EMITTER International Journal of Engineering Technology
Vol. 5, No. 2, December 2017
ISSN: 2443-1168

Determination of Nearest Emergency Service Office using Haversine Formula Based on Android Platform

M.Basyir[1], M.Nasir[2], Suryati[3], Widdha Mellyssa[4]

[1,3,4]Department of Electrical Engineering,
[2]Department of Information and Communication Technology
Lhokseumawe State Polytechnic, 24301 Aceh, Indonesia
Email: m.basyir@pnl.ac.id[1], masnasir.tmj@gmail.com[2] , suryati@pnl.ac.id[3],
widdha.mellyssa@pnl.ac.id[4]

ABSTRACT

Emergency Reporting Application is an Android-based application that serves to help the community in reporting the emergency condition. This application allows users to choose and contact the emergency services office, without the need to notice their position and phone number. Selection of emergency services office is also automatically selected by the system by taking into account the distance between the complainant and the emergency services office. The selected emergency services office is the nearest emergency service office from the complainant so that the delay in coming assistance can be minimized. Therefore, this proposed application requires a GPS (Global Positioning System) feature recording, reporting and SMS (Short Message Services) positioning for message delivery of reports. The distance between the position of the complainant and the position of the emergency service office, in the form of latitude and longitude data, is requested using the Haversine formula taking into account the degree of curvature of the earth. Emergency service offices include police and hospital offices spread over 25 different districts. Furthermore, the reporter's position calculation results were compared with all selected emergency service offices and obtained 1 nearest emergency service office. Calculating the accuracy and delay value of the system will do system testing. Accuracy test results using the method of 100% Haversine and the average delay of the system is 4.5 seconds.

Keywords: delay, distance, gps and haversine formula

1. INTRODUCTION

Emergency often occurs unnoticed suddenly; generally, a person is not prepared to deal with emergency conditions that befall him. The government has released a contact number that can be contacted by the public in an emergency situation so that help is on the way immediately [1]. However, most people do not keep the number, so in the search for assistance must go through several parties and take longer.

Emergency service office especially police stations and hospitals are available in every sub-district that is intended to facilitate reporting and anticipate delays in handling emergency situations. Therefore, we proposed and created an Android-based app that is able to run on smartphones to assist people in reporting emergency situations. This app aims to locate the nearest service office of the whistleblower by sending reporter coordinate data directly to the emergency services office phone number that has been stored by the system.

The emergency service office that is contacted by the system is the closest distance emergency services office from the complainant. Information on reporting positions and emergency services office in the form of coordinates taken using GPS. The position of the reporter is taken in real-time, at the location where the reporting is submitted, while the positions of all emergency service office have been stored in the admin database.

Selected emergency service office and reporting data are recorded in the database web-based presented. From that point of view, information is evaluating the level of accuracy while the delay of the system is measuring from the time the reporter submits the report until the report is received by the emergency services office.

2. RELATED WORKS

Several previous studies have discussed the search for the distance between one-point to another by using the Haversine formula. From the results of conducted studies, there are reference libraries relevant to this research by Putra, D. (2015), Haversine formula is used to measure the land area in the form of web-based information system, the results obtained is the level of accuracy calculation of land area between the result of measurement using Haversine formula to the actual measurement result by manual measurement method [2]. Prasetyo, D (2012), Haversine formula used to calculate the distance of the user position by the church in a region, the results obtained from the study is an Android-based application that displays information about the distance between users and the church contained in the system database [3]. Khairina, D. M. (2017), Haversine formula is used to find the courier location of the nearest web-based JNE, the result of this research is a web that can be accessed by people in Samarinda, Indonesia [4].

The application of emergency reporting is an application to locate and contact the nearest service office of the user i.e. ambulance and police station. In Indonesia in particular, there are no emergency reporting apps ca search and contact automatically. The determination of the distance between reporter (user) and the emergency services office used Haversine formula and the test results obtained from the formula are compared with results obtained from Google maps. Next, in this research, the calculation of the accuracy level of determining the nearest service office using distance calculation based on Haversine formula and based on distance of land transportation line calculated by Google Maps. In addition to the distance, detection required also the observation of the time required for the system to

forward the reporting information sent by the user to arrive at the nearest emergency services office.

3. HAVERSINE FORMULA

The calculation of the distance from one point to another on the surface of the earth is affected by a certain degree of curvature [2,3,4]. Therefore, the choice of distance calculation method on the surface of the earth greatly affects the accuracy of the results to be obtained. Haversine formula is a method that calculates the considered distance appropriately and accurately. In this research, Haversine formula is used to calculate the distance between two points using latitude and longitude data.

In Figure 1 we can see the difference between the latitude and longitude lines. Latitude is the line used to measure the distance between the north and south of the earth against the equator line. While longitude is a line used to measure the distance between the west and east of the earth from the main meridian line.

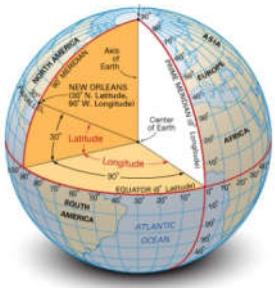

Figure 1. The hemisphere shows the difference between the latitude and longitude lines [5]

Haversine formula: $d =$

$$2r\arcsin\sqrt{sin^2\left(\frac{\phi_2-\phi_1}{2}\right)+\cos(\phi_1).\cos(\phi_2).sin^2\left(\frac{\psi_2-\psi_1}{2}\right)} \quad (1)$$

where d is a distance (km), r is a radius of the earth, which is 6371(km), ϕ is latitude and $\boldsymbol{\psi}$ is longitude. 1 degree is equal to 0.0174532925 radians.

4. SYSTEM DESIGN

The system is designed using a client-server architecture, where the client is an application user that accesses the server and the server is the database where all data storage required by the system. Figure 2 shows the sender request data flow from the user to the database and sends the response from the database back to the user. Service requests in the form of a selection of the nearest service office sent by the user using POST request format to obtain coordinate information office services. POST method is one of the data transmission formats in PHP programming language to send sensitive data. Furthermore, the server provides a response in the form of JSON (JavaScript Object Notation) response to the client to get

the phone number of the nearest selected service office and SMS format that contains the condition and coordinates of the user.

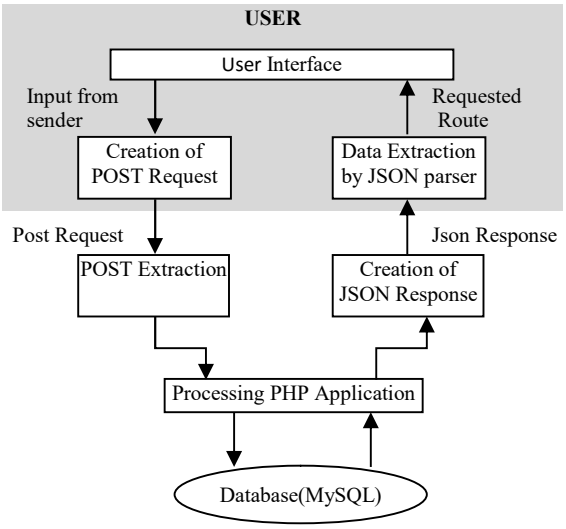

Figure 2. Emergency reporting apps service system design

4.1 Architecture Design

The application is developed so that users can report the emergency to the closest distance service office. The user position is taken in real-time using the GPS feature on the mobile device whereas the position of the entire office service is stored in the database. Figure 3 indicates the service architecture of the built application. Service architecture is designed simply where senders as reporters submit service requests through their smartphone devices. Requests are sent to the database server via the Internet. The server then calculates the distance between the coordinates of the sender with all coordinates of the service office stored in the database. The results are sent back to the user along with the messages sent by the sender to the receiver automatically using the SMS feature.

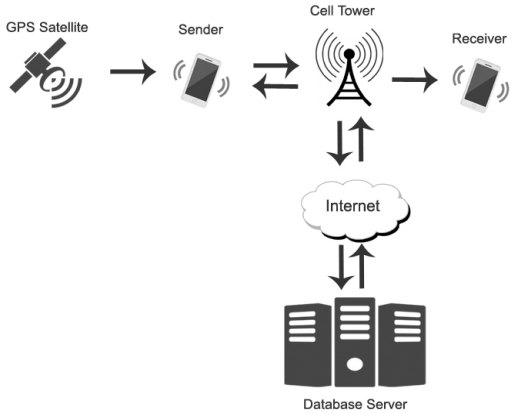

Figure 3. Emergency Reporting Apps service architecture

4.2 User Interface Design

Development of this proposed app is a user interface using Android Studio software with Java programming language and XML as a display. Features used in the form of Google maps API and GPS to record the location of the reporter, as well as SMS to send a message to the recipient. Broadly speaking the application page consists of 4 main pages, the registration, log page, pattern lock and the main page, respectively. To confirm the truth of the menu options, it is available by applying pop-up notifications appear.

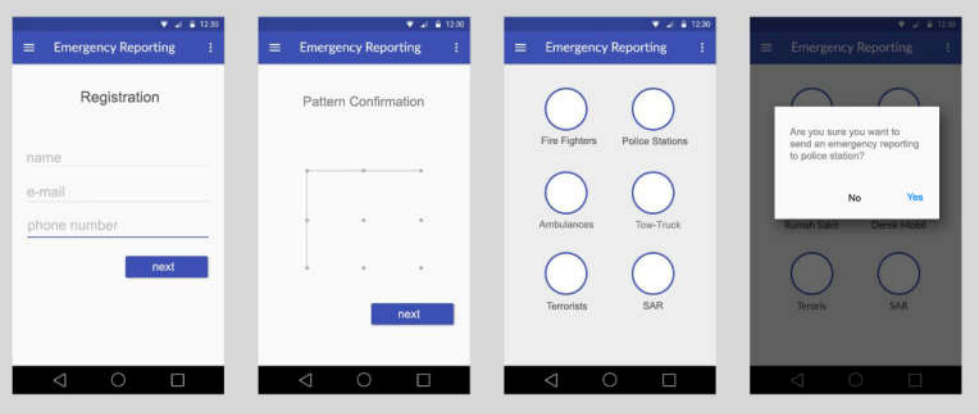

Figure 4. User interface design application emergency reporting

5. SIMULATIONS RESULT

Measuring the level of accuracy and the delay does the testing of the system. Accuracy is the system success rate of choosing the nearest service office of the complainant. While the system delay is measured by calculating the time required by the system in receiving and processing requests from the user. The measurement of time starts from the user sending the service report until the report gets to the selected emergency service office. System delay calculations are not affected by network conditions since network conditions are considered ideal in the test area.

Taking 5 random samples from different district areas is the way the simulation conducted. The sample is a coordinate reporter who accesses the Emergency Reporting application to locate the nearest service office. Simulated emergency services are police and hospital (ambulance).

5.1 Accuracy

Comparing the position of 3-service office from the reporting position is the way the accuracy level testing conducted. The position of the service office and the reporter is expressed in the value of latitude and longitude. In Table 1, the 1st and 2nd columns show the coordinates of the interim reporters. While the 3rd and 4th columns show the coordinates of the service office tested. The number of reporting positions tested is 5 positions where each position accesses 2 service office namely ambulance and police station

so that the total number of samples is 10 samples. The accuracy level of selection of nearest emergency services office can be seen in table 1.

Table1. Distance calculation using haversine formula and google maps

Coordinate of user		Coordinate of service office		Distance-Haversine (km)	Distances-Google maps (km)	Type of service
lat1	long1	lat2	long2			
1	2	3	4	5	6	7
5.1798	97.1487	5.1751	97.1383	1.2647	2.0	Ambulance
		5.1808	97.1218	2.9810	4.0	
		5.1134	97.1671	7.6594	10.9	
5.1199	97.1573	5.1125	97.0781	8.8101	11.2	Ambulance
		5.1134	97.1671	1.3040	1.8	
		5.1808	97.1218	7.8303	8.3	
5.0750	97.2568	5.1160	97.2027	7.5291	8.9	Ambulance
		5.1032	97.2533	3.1596	4.3	
		5.0670	97.2644	1.2247	1.5	
5.1107	97.2328	5.1032	97.2533	2.4188	2.5	Ambulance
		5.1160	97.2027	3.3853	3.8	
		5.0561	97.2030	6.9104	10.2	
5.1108	97.2329	5.1160	97.2027	3.3943	3.8	Ambulance
		5.0670	97.2644	5.9910	6.5	
		5.1032	97.2533	2.4122	2.5	
5.1798	97.1487	5.1759	97.1409	0.9665	1.3	Police Station
		5.2179	97.0544	11.2692	13.9	
		5.1161	97.1737	7.6050	11.2	
5.1199	97.1573	5.1122	97.0786	8.7581	11.2	Police Station
		5.1161	97.1737	1.8648	2.1	
		5.2179	97.0544	15.7671	18.1	
5.0750	97.2568	5.0640	97.2628	1.3920	1.9	Police Station
		5.1033	97.2477	3.3043	3.7	
		5.1166	97.2245	5.8476	6.4	
5.1107	97.2328	5.07228	97.2065	5.1707	8.4	Police Station
		5.1166	97.2245	1.1293	1.3	
		5.1033	97.2477	1.8440	1.9	
5.11089	97.2329	5.1166	97.2245	1.1320	1.3	Police Station
		5.1033	97.2477	1.8391	1.9	
		5.0640	97.2628	6.1683	6.9	

The 5th and 6th columns (Table 1), are the results of distance calculations using the Haversine formula and the distance indicated by Google maps. The yellow colored column shows the closest distance between the 2 other test points. From that point of view, we can see that the test results used two test methods show the position of the nearest emergency office of the same service, although the distance calculation results and the distance indicated by Google Maps have different values. This is very

reasonable because the distance indicated by Google maps follows the direction of the road while the Haversine formula calculates the distance of 2 points in a straight line.

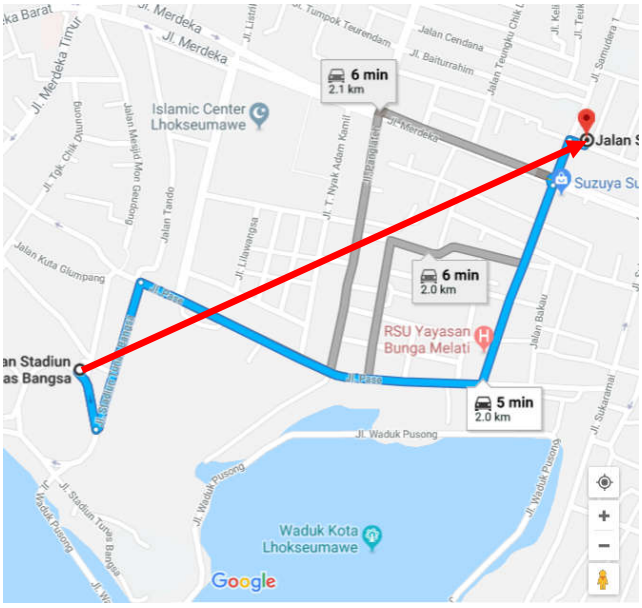

Figure 5. Example of distance using the formula of Haversine (red line) and Google maps (blue line)

Figure 5 shows the example of calculating the distance between users located on latitude: 5.1798 and longitude: 97.1487 with ambulance located at latitude: 5.1751 and longitude: 97.1383. From the determination of the distance using google map, the distance between the two points is 2.0 km. Then, the determination of the distance using Haversine is as follows:

$$d = 2r\ arcsin\left(\sqrt{sin^2\left(\frac{\phi_2 - \phi_1}{2}\right) + \cos(\phi_1) * \cos(\phi_2) * sin^2\left(\frac{\psi_2 - \psi_1}{2}\right)}\right)$$

$$d = 2 * 6371 * arcsin\left(\sqrt{sin^2\left(\frac{5{,}1798\ - 5{,}1751}{2}\right) + \cos(5{,}1751) * \cos(5{,}1798) * sin^2\left(\frac{97{,}1487\ - 97.1383}{2}\right)}\right)$$

$$d = 12742 * arcsin\left(\sqrt{sin^2\left(\frac{0{,}0047}{2}\right) + \cos(5{,}1751) * \cos(5{,}1798\ ) * sin^2\left(\frac{0{,}0104}{2}\right)}\right)$$

$$d = 12742 * arcsin\left(\sqrt{1{,}68225 * 10^{-9} + 0{,}9959 * 0{,}9959 * 8{,}2368 * 10^{-9}}\right)$$

$$d = 12742 * arcsin(9.9257 * 10^{-5})$$

$$d = 1{,}2\ km$$

Calculation of accuracy value using Haversine formula, as follows:

$$\text{Accuracy of nearest office} = \frac{\text{Similarity of the nearest service office between Haversine formula and Google map}}{\text{number of service offices tested using Google map}} \text{x}100\% \quad (2)$$

$$Accuracy\ of\ nearest\ office = \frac{10}{10} x100\%$$

$$Accuracy\ of\ nearest\ office = 100\%$$

5.2 Delay System

Calculating the time required by the system to deliver emergency reports is done to the system delay test. Time is calculated from the submitted reports by the user until reports are received by the nearest emergency service office. The test is conducted 10 times with the number of reporting positions tested by 5 positions where each position will access 2 service offices, namely ambulance and police station. System delay testing can be seen in figure 6.

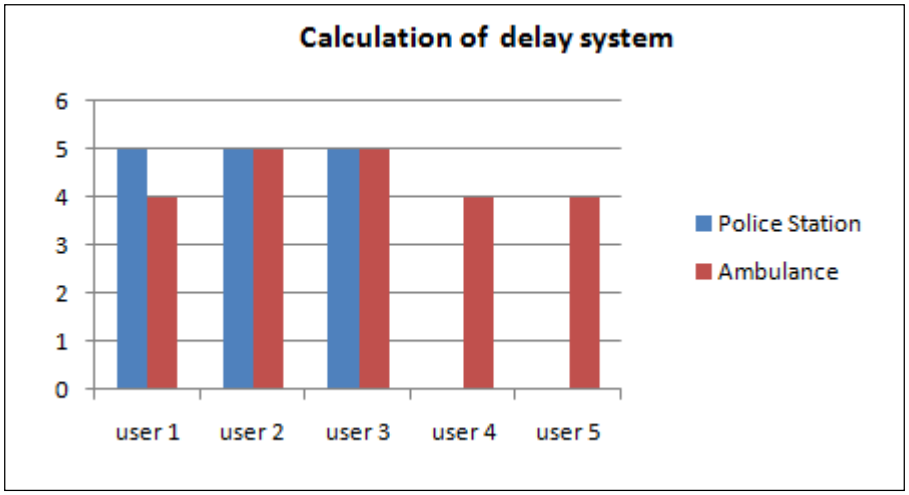

Figure 6. Calculation of delay system graph

The average time the system needs to deliver emergency reports:

$$DelaySystem = \frac{number\ of delay}{number\ of\ test}(s) \quad (3)$$

$$DelaySystem = \frac{4+5+5+4+4+5+5+5+4+4}{10}(s)$$

$$DelaySystem = 4.5\ s$$

6. CONCLUSION

We have successfully developed an emergency reporting apps to assist the community in reporting assistance requests. Emergency services are selected by calculating the distance between the complainant and all available nearest emergency services and finding the closest distance to the complainant. Determination of distance using the Haversine formula as a distance search formula that takes into account the degree of curvature of the earth. From the test results, the level of accuracy of the system in determining the nearest service office for 100% and the average system delay is 4.5 seconds.

References

[1] Menkominfo.(2017). **Kemenkominfo Creates Emergency Call Center Service 112 like 911**. Retrieved from https://news.detik.com/berita/d-3394190/kemenkominfo-buat-layanan-call-center-darurat-112-seperti-911

[2] Putra, D., & Herwan, R. (2015). **Implementation of Haversine method formula in the information system of geographical landscaping**. *Jurnal Sistem dan Teknologi Informasi (JustIN)*, *1*(1).

[3] Prasetyo, D., & Hastuti, K. (2012). **Application of Haversine Formula for selecting Location and Christian Church based on Mobile**. *Semarang: Universitas Dian Nuswantoro*.

[4] Khairina, D. M., Ramadhinata, F. W., & Hatta, H. R. (2017). **Determinating of the Nearest Jalur Nugraha Ekakurir (JNE) Office Using Haversine Formula (Case Study in Samarinda)**. *Prosiding SENIATI*, *3*(1), 10-1.

[5] Chopde, N. R., & Nichat, M. (2013). **Landmark based shortest path detection by using A* and Haversine formula.** *International Journal of Innovative Research in Computer and Communication Engineering*, *1*(2), 298-302.

[6] Blattner, A., Vasilev, Y., & Harriehausen-Mühlbauer, B. (2015). **Mobile indoor navigation assistance for mobility impaired people**. *Procedia Manufacturing*, *3*, 51-58.

[7] Sekar, B., & Liu, J. B. (2014, June). **Location based mobile apps development on Android platform**. In *Industrial Electronics and Applications (ICIEA), 2014 IEEE 9th Conference on* (pp. 2148-2153). IEEE.

[8] Higuera, S de Frutos dan M. Castro.2013. **Using smartphones as a very low-cost tool for road inventories**. *Elsevier.* Transportation Research Part C: 136-145.

[9] The Editors of Encyclopædia Britannica(2017). **latitude and longitude. Retrieved** from https://www.britannica.com/science/latitude

[10] Basyir,M.,Nasir,M.,Suryati.,Widdha. (2017).**Emergency Reporting Apps Development on Android Platform**. *Proceeding LIS Malaysia*.

[11] Karlita, T., Basuki, A., & Makarti, L. (2013). Mobile Application to Identify Indonesian Flowers on Android Platform. *EMITTER: International Journal of Engineering Technology*, *1*(1), 1-1.