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Preface

The 2nd International Conference on Applied Science and Technology - Engineering Sciences (iCAST-ES 2019), organized by the Indonesian Polytechnics Consortium has been held in Bali Nusa Dua Convention Center, Bali, Indonesia on October 24-25, 2019.

This prestigious conference is aimed at bringing together the researchers and experts in intelligent technology from educational institutions, R & D, industry, government and the community to exchange and share ideas, knowledge through a discussion of a wide range of issues related to green development through millennial industrialization.

All full papers have been reviewed and evaluated based on originality, research content, depth, correctness, relevance to conference issues, contributions, and readability. Topics of Interest (iCAST-ES 2019) include, but not limited to, civil engineering advancements for sustainable infrastructure, innovate and applied mechanical engineering to support sustainable industrial revolution, intelligence system for sustainable electricity and informatics engineering, renewable energy system and smart grid technology, control system, robotics, mechatronics and automation, food processing and technology, physics technology, chemical engineering and basic engineering science. The papers are published in open access Journal of Physics: Conference Series.

Warm regards,

Dr. Dra. Ni Nyoman Aryaningsih, MM

General Chair

Peer review statement

All papers published in this volume of *Journal of Physics: Conference Series* have been peer reviewed through processes administered by the proceedings Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

Measure distance locating nearest public facilities using Haversine and Euclidean Methods

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Abstract. The application of finding the nearest public facility using 2 methods to measure the distance between 2 points, i.e. the Euclidean Method and the Haversine Formula. Euclidean is a heuristic function obtained based on direct distance without obstacles such as to get the value of the length of a diagonal line on a triangle. Whereas Haversine is an equation that looks for the distance of an arc between two points on longitude and latitude. The results of the calculation of the average distance Euclidean deviations with an average value of data 2.539764, and Haversine 2.536912. This shows that the comparison of the measurements of the distance between Euclidean and Haversine has a difference of 0.002852 or the percentage of the distance between the two methods is 99.89 percent. Of the two methods, which yield values almost by measurements on Google maps is Haversine. For Euclidean, it is used to measure the distance between two points on a flat plane so that the results have differences when compared to the Haversine formula.

1. Introduction

As the Capital of the Province of East Kalimantan, Indonesia. The city of Samarinda has developed urban activities and functions, even becoming one of the centers of economic growth and an activity center for the eastern part of the island of Borneo. Astronomically, Samarinda is located between 0◦21'81"-1◦09'16" South Latitude and 116◦15'16"- 117◦24'16" South Latitude, and is located on the equator which is located at latitude [1]. The city is divided by the Mahakam River and has an area of 71,800 Ha. Seen from an altitude line, Samarinda has a flat topography and is located in a low-lying area, divided by the Mahakam River, Samarinda's mainland region is located at an altitude of 7-25 meters above sea level. Like other cities that are crossed by rivers, most settlements are on river banks. However, due to population growth and uncontrolled migration from outside the region, locations along the river line are increasingly densely populated.

The type of land use in Samarinda is developing following the pattern of distribution of the urban population. Most of the population accumulation is at the location of activities developed by the City Government and supported by the development of adequate infrastructure and facilities, such as trade centers, industry, education, health, places of worship, and other public facilities. With the increasing number of public facilities and the increasing range of community roaming, the ability to remember the nearest location of public facilities will be reduced. This is one of the reasons why people need information about the location of public facilities that are often needed in their daily lives.

This paper discusses the implementation of the Haversine and Euclidean methods as a formula for measuring distances to the location of the nearest public facility from the user's position. The purpose of this research is to develop a public facility search system that implements location-based services, a general term used for the use of technology to find the position of objects and device locations using global positioning (GPS) technology and cell-based location from Google.

2. Methodology

2.1. Haversine formula and Euclidean method

One method for calculating the distance points of latitude-longitude in the earth's surface as an input variable is used the Haversine formula [1]. Haversine as a formula in navigation calculates the distance of a circle between latitude and longitude points assuming the radius of R of the earth is 6367,45 km, and the location of 2 points in spherical coordinates (latitude and longitude) are $\phi 1$, $\lambda 1$, and $\phi 1$, $\lambda 1$ [2]. The assumption of the Haversine formula ignores the structure of the earth's surface (valley depth and hill height), which is quite accurate for most calculations because the ellipsoidal effect is eliminated. Here is the Haversine formula [3] written in equation (1) as follows:

$$D = 2r\, arc \sin \sqrt{sin^2\left(\frac{\emptyset_2-\emptyset_1}{2}\right) + cos(\emptyset_1)\,.cos(\emptyset_1)\,.sin^2\left(\frac{\lambda_2-\lambda_1}{2}\right)} \quad (1)$$

Where refers to [3] D is a distance (km), radius r = 6371(km), λ = longitude and ϕ = latitude, 1^0 equal 0.0174532925 rad.

Apart from the Haversine method, it can use the Euclidean method. The distance of two Euclidean points studies the relationship between angles and distance (2D or 3D), simple if implemented at a higher dimension [4]. In Euclidean distance, the calculation of the distance from two points is based on the Pythagorean Theorem. Euclidean distances [5], can be formulated with equation (2) as follows:

$$D = \sqrt{(\emptyset_1 - \emptyset_2)^2 + (\lambda_1 - \lambda_2)^2} \quad (2)$$

Where, D = Euclidean distance in degrees, ϕi = latitude location i, λi = longitude location i.

The distance D in degrees is converted to kilometers by multiplying D by 111,319 km (1-degree earth = 69 miles ~ = 111,319 km). The Euclidean is a heuristic function obtained based on direct distance free of obstacles such as to get the value of the length of the diagonal line on the triangle.

2.2. Location-Based Service (LBS)

LBS is a technology that integrates location, geographical position, and mobile devices. be an information service technology and has several uses in current social networks as information, entertainment or security, which can be accessed by mobile devices through mobile networks and which uses information about the geographical position of mobile devices [6]. The LBS consists of several components including mobile devices, communication networks, position components, and service and content providers. Mobile devices are components that can function as navigation tools or GPS-based navigation tools [7]. This communication network component is a mobile telecommunications network that transfers user data from the device to the service provider. The component position in question is the user's position must be determined. This position can be obtained with a telecommunications network or with GPS.

While the service and content provider is a service provider that provides different services to users such as route search, position calculation, and others. With the LBS service we can find out where we are, the position of friends, and the position of hospitals or gas stations that are close to us [8]. In measuring position, latitude and longitude are used to determine geographical location.

2.3. Public facility data

This study, the distance of Samarinda's public facilities is the object of testing. The author takes 40 location points, which are divided into 8 hospitals, 8 places of worship, 8 markets, 8 pharmacies, and 8 gas stations. Table 1 is a list of public facilities with the coordinates of each place.

Table 1. The list of public facilities with the coordinates of each place.

Public Facilities	Latitude	Longitude	Public Facilities	Latitude	Longitude
Hospital	-0.478923	117.145491	Pharmacies	-0.466314	117.148638
	-0.472929	117.124877		-0.477729	117.146593
	-0.498840	117.136545		-0.478686	117.144804
	-0.495257	117.148771		-0.471982	117.133778
	-0.558828	117.110364		-0.447508	117.154647
	-0.495792	117.147195		-0.47933	117.12457
	-0.506828	117.159399		-0.47796	117.123655
	-0.4741206	117.1399983		-0.498944	117.136214
Places of worship	-0.503029	117.12171	Markets	-0.501723	117.14585
	-0.505938	117.11717		-0.507774	117.116931
	-0525857	117.092072		-0.53169	117.093191
	-0.428495	117.1616		-0.482925	117.148785
	-0.492867	117.138297		-0.427536	117.162061
	-0.484085	117.12655		-0.498367	117.128839
	-0.466015	117.155589		-0.50405	117.160352
	-0.568170	117.089953		-0.487208	117.165012
	-0.477448	117.157729		-0.460895	117.173825
Gas stations	-0.501252	117.124504			
	-0.529046	117.111738			
	-0.532811	117.100826			
	-0.508582	117.095258			
	-0.503871	117.110724			
	-0.482366	117.132275			
	-0.451702	117.141721			
	-0.476494	117.167727			

3. Results and discussion

3.1. System development results

The development of a public facility location search system utilizes Location-Based Service (LBS) technology that allows users to search for locations based on their needs. User coordinate identification enables the LBS application to collect data, distribute and analyse data for mobile device users. Figure 1 is a screenshot of the application interface to search for the location of Samarinda city public facilities.

Figure 1. Screenshot of the Main Interface Application for Searching the Location of Samarinda Public Facilities.

This service application is created by using a combination of map images, databases, and interactive objects. Utilization of the Google API with maps that can be traced by users, changing the display type of the map and the level zoom. This service provides several location search facilities based on keyword input: city, street, place and other facilities such as tracking the route of the road from one place to another.

3.2. Implementation of the Haversine formula and Euclidean method

The location search page for the nearest public facility on the application menu serves to carry out the process of searching for the nearest location route (address, street name, the place name) provided that the visitor must enter a keyword or select a list of locations that have been presented. The system will determine the search location based on the results of geocoding, and display it to the user as shown in Figure 2.

The Haversine Formula and Euclidean Method were tested to calculate 2 distances. Testing 2 methods on the system are done by determining the location as a public facility search simulation. This search simulation is used to calculate the distance between public facility objects and predetermined search locations. For example, in this study there are 40 public facility objects in the Samarinda city area and have been inputted into the system, then a public facility search will be made from a starting coordinate (-0.494426, 117.164832) as a simulation in applying the LBS technology to the nearest public facility location search.

Figure 2. Search for the location of the nearest public facility based on coordinates.

The calculation results based on equation (1) of the Haversine formula and equation (2) of the Euclidean method at the location of public facilities are seen in Table 1.

Table 2. The Results of Calculating the Distance of Public Facilities using the Haversine formula and Euclidean method

	Public facilities	Starting coordinate	Latitude 2	Longitude 2	Euclidean (Km)	Haversine (Km)	Deviation (Km)
1	Hospital	-0.494426, 117.164832	-0.478923	117.145491	2.759348	2.756255	0.003093
2			-0.472929	117.124877	5.050688	5.044998	0.005689
3			-0.498840	117.136545	3.187031	3.183412	0.003619
4			-0.495257	117.148771	1.790330	1.788296	0.002034
5			-0.558828	117.110364	9.389429	9.378945	0.010483
6			-0.495792	117.147195	1.969257	1.967020	0.002237
7			-0.506828	117.159399	1.507258	1.505593	0.001665
8			-0.474120	117.139998	3.570992	3.566992	0.004000
9	Places of worship	-0.494426, 117.164832	-0.503029	117.12171	4.894940	4.889382	0.005557
10			-0.505938	117.11717	5.458299	5.452105	0.006194
11			-0.525857	117.09207	8.823029	8.813039	0.009990
12			-0.428495	117.16160	7.348188	7.340113	0.008075
13			-0.492867	117.13829	2.958988	2.955627	0.003361
14			-0.484085	117.12655	4.414298	4.409297	0.005001
15			-0.466015	117.15558	3.325860	3.322194	0.003666
16			-0.568170	117.08995	11.699154	11.686042	0.013112
17	Pharmacies	-0.494426, 117.164832	-0.466314	117.148638	3.611514	3.607513	0.004000
18			-0.477729	117.146593	2.752677	2.749598	0.003079
19			-0.478686	117.144804	2.835652	2.832473	0.003179
20			-0.471982	117.133778	4.265289	4.260502	0.004787
21			-0.447508	117.154647	5.344519	5.338638	0.005881
22			-0.479330	117.12457	4.786652	4.781241	0.005411
23			-0.477960	117.123655	4.936728	4.931150	0.005578
24			-0.498944	117.136214	3.225227	3.221565	0.003662

	Public facilities	Starting coordinate	Latitude 2	Longitude 2	Euclidean (Km)	Haversine (Km)	Deviation (Km)
25	Markets	-0.494426, 117.164832	-0.501723	117.14585	2.263851	2.261289	0.002562
26			-0.507774	117.11693	5.535491	5.529212	0.006279
27			-0.531690	117.09319	8.989377	8.979215	0.010162
28			-0.482925	117.14878	2.197788	2.195320	0.002468
29			-0.427536	117.16206	7.452516	7.444326	0.008190
30			-0.498367	117.12883	4.030695	4.026117	0.004579
31			-0.504050	117.16035	1.181741	1.180434	0.001307
32			-0.487208	117.16501	0.803749	0.802866	0.000883
33	Gas stations	-0.494426, 117.164832	-0.501252	117.12450	4.553170	4.548000	0.005170
34			-0.529046	117.11173	7.055868	7.047917	0.007951
35			-0.532811	117.10082	8.308177	8.298802	0.009375
36			-0.508582	117.09525	7.903641	7.894665	0.008976
37			-0.503871	117.11072	6.114370	6.107426	0.006944
38			-0.482366	117.13227	3.864915	3.860544	0.004370
39			-0.451702	117.14172	5.407259	5.401275	0.005984
40			-0.476494	117.16772	2.022012	2.019788	0.002224
				Std. Deviation	2.539764	2.536912	0.002852
			Distance comparison (%)				99.89

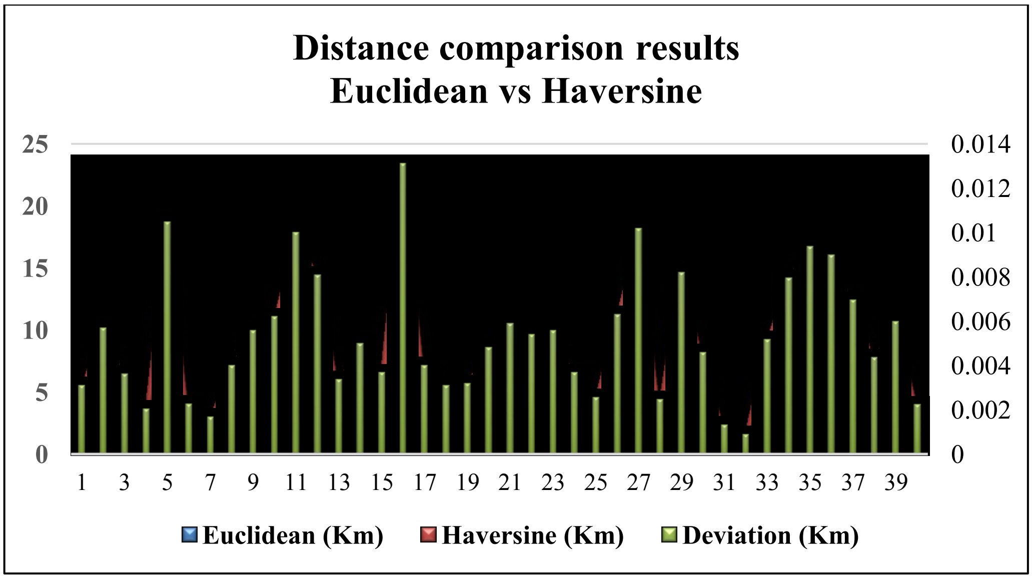

Figure 3. The comparison graph of distance measurements between the Euclidean method and Haversine formula.

Figure 3 shows a comparison graph of the average distance of the deviation of the data points calculated by the Euclidean Method with an average value of data of 2.539764, and 2.536912 from the Haversine Formula calculation results. This shows that the comparison of the results of distance measurements between the Euclidean method and the Haversine Formula has a difference of 0.002852 or a percentage ratio of the distance between the two methods of 99.89%.

4. Conclusions

This research develops a location-based service (LBS) closest public location search application using two distance measurement methods, namely the Euclidean Method and Haversine Formula. Euclidean is a heuristic function that is obtained based on direct distance free of obstacles such as to get the value of the length of the diagonal line on the triangle. So, the workings of the algorithm don't need to be calculated based on the shape of the rounded earth and in Euclid's Geometry, only one path is the shortest distance. While the Haversine Formula is an important equation in the field of navigation to find the arc distance between two points on the ball of longitude and latitude. The law of Haversine, looking for the relation of angles and sides to triangles in the spherical plane. So how good are these two methods of measuring distance in the real world? This depends on the circumstances. Because the earth is round, this means that it is in a relatively small area of the earth' surface that's pretty good, as long as it's the distance we want to find. Euclidean formulas have limitations in measuring how fast the movement of a particular point and speed may be, unable to provide that answer. Euclidean formulas have limitations in measuring how fast the movement of a particular point and speed maybe, not being able to provide that answer because it is difficult to move from one point-to-another. There are buildings, busy streets with traffic, fences and more. Haversine is a popular formula used to find the distance between 2 points. But no research proves the number of formulas to find which distance is the "best". In this case, each formula has its strengths and weaknesses, depending on the needs used.

5. References

[1] Chopde N R and Nichat M K 2013 *International Journal of Innovative Research in Computer and Communication Engineering* **1** 298–302
[2] Hartono S, Furqan M, Siahaan A P U and Fitriani W 2017 *International Journal of Recent Trends in Engineering and Research* **3** 187–195
[3] Basyir M, Nasir M S and Mellyssa W 2017 *EMITTER International Journal of Engineering Technology* **5** 270–278
[4] Pramudita R and Hariadi F I 2019 *International Symposium on Electronics and Smart Devices: Smart Devices for Big Data Analytic and Machine Learning*
[5] Bapat R B and Kurata H 2019 *Linear Algebra and Its Applications* **562** 135–153
[6] Zipf A and Jöst M M 2012 *Springer Handbook of Geographic Information Location-based services* (Germany: Springer-Verlag Berlin Heidelberg)
[7] Vanjire S, Kanchan U, Shitole G and Patil P 2014 *International Journal of Advanced Research in Computer and Communication Engineering* **3**
[8] Kushwaha A and Kushwaha V 2011 *International Journal of Advances in Engineering and Technology* **1** 14

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