Calculation
   a) The comparison of the Haversine formula calculation results with mapping applications such as Google Maps showed a small deviation (±2 meters), which is still within acceptable tolerance for attendance purposes.
   b) The laboratory and student locations were tested under various GPS conditions (outdoor vs. indoor), with the results being fairly stable.
2) System Performance Testing
   a) The system is able to process and validate attendance in less than 2 seconds.
   b) The server load for storing attendance data remains light, as it only stores coordinates and attendance time.
3) User Evaluation (Students & Admin)
   a) 90% of students found the attendance system to be more practical compared to manual methods or barcode scanning.
   b) The laboratory admin felt that the attendance system was more accurate and transparent, reducing the possibility of proxy attendance.

4. Conclusion

The results of this study indicate that the Haversine Method is capable of accurately calculating the distance between the student's coordinate points and the laboratory location, with a distance of ≤ 50 meters. This allows the system to determine whether the student is within the allowed radius to perform attendance at Latitude: -2.123900 and Longitude: 106.788800. With this system, the attendance process becomes more practical and automated, reducing the likelihood of fraud, such as proxy attendance, due to real-time location-based validation.

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