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Geographic Information System for Searching Honda Motorcycle Dealers in Medan City Using A-Star Algorithm

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ABSTRACT

Currently, motorbikes are a means of transportation that are often used by the community because they have advantages when compared to other means of transportation. One type of motorcycle that is widely used is a Honda motorcycle. Currently, there are many Honda motorcycle dealers spread across Indonesia, especially in Medan, but have not yet been integrated into a system, making it difficult for people who want to find such dealers. Another problem is that there is no map of the distribution of the nearest dealer from the community's location and there is no information about dealers covering products and ordering services online. With technology, the authors build a geographic information system with the A-Star algorithm that can assist in mapping dealer locations and can calculate the closest route that can be taken. This system is built based on Android using Kodular, Java and PHP programming languages, and uses Openstreetmap as a geographical map.

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1. INTRODUCTION

The an information system can be utilized to obtain accurate, timely, reliable, efficient, and non-duplicated information. The rapid development of science and technology has led to many work activities using computer technology, including information systems[1]. One of the uses of technology is a geographic information system to provide information in the form of maps depicting the conditions or objects on the earth's surface.

Currently, motorcycles have become one of the transportation tools widely used by the community. Motorcycles have advantages compared to other vehicles, including being easier and more practical to use, especially in tackling road congestion. There are several issues related to the purchase and maintenance of motorcycles, such as many people having difficulty finding the nearest Honda motorcycle dealer to their location. as a result, individuals who wish to acquire information about Honda motorcycle dealers in Medan City must search for each one individually or inquire from people around them.

As a solution to the above problem, a system will be developed to map all Honda motorcycle dealers in Medan City and present the nearest locations, as well as provide the nearest routes that the community can take from their location to the desired dealer. For the route search process, the A-star algorithm will be implemented in the system being developed.

The A star algorithm itself is a development and improvement of the Best First Search algorithm. In the A star algorithm, there is an addition of a heuristic function that minimizes the total cost of path distance,

which can provide a path closest to the destination at the right time [2]. This A-Star algorithm can calculate the nearest route from the starting location to the destination location. The system to be built in this research can also display dealer locations in the form of markers and provide information about the nearest routes that the community can take.

Similar research has been conducted by Malvin Zakaria Ginting, which resulted in a study of a geographic information system that displays the locations of Suzuki car dealers and spare parts. However, in this study, there has not yet been an implementation of an algorithm for finding the nearest route[3].

This system serves as a solution to the occurring problem and as a connection between the community and Honda motorcycle dealers, enabling individuals or customers to find the nearest dealer location from their own location and display the nearest route that can be taken from the community's location to the dealer's location. This system also allows for online booking of services, products, and spare parts through direct messages.

2. RESEARCH METHODE

2.1 System

Information and communication technology has rapidly evolved over the past decade and has had a significant impact in various fields[4]. A system is a workflow based on a set of interconnected steps and procedures to perform collective activities[5]. A system can be defined as an organized collection that interacts and is interrelated, and has a goal. Systems become a unified entity that is interconnected, facilitating the flow of generated information[6]. A system has several characteristics, including: components, the external environment of the system which is the area outside the system, system boundaries, system interfaces, inputs, outputs, processing processes, and system objectives[7].

2.2 Information System

Information system is a data processing that transforms into information of quality, usable, and can be utilized in decision-making process, coordination, control, and analysis[8]. Information systems themselves have several functions, including improving data accessibility, making system development and maintenance processes more productive and efficient, serving as a tool to identify system needs, and enabling effective and efficient planning processes to be developed[9].

2.3 Geographic Information System

Geographic can also be defined as a term used to indicate a portion of space (spatial)[10]. Geographic Information System can be defined as a system that has specific advantages in handling spatial and non-spatial oriented data[11]. Geographic Information System consists of several components, including hardware, software, data, and users, where all these components interact in performing processes such as input, storage, editing, updating, management, analysis, manipulation, and displaying or generating output in the form of geographic-based information[12].

2.4 A-Star Algorithm

The A-star algorithm itself is a development and improvement of the Best First Search algorithm. This algorithm was first introduced in 1968 by Peter Hart, Nils Nilsson, and Bertram Raphael. The components of A-Star are: starting node, goal node, open list, closed list, and cost[2]. In performing calculations using the A-star algorithm, the first step to take is to perform Path Finding calculations to create a graph. Then, search for the heuristic value[13]. Here is the equation for the Euclidean Distance Heuristic:

$$d(x+y) = \left|\sqrt{(x1-x2)^2 + (y1-y2)^2}\right| \quad (1)$$

The calculation of the heuristic value above results in an output in the form of the value $h(n)$, which will become the input into the formula of the A Star algorithm equation[14]. Next, do the A-Star calculation with the equation [13]:

$$f(n) = g\,(n) + h(n) \quad (2)$$

2.5 Motorcycle

The first gasoline-powered motorcycle was created by two Germans, Gottlieb Daimler and Wilhelm Maybach, in 1885, and it was called the "Reitwagen." Motorcycles began to be sold in 1894, and since then, many people have known about and purchased motorcycles up to the present day[15].

2.6 Kodular

Kodular is a tool used by individuals to create and build Android-based applications. Kodular itself is web-based and utilizes block-based programming. Application developers write code within Kodular by using drag-and-drop methods[16].

2.7 Android

The Android operating system was initially developed by a company named Android Inc, but in 2005, it was acquired by Google[17]. Android is an operating system that is widely used today. Android also provides tools for writing script coding for the development of the Android operating system[18].

2.8 Mixed Methods Research

Mixed Methods is a combined method that merges quantitative and qualitative methods[19]. Qualitative research generates results that cannot be obtained through mathematical and statistical calculations. Quantitative research yields results obtained through statistical and mathematical processes[20]. In mixed methods, comprehensive outcomes can be achieved, capable of producing significant and dynamic data[19].

2.9 Waterfall System Development Method

System development is an approach to how information systems provide support for business needs, system design, and others within an organization[21]. The waterfall system development method is a method for developing systems that mimics the nature of a waterfall. The steps in this method are carried out sequentially and systematically, with no repetition of stages[22]. One of the advantages of using this waterfall method is that every plan in the initial steps will be followed in an orderly manner until the implementation stage is reached[23].

2.10 UML (Unified Modelling Langugae)

UML (Unified Modeling Language) is a visual language for creating models and interacting with systems through diagrams and text as supportive elements for its depiction. There are several UML diagrams, including: Usecase Diagram, which depicts the relationship between actors and the system[24], Activity Diagram, which provides an overview of activities or processes that occur in the system[25], Sequence Diagram, which illustrates system modeling based on the sequence of time, with a focus on message transmission and reception[26], and Class Diagram, which depicts relationships among each class with detailed explanations of each class[27].

3. RESULT AND ANALYSIS

3.1 Analysis of A-Star Algorithm

As an example, with the starting point located at Eka Surya Indah Housing Road and the end point located at the Honda Motorcycle Dealer on Karya Jaya Street. Berikut adalah tampilan jalur atau rute dari titik awal ke titik akhir yang tersaji pada Google Maps:

Figure 1. Route Presented by Google Maps

Afterwards, the route shown on Google Maps above will be transformed into an image of the path by determining the points or nodes of each route. Here is the image of the path points:

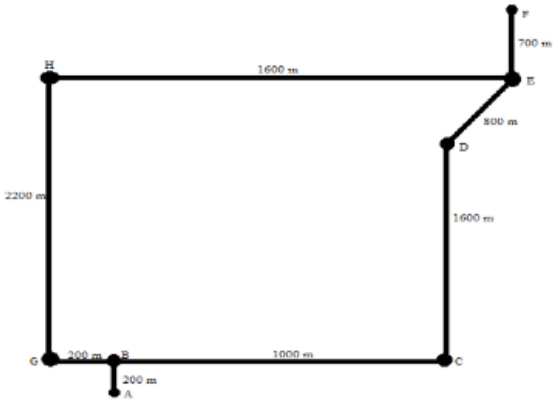

Figure 2. Route Points

The path presented in the image above is divided into two routes, namely: Route I with points A-B, B-C, C-D, D-E, and E-F. Meanwhile, for Route II, it consists of points A-B, B-G, G-H, H-E, and E-F. The image of the route points in Figure 2 will be depicted in the form of a matrix. Each box in the matrix has a value of 100m.

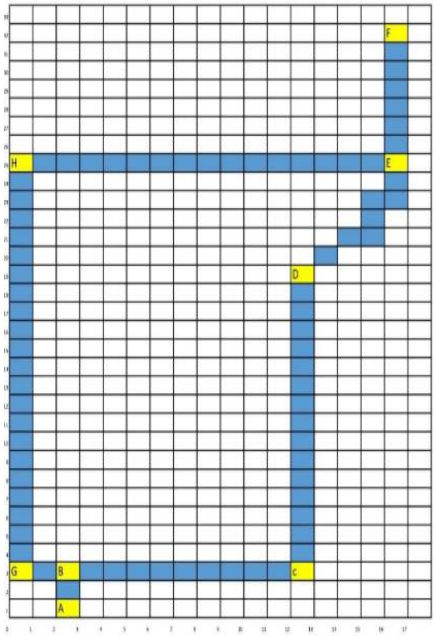

Figure 3. Index Points

After that, calculate the index point values based on the coordinates as shown in Figure 1. Here is the description of the coordinates for each path. These values will serve as input values in the calculation of the heuristic value using equation (1):

Path I: A(0,3)-B(3,3), B(3,3)-C(13,3), C(13,3)-D(13,19), D(13,19)-E(17,25), and E(17,25)-F(17,32)
Path II: A(0,3)-B(3,3), B(3,3)-G(0,3), G(0,3)-H(0,25), H(0,25)-E(17,25), and E(17,25)-F(17,32)

Here are several calculations of heuristic values for the sample used in this study:

a. Path I: A(0,3)-B(3,3)

$$d(x+y) = \sqrt{(x1-x2)^2 + (y1-y2)^2} = \sqrt{(0-3)^2 + (3-3)^2} = \sqrt{9+0} = 3$$

b. Path I: B(3,3)-C(13,3)

$$d(x+y) = \sqrt{(x1-x2)^2 + (y1-y2)^2} = \sqrt{(3-13)^2 + (3-3)^2} = \sqrt{100+0} = 10$$

c. Path II: A(0,3)-B(3,3)

$$d(x+y) = \sqrt{(x1-x2)^2 + (y1-y2)^2} = \sqrt{(0-3)^2 + (3-3)^2} = \sqrt{9+0} = 3$$

d. Path II: B(3,3)-G(0,3)

$$d(x+y) = \sqrt{(x1-x2)^2 + (y1-y2)^2} = \sqrt{(3-0)^2 + (3-3)^2} = \sqrt{9+0} = 3$$

Perform calculations for all points on each path. Here are the calculation results for Path I.

Table 1. Index Points Path I

No.	Index Points Path I	Values
1	A-B	3
2	B-C	10
3	C-D	16
4	D-E	7,2
5	E-F	7

Here are the calculation results for Path II.

Table 2. Index Points Path II

No.	Index Points Path II	Values
1	A-B	3
2	B-G	3
3	G-H	22
4	H-E	17
5	E-F	7

After that, the A-Star algorithm calculation is performed using equation (2). Here are the A-Star algorithm calculation results for each path presented in the table below.

Table 3. Calculation Results for Path I

No.	Path I	Values
1	A-B	5
2	B-C	20
3	C-D	32
4	D-E	15,2
5	E-F	14
	Total	86,2

Table 4. Calculation Results for Path II

No.	Path II	Values
1	A-B	5
2	B-G	5
3	G-H	44
4	H-E	33
5	E-F	14
	Total	86,2

Conclusion from the analysis of the calculations conducted is that the closest route that can be taken is Path I with the route A-B, B-C, C-D, D-E, and E-F with a distance of 8620 m or 8.6 km.

3.2 UML Design

a. Usecase Diagram

Here is the usecase diagram:

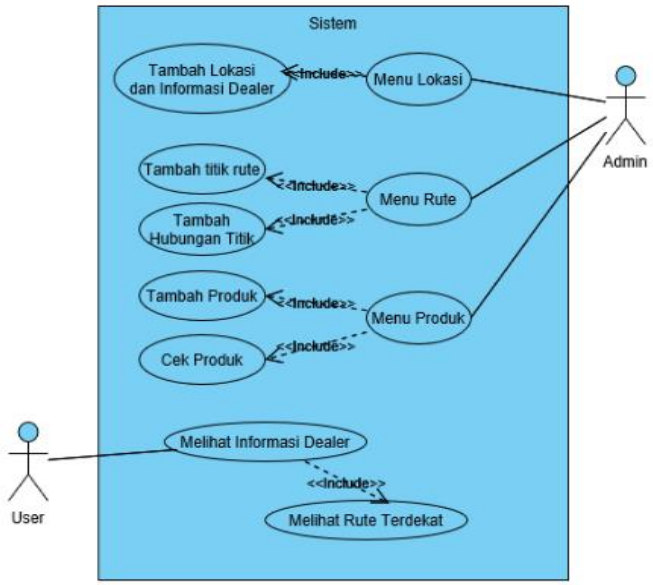

Figure 4. Usecase Diagram

b. Activity Diagram

Here is the activity diagram for the process of viewing dealer information in the application and for checking the nearest route from the user's location to the desired dealer location.

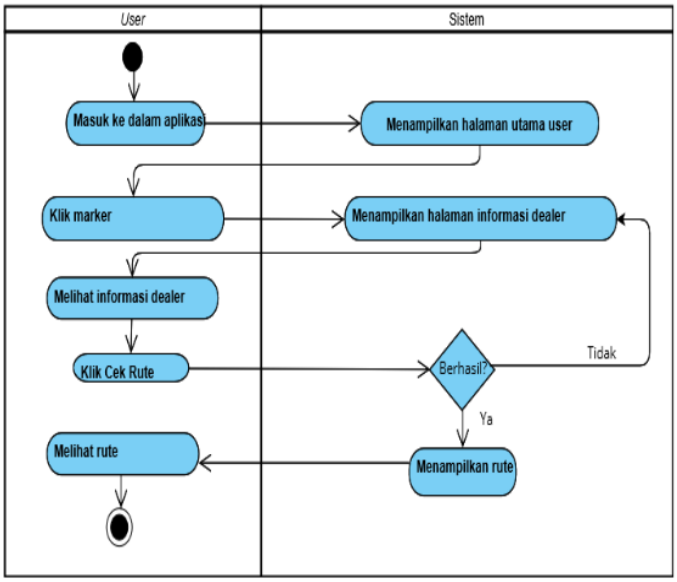

Figure 5. Activity Diagram Viewing Information and Checking Dealer Route

c. Sequence Diagram

Here is the sequence diagram for the process of viewing dealer information in the application and for checking the nearest route from the user's location to the desired dealer location.

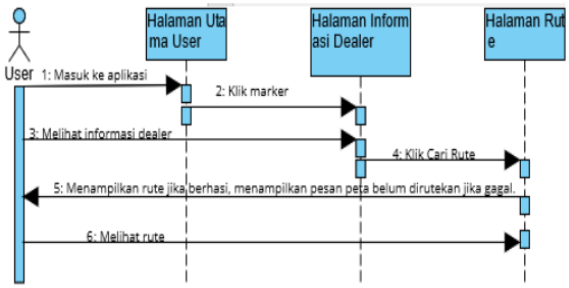

Figure 6. Sequence Diagram Viewing Information and Checking Dealer Route

d. Class Diagram

Here is the class diagram in this study:

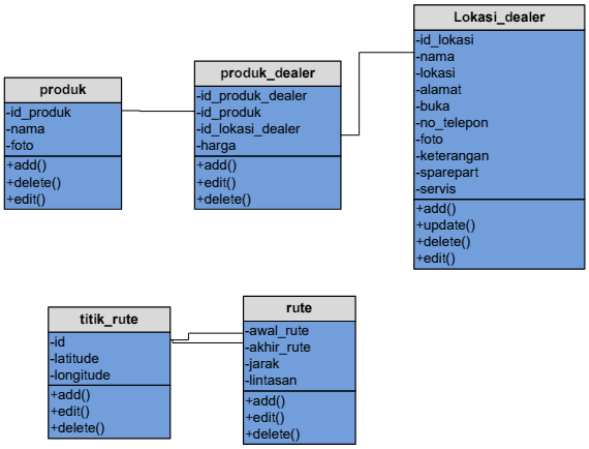

Figure 7. Class Diagram

3.3 System Implementation

The implementation of this system will showcase the display of the built system as a solution to the existing problem. Here are several views within the application:

a. Main Page of Admin Application

The first page that appears when the application is opened or launched. On this page, there are three menus: location, route, and products.

Figure 8. Main Page of Admin Application

b. Main Page of User Application
The display will show markers indicating the locations of dealers that users can click on to view dealer information.

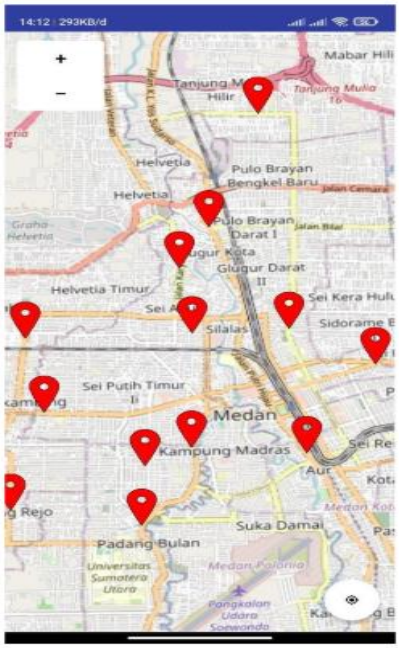

Figure 9. Main Page of User Application

c. View Dealer Information and Check Route Page
Users can view information about the selected Honda motorcycle dealer.

Figure 10. Dealer Information Page

When the "Check Route" button is clicked, the route that users can take from their location to the selected Honda motorcycle dealer's location will appear.

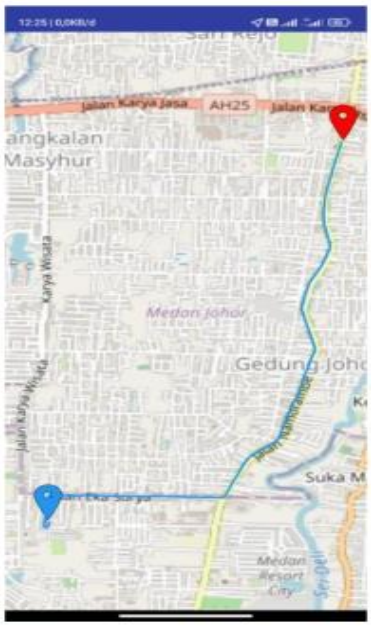

Figure 11. Dealer Route Page

4. CONCLUSION

Based on the research conducted by the author, the conclusion that can be drawn from this study is that the geographic information system (GIS) application for Honda motorcycle dealers serves as a platform that can be utilized by individuals seeking the nearest Honda dealer from their location and provides the nearest route that can be taken by the public. This is made possible as the application incorporates the A-star algorithm. In relation to the research results concerning the analysis of the algorithm using two paths, namely Path I and Path II, after manual and systematic calculations, both results yield the same answer, which is that the nearest path is Path I. In this application, users can also view product information that has been input by each dealer, and they can place orders for products and services through direct WhatsApp messages. This application contributes to resolving issues related to locating the nearest Honda motorcycle dealer and streamlines the process, making it more effective.

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