On Designing Application of Finding Nearby Islamic Boarding Schools in West Java using Haversine Formula and Euclidean Distance Algorithms

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Abstract. Islamic Boarding School is one of the alternative schools that are of interest to Indonesians. Finding the most appropriate boarding school is one of the initial strategies in determining schools. There are 25,938 pesantren in Indonesia, 8,264 of them are in West Java. The search for Islamic boarding schools is important considering the large number of them. This paper aims to tell the design of the search application for the nearest boarding school using Haversine Formula and Euclidean Distance algorithm. Applications that will be made compare the two methods so that they get the best results by using Longitude and Latitude calculations. The results showed that the application of the Haversine formula algorithm and the Euclidean distance on the nearest location search application was successfully built and could be used to find Islamic boarding schools in West Java. Haversine Formula and Euclidean Distance algorithms are able to provide distance accuracy to the location. But the Euclidean distance algorithm is more accurate than the haversine formula with a difference of 0.07 KM.

Keywords: Havesine Formula, Euclidean Distance Algorithm, Islamic Boarding School, location, Geographic information system.

1 Introduction

Indonesia is considered as a home for Muslims because it ranks first as the country with the highest number of Muslims in the world. About 202.9 billion Indonesians, or 87.2% of the population, embrace Islam [1]. This triggered the growth of Islamic boarding schools from year to year as the choice of Muslims to send their children to school [2]. Based on data from the Indonesian Ministry of Religion Headquarters, currently, there are 25,938 Islamic boarding schools spread in Indonesia [3]. Of the total existing pesantren, the province of West Java has the highest number of pesantren, 82.2% or as many as 8264 pesantren. With a provincial area of 35,378 km², the location of Islamic boarding schools in West Java is spread throughout the region.

One of the things that are considered by parents in choosing a child's school is in terms of distance [4]. Sometimes parents or prospective students need to know which pesantren is ideally located with the criteria they have while knowing the profile of the pesantren. Knowledge about distance is also needed by employees of the Ministry of Religion when conducting surveys. Given the amount is not small, it takes an application that can facilitate the search for the location

of Islamic boarding schools. For this reason, we created an application that can search for the location of the closest pesantren from the user's home location.
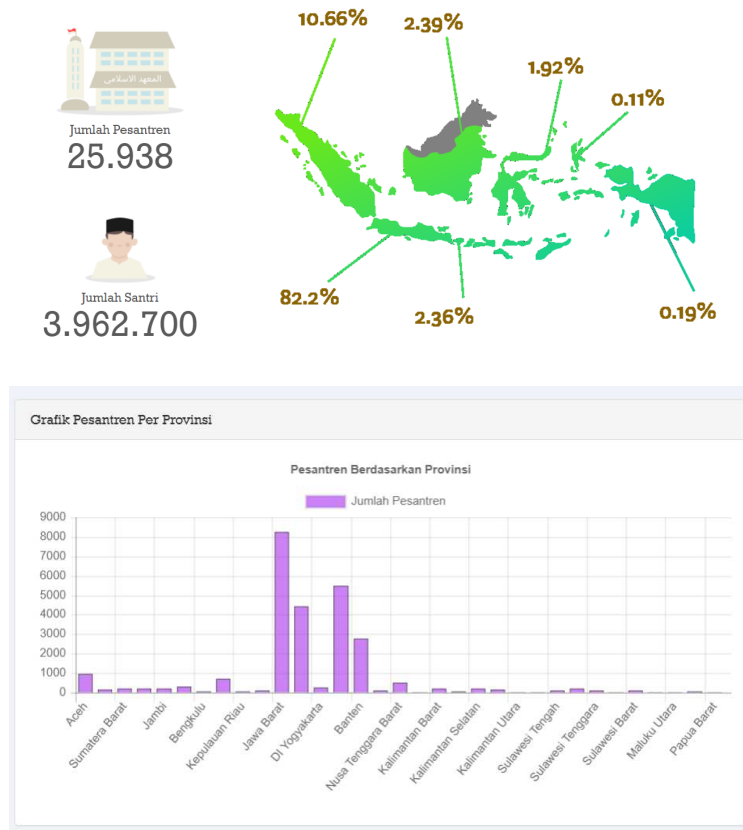

Figure 1. Islamic School Spread Statistics in Indonesia

The method used in this application is the Haversine Formula and Euclidian Distance Algorithm. The Haversine method has been used in research aimed at finding the nearest location, for example for the search for attractions [5], tourism locations [6], college locations [7], and searching for hospitals and health centers [8]. Based on previous research, this method is able to produce real distance calculations through sky and latitude calculations from several locations. The Euclidian Distance algorithm can also be used for location search. Like looking for attractions, culinary objects, and accommodations that can be used by users [9]. In this paper, we will present a system that applies the Haversine Formula and Euclidian Distance algorithms to search for the location of the nearest boarding school. Next, we will explain the performance of the two algorithms to find out which algorithm is better.

2   Haversine Formula

The haversine formula is an important equation in the navigation system, later Haversine this formula will produce the shortest distance between two points, for example on a ball taken from longitude and latitude. This method calculates the distance between coordinate and other coordinates in a straight line and ignores the hills or valleys on the surface. The input of this method is in the form of latitude and longitude (coordinates) the location to be calculated and the output is in the form of distance values between the two locations. The coordinates used can vary depending on the application [5].

Navigation usually uses coordinates in longitude and latitude, while air navigation can also include heights. Waypoint is usually used for navigation systems on the Global Positioning System (GPS) and certain types of radio navigation. Waypoints located on the surface of the earth are usually defined in two dimensions, longitude, and latitude, while those used in the atmosphere of the earth or in space are defined in at least three dimensions or four if time is one of the coordinates for some points outside Earth. The use of this formula is quite accurate for most calculations, also ignoring the height of the hill and the depth of the valley on the surface of the earth [5]. The search for haversine is written with the following equation.

$$x = (lon_2 - lon_1) * \cos(\frac{lat_1 + lat_2}{2}); \tag{1}$$

$$y = (lat_2 - lat_1); \tag{2}$$

$$d = sqrt\ (x * x + y * y) * R \tag{3}$$

With:
X: Longitude,
Y: Latitude,
d : Distance
R = Earth Radius = 6371 km, (1 degree = 0.0174532925 radian).

Angles on formulas use radians to use trigonometric functions. The haversine formula is used in this study to calculate the range of the radius of search for Islamic boarding schools whose position is closest to the user. This formula is also used to substitute the calculation of the distance between the position of the Islamic boarding school and the user's position.

This algorithm will be used to calculate the distance between two GPS coordinate points. In this case the coordinate point of the user's position with the position of the coordinated destination, so that this algorithm becomes the main key to determine the distance between the user's position and the Islamic boarding school based on the radius. Figure2 ball triangle with the following Haversine Formula law.
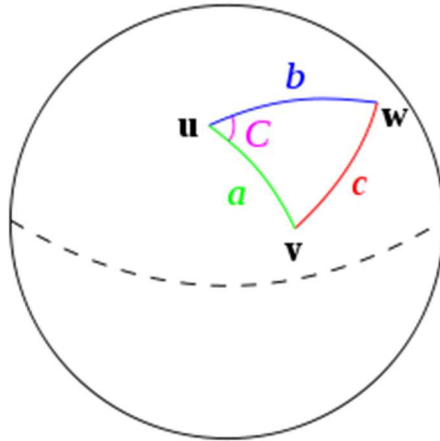
Figure 2. The ball triangle with the Haversine Formula law

If the lengths of the three sides are a (u to v), b (from u to w), and c (from v to w), and the opposite angle c is C, then the law of haversine formula is as follows. Haversine (c) = haversine (a-b) + sin (a) sin (b) haversine (c).

In search of distance, the Haversine Formula method can be used in the calculation between the current position to the location using latitude and longitude. Following is an example of calculating the distance using Haversine Formula, point A is the Sunan Gunung Djati Bandung Islamic University, A.H. Nasution Cibiru (-6.9316435, 107.7150027) and point B is the Jakarta National Monument (-6.1753871, 106.8249641). if it is displayed on Google Maps it will be as shown in Figure3 as follows.
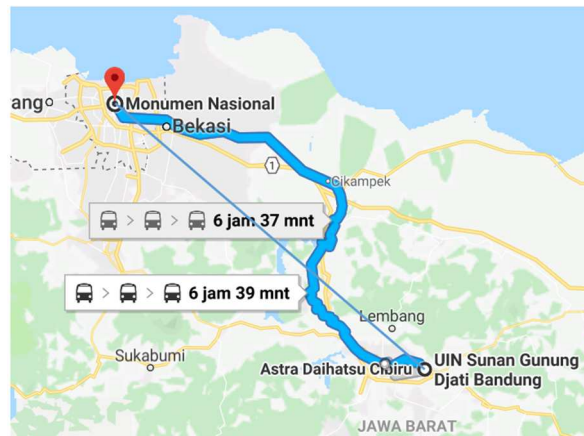

Figure 3. Distance between 2 locations on Google Maps

From the map, there are 2 points between UIN Bandung and the National Monument Monument, so:

Lat 1   : -6.9316435   long 1   : 107.7150027
Lat 2   : -6.1753871   long 2   : 106.8249641

First, multiply latitude and longitude with a radius.

Lat 1   = -6.9316435 * 0.0174532925 radian
               = -0.120980001 radian
Lon 1   = 107.7150027 * 0.0174532925 radian
               =1.879981449 radian
Lat 2   = -6.1753871 * 0.0174532925 radian
               =-0.107780837 radian
Lon 2   = 106.8249641 * 0.0174532925 radian
               = 1.864447345 radian

After obtaining from the multiplication, then it is entered into the formula haversine formula as follows:

$$x = (lon_2 - lon_1) * \cos(\frac{lat_1 + lat_2}{2})$$

$$= (1.864447345 - 1.879981449) * \cos((-0.120980001 + \frac{-0.107780837}{2})$$

$$= (0.015534104) * \cos\frac{-0.013199164}{2}$$

$$= 0.015534104 * \cos(-0.006599582) = 0.015533765 => 0.0153377$$

$$y = (lat_2 - lat_1)$$
$$= (-0.107780837 - (-0.120980001)$$
$$= 0.01317631$$

$$d = sqrt\ (x * x + y * y) * R$$
$$= sqrt\ (0.0153377^2 + 0.01317631^2) * 6371$$
$$= sqrt\ (0.004147898) * 6371$$
$$= \sqrt{0.004147898} * 6371$$
$$= 6.020366388 * 6371$$
$$= 129.7542579 \quad => \quad 129.7\ km$$

Then the distance obtained between the location of the UIN Bandung and the Jakarta National Monument using the Haversine Formula algorithm is 129.7 km.

3 Euclidian Distance Algorithm

Euclidean distance is a method for searching distances between 2 coordinate points, which in this method is a distance calculation using the latitude and longitude [9]. The following is an example of calculating the distance using Euclidian Distance Algorithm, point A is the Sunan Gunung Djati State Islamic University Bandung A.H. Nasution Cibiru road (-6.9316435, 107.7150027) and point B is the Jakarta National Monument (-6.8917817,107.7358739). Then obtained:

Lat 1   = -6.9316435   *long 1*   = 107.7150027
Lat 2   = -6.1753871   *long 2*   = 106.8249641

The Euclidean distance formula is as follows:

$$Ed = \sqrt{(lat_1 - lat_2)^2 + (long_1 - long_2)^2}$$

$$Ed = \sqrt{\begin{array}{l}(-6.1753871-(-6.1753871))^2 + \\ (107.7358739-107.7150027)^2\end{array}} * 111.319$$

     First, calculate the latitude and longitude parts to be as follows.

$$Ed = \sqrt{(0.7562564)^2 + (0.8900386)^2} * 111.319$$

     Calculate by lifting each one.

$$Ed = \sqrt{1.364092452} * 111.319$$
$$Ed = 1.167943685 * 111.319$$
$$= 130{,}014$$

     Then the results obtained from the distance between UIN Bandung to Jakarta national monument are = 130 km.

4 Comparison of the Haversine Formula and Euclidean Distance Algorithms

     The search system for the location of the nearest boarding school can calculate the distance between 2 coordinate points using the haversine formula and Euclidean Distance algorithm. From the calculation results, the distance from UIN Bandung to the Jakarta National Monument is obtained.

     The results of the google map distance between UIN Bandung to the Jakarta National Monument is 129 km, while the results obtained using the haversine formula algorithm are 129.7 km while using the Euclidean Distance algorithm is 130 km, therefore the calculation of the Euclidean Distance and haversine formula algorithm is more accurate than with google maps.

     The difference from google maps with the algorithm used is quite far, which is 3 km, therefore the haversine and Euclidean distance algorithms are quite accurate in calculating distances.

5 Implementation

5.1 Home Page

     The Android home page is the starting page on Android. On this page, there are 4 menu choices including, maps menu, category menu, news menu, and menu about. Can be seen in Figure 4.

5.2 Maps Page

On this page, the community can see Islamic boarding schools using 2D maps, in which there will be all Islamic boarding schools in West Java. Can be seen in Figure5.

5.3 Category Page

On the category page, the community can choose a cottage by category. These categories include Nadhlatul Ulama, Persatuan Islam, and Muhammadiyah. Display of categories can be seen in Figure6.
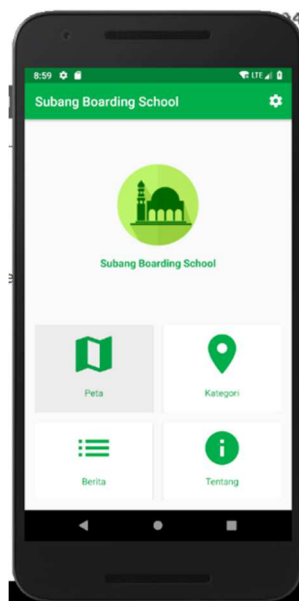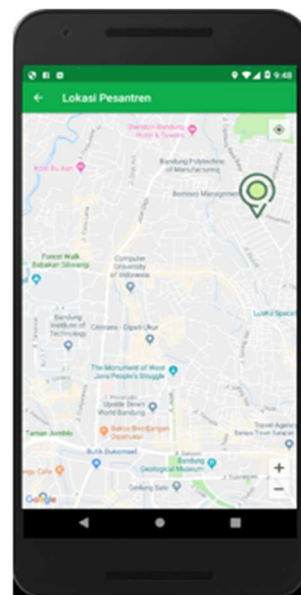

Figure 4. Homepage display

Figure 5. Maps display

5.4 List Pondok Pesantren

This page is a page after selecting a category, the list of boarding schools will appear. On this page, all Islamic boarding schools will appear at a distance. Can be seen in Figure 7.
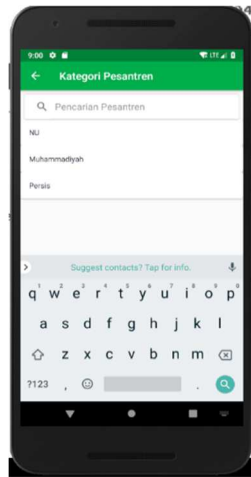
Figure 6. Category Page   **Figure 7.** Boarding School List

5.5 Detail Page

On the detail page contains detailed information from the Islamic Boarding Schools that were previously selected. Data in the form of address, contact, and distance from the starting point.
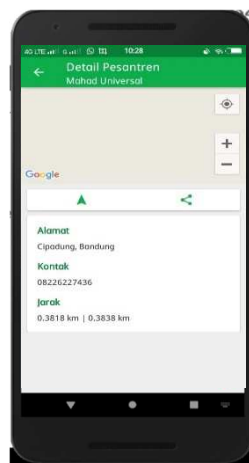

Figure 8. Boarding School details page

6 Result and Discussion

The test results from the Haversine Formula and Euclidean Distance algorithms are then compared with the distance from Google map, so the test data is obtained as follows. In this test, the starting point came from the same location, namely UIN Sunan Gunung Djati Bandung.

Table 1. Comparison of Algorithm

No	End Point (Destinations)	Google Maps	Haversine Formula	Euclidean Distance
1	Al Falah	14.7 km	14.7553 km	14.7616 km
2	Al Hidayah	15.06 km	15.1202 km	15.1271 km
3	As Syfa	13.1 km	13.2033 km	13.2072 km
4	Al Mukhlis	24.7 km	24.1492 km	24.1854 km
5	Miftahul Jaza	30.4 km	30.1154 km	30.1339 km
6	Persis No 84 Ciganitri	10 km	10.0644 km	10.0771 km
7	Al Mukhlisin	11.1 km	11.1709 km	11.1819 km
8	Yayasan Salafiyah A	15.22 km	15.2919 km	15.2979 km
9	Al Misbah	7.6 km	7.6708 km	7.71 km
10	Darul Hikmah	13.58 km	13.6552 km	13.1367 km
11	Persis 31 Banjaran	20.15 km	20.2268 km	10.2704 km
12	Darul Ulum	12 km	12.0434 km	12.0294 km
13	Mathla'ul Huda	13.4 km	13.4645 km	13.5109 km
14	Al Ihsan	14.31 km	14.3851 km	14.4119 km
15	Al Basyariyah 3	19.78 km	19.8574 km	19.864 km
16	Al Huda	25.5 km	25.5603 km	25.5653 km
17	Al Burhan	10.8 km	10.8891 km	10.886 km
18	Al Barokah	15.2 km	15.9115 km	15.9015 km
19	Al Adzkar	17.37 km	17.4475 km	17.4299 km
20	Ahmad Dahlan	14.26 km	14.3329 km	14.3196 km

The results of testing of the haversine formula and Euclidean distance on the search for the location of the nearest Islamic boarding school were then tested for the accuracy level as follows.

$$Accuracy = \frac{Amount\ of\ Correct\ Data}{Amount\ of\ overall\ data} \; x\; 100\%$$
$$= \frac{18}{20} \; x\; 100\% = 85\%$$

So the accuracy of the haversine algorithm and the Euclidean distance is 85%.

Accuracy is a formula for calculating the accuracy made after testing with 20 test rules contained in the system and resulting in 3 failures, then a total accuracy of 85% is obtained. This number is the accuracy given based on the performance of the haversine formula algorithm and Euclidean distance to the system.

7 Conclusion

The application of the haversine formula and Euclidean distance algorithms on the nearest location search application was successfully built and can be used to search for Islamic boarding schools in West Java so that people can choose and search for the closest Islamic boarding schools in the community using Android. The application is made capable of displaying all Islamic boarding schools in West Java equipped with information and distance to the location of Islamic boarding schools. The haversine formula and Euclidean distance algorithms can provide distance accuracy to the location. The level of accuracy of Euclidean distance is higher than the haversine formula by showing the average distance difference of 0.07km from 20 trials.

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