Journal of Social Research

P-ISSN: 2827-9832
E-ISSN: 2828-335x
http://ijsr.internationaljournallabs.com/index.php/ijsr

COMPARISON ANALYSIS OF NEAREST ROAD CALCULATIONS ON DIJKSTRA ALGORITHM AND A*(A-STAR) ALGORITHM FOR MAPPING BTS TOWER AREA

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ABSTRACT

BTS (Base Transceiver Station) is a telecommunications infrastructure in the form of a tower with a transmitting antenna that facilitates wireless communication between communication devices and operator networks. BTS as a signal receiver and transmitter, its existence must be known to a user, such as maintenance staff and BTS tower operation staff to deal with existing problems. So a special system is needed for users to use in determining the closest path between the user and the location of the BTS tower. The purpose of this study is to make it easier for the user to determine the shortest path to the intended BTS tower location and to analyze the Dijkstra algorithm and the A* algorithm in determining the shortest route between the user's location and the location of the Telkomsel BTS tower in Semarang, Central Java. The results obtained from the 82 test data tested with the information system created show that Dijkstra's algorithm is more efficient than the A* algorithm. Validation is carried out by calculating with the system between the user's location and 82 test data or the location of BTS towers in the city of Semarang. The results of the validation carried out explained that the system was running according to the functions made and the results of the calculations carried out by the system were appropriate.

Keywords: *dijkstra, a-star, comparison analysis, nearest road*

INTRODUCTION

The rapid development of technology, especially in the field of communication technology, means that people no longer have to be in a special place to communicate over long distances. Technological developments in the field of communication have also made it easier for people to communicate anywhere and anytime by using a technology called mobile cellular. Where to connect devices between mobile cellular, a BTS tower is needed (Okedere dan Oyelami 2021).

BTS (Base Transceiver Station) is a transmitting station or a telecommunication infrastructure in the form of a tower with a transmitting antenna that facilitates wireless communication between communication devices and operator networks, by sending and receiving radio signals to communication devices such as cellular telephones, home telephones and the like (Li et al. 2020). The radio signal that has reached the communication device will then be converted into a digital signal which is then sent to the other terminal to become a message or data. BTS is connected to the MS (Mobile Station) or cell phone through the air interface and is connected to the BSC (Base Station Controller) by using the a-bis interface to send and receive signals (Cardoni et al. 2022).

Based on published data from the BPS (Central Statistics Agency) for 2021, Semarang Regency has an area of 950.20 km2 or 2.9% of the area of Central Java Province. With the area they have, many do not know the exact location of the BTS tower. BTS as a signal receiver and transmitter must know its whereabouts, especially for a user such as maintenance staff and BTS tower operation staff. The location of the BTS tower affects the quality of the signal

received by the mobile station, the farther the location of the BTS tower, the weaker the signal received by the mobile station and the closer the location of the BTS tower, the stronger the signal received by the mobile station (Li et al. 2020). As a result, there are more and more disturbances such as blank spots, disconnection of signals and also affecting the mobile station's battery to become weak quickly, due to the difficult signal search conditions in BTS tower locations which are far from the location of the mobile station. Therefore, the BTS tower is a technology that has a vital role for communication.

Telkomsel is a company engaged in the telecommunications sector which was established on May 26, 1995. By providing telecommunications access, Telkomsel consistently serves the Indonesian people who are spread from Sabang to Merauke. Having 150,982,880 total subscribers in 2019, as well as Telkomsel's total market share of 59.20% in 2019, which has made Telkomsel one of the largest cellular operators in Indonesia (Kussoy et al. 2021). A user at a Telkomsel company such as operation staff and maintenance staff really needs to know the location, the exact distance of a BTS tower and the shortest path to arrive or be at that location, with the aim that if an error occurs on the BTS tower so that it can be repaired immediately. Such as the blackout of electricity and the importance of maintaining BTS towers (Oktarini & Kawano, 2019).

Because there is no system specifically used for users to determine the closest path between the user and the location of the BTS tower in Semarang, Central Java, it is necessary to analyze and construct a system to determine the shortest path. This was done by comparing the speed and efficiency using the Dijkstra algorithm and the A* (A-Star) algorithm on the Telkomsel BTS tower in Semarang, Central Java. The system that will be made has advantages, namely being able to find out what algorithm is used, and the running time of the algorithm ((Mirahadi dan McCabe 2021).

Seeing the advantages and disadvantages of Dijkstra's algorithm and A* algorithm, the author compares the two to show the results of the two algorithms based on deterministic, one of which will be the optimal solution. The purpose of this research is to create a system that can provide results in finding the shortest route between user locations and Telkomsel BTS towers in Semarang, Central Java, and knowing which algorithm is more optimal between Dijkstra's algorithm and A* algorithm for searching the location of users and Telkomsel BTS towers in Semarang, Central Java.

METHOD

System Analysis

System analysis is a stage that explains several problems that will be used to design a system model that will be implemented. The system analysis that will be made is used to determine the shortest path using Dijkstra's algorithm and A* algorithm on the Telkomsel BTS tower in Semarang, Central Java, with the aim of comparing the speed and efficiency between the two algorithms. This system analysis has 3 stages in describing system development, namely problem analysis, system requirements analysis, and process analysis (Bagheri et al. 2021).

Process Analysis

The system built uses the web programming language with the CI (Code Ignater) framework. The user can activate the device location so that the system can detect the location of the device to be used as the starting position (Martins, dkk, 2022). The BTS tower location that has been determined for the final position is the BTS tower from Telkomsel in Semarang, Central Java. The system to be built uses Dijkstra's algorithm and A* algorithm to find the shortest route. Users can choose the algorithm they want to use in the process of searching for the shortest distance, then the system will display the results of the processing in the form of distance, route, and time needed to execute the program (Isihak, Akpan, dan Bhattacharyya, 2022).

System Planning

The design of the shortest distance search system between users and BTS towers is carried out using the UML (Unified Modeling Language) model. UML is used as a standard specification language that functions to build a system. This system will be built with use case diagrams, sequence diagrams, activity diagrams, and flowcharts vektor (Nakagawa, Watanabe, dan Hyodo, 2021).

RESULTS AND DISCUSSION

This research produces an information system that can provide information in finding the shortest route between user locations and Telkomsel BTS towers in Semarang, Central Java. The results of the system design include website-based interface design, application of Dijkstra's algorithm, and A*. System functionality testing uses the black box testing method to find out the functions that exist on the system can operate properly and the output is produced correctly.

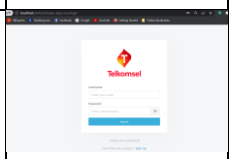
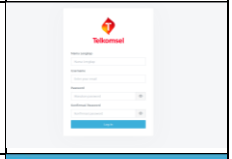
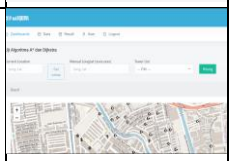
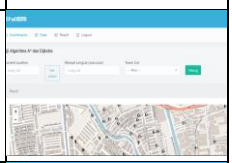
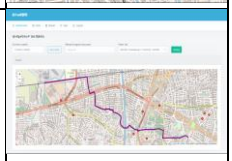
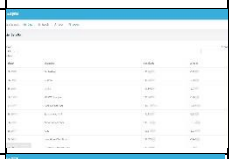
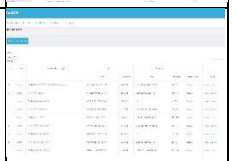
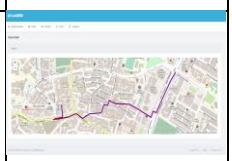
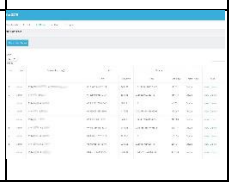
System Testing

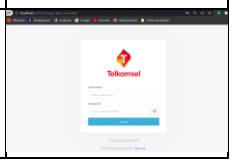
Testing this system aims to validate by ensuring a program or system runs properly without any errors and can run as expected. System testing is carried out using the black box testing method. Black box testing is used to show that the functions in the system can operate, that the input is received properly and the output is produced correctly (Sunita dan Garg, 2021). Black box testing tests some of the basic aspects of a system with little attention to the internal logic structure of the system Chen (2020). The validation is carried out by running the system to test the overall distance between the user point and the BTS tower points spread across the city of Semarang. The results shown from the test are the distance, route, running time of the A* algorithm and Dijkstra's algorithm. From there, a better algorithm will be found to be used in the use of the system created.

Blackbox Testing

This test is carried out to ensure that every feature on the system works properly without errors, the test is carried out using the black box testing method. The results of this blackbox test can be seen in Table 1. below:

Table 1. Blackbox Test Results

No.	*Test Case*	Input	*Expect Result*	*Actual Result*
1.	Enter the browser, web address: http://localhost/comparison_algo_new/login	Enter the address into the search url.	Displays the login page.	
2.	Registration	Fill out all available forms.	Displays the registration page.	
3.	Login admin	Fill in the admin username and password.	Displays an admin dashboard page that can display all results from users and has a user login settings page.	
4.	Login user	Fill in the user username and password.	Displays the user dashboard page.	
5.	Process count	Retrieve user location data and input the intended tower location.	Displays the results of Dijkstra's algorithm and A* algorithm.	
6.	Display data	Click the data menu.	Displays a data table for Telkomsel BTS towers in the Semarang area.	
7.	Showing results	Click the results menu.	Displays the results of all the calculation processes of Dijkstra's algorithm and A* algorithm.	
8.	Displays the path of the process results	Click the result menu and select view process results.	Displays the path of the results of the calculation process.	
9.	Deleting results	Click the result menu, select delete process results.	Displays a pop up confirming the deletion of the results.	

No.	*Test Case*	Input	*Expect Result*	*Actual Result*
10.	Logout	Click the logout menu.	Displays the login menu.	

Dijkstra's Algorithm Testing

This test is carried out to find out the performance of the Dijsktra algorithm calculation in the system can work well in determining the shortest route between the user and the location of the BTS tower which is displayed on the map according to calculations done manually. The test was carried out with the user's location located on Jalan Pahlawan Semarang to the location of the BTS tower located on Jalan Veteran Semarang using Dijkstra's calculations manually.

The calculation starts from node A to B which has a distance value of 550A and calculates the shortest path with the smallest distance value to the destination, namely at node V with a value of 1460V. From the results of calculations using Dijkstra's algorithm which is done manually, the result of the track distance is 1460 meters or rounded to 1.5 km. The shortest route results are: A-B-C-R-Q-P-O-N-V-W. The test results from the user location located on Jalan Pahlawan Semarang to the location of the BTS tower located on Jalan Veteran Semarang with Dijkstra's algorithm obtained the shortest path shown in Figure 1.

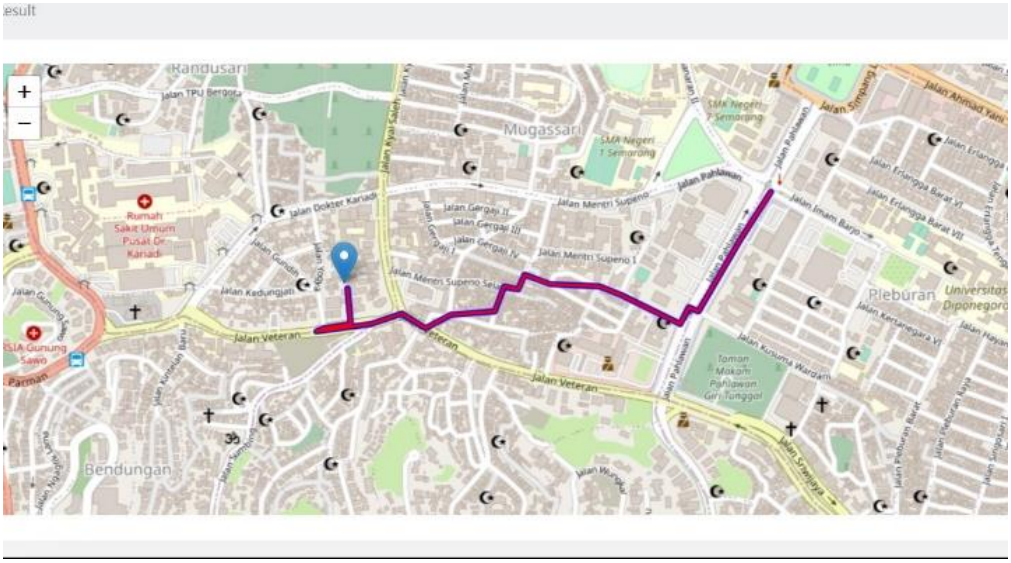


Figure 1. Results of Dijkstra's Algorithm Trajectory on the System

The results of Dijkstra's algorithm calculations on the system are shown in Figure 4.12. The result of calculating the distance is 1492.31 meters or 1.5 km which is shown in the distance column in the image table and the time is obtained on the system, namely 0.007979869842529297 seconds.

From this test the application of the Dijkstra algorithm in the system, the results obtained from manual calculations and system calculations are appropriate and are able to provide recommendations for the closest route that must be passed in order to get to the customer's location and are in accordance with calculations done manually.

*Algorithm Testing A**

This test is carried out to determine the performance of the A* algorithm calculation in the system can work well to determine the shortest route between the user and the location of the BTS tower which is displayed on the map according to calculations done manually. The test is carried out with the user's location located on Jalan Pahlawan Semarang to the location of the BTS tower located on Jalan Veteran Semarang using manual A* calculations.

The calculation results using the A* algorithm which is done manually, the route distance is 1456 meters or 1.5 km and the shortest route results are: A-B-C-R-Q-P-O-N-V-W. Test results on the information system from the user's location which is located on Jalan Pahlawan Semarang to the location of the BTS tower which is on Jalan Veteran Semarang with Dijkstra's algorithm obtained the shortest path shown in Figure 2.

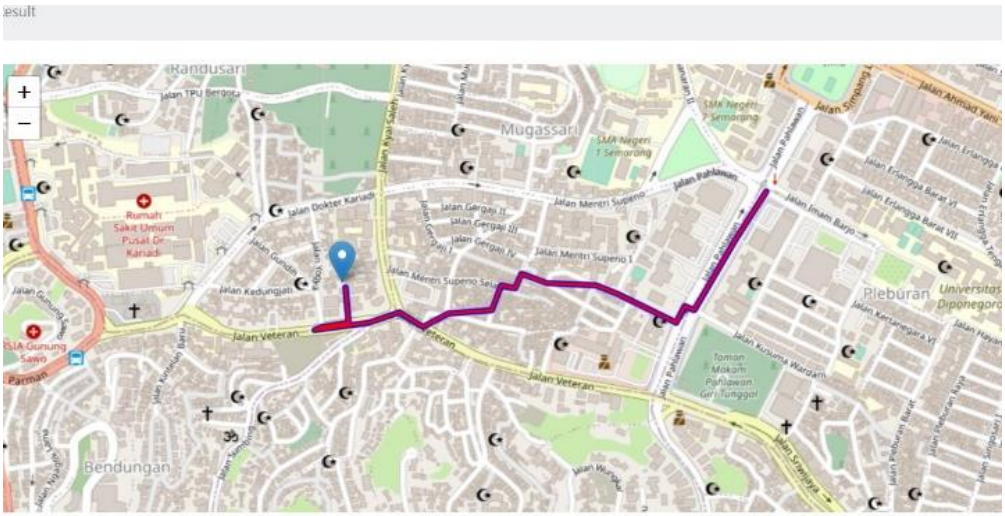


Figure 2. A* Algorithm Track Results on the System

The results of Dijkstra's algorithm calculations on the system are shown in Figure 4.24. The results of the calculation of the distance obtained are 1492.31 meters or 1.5 km which is shown in the distance column in the image table and the time obtained for working on the system is 0.32848286628723145 seconds. From this test, the application of the A* algorithm in the system has been successful and is able to provide recommendations for the closest route that must be passed in order to get to the customer's location and is in accordance with calculations done manually.

Results of Dijkstra's Algorithm and A on the System*

The results of system testing are shown in Figure 3. where from 82 test data tested using Dijkstra's algorithm and A* algorithm, it was found that Dijkstra's algorithm is more efficient than A* algorithm. These results are obtained based on the average test value of the time and distance parameters of the two algorithms.

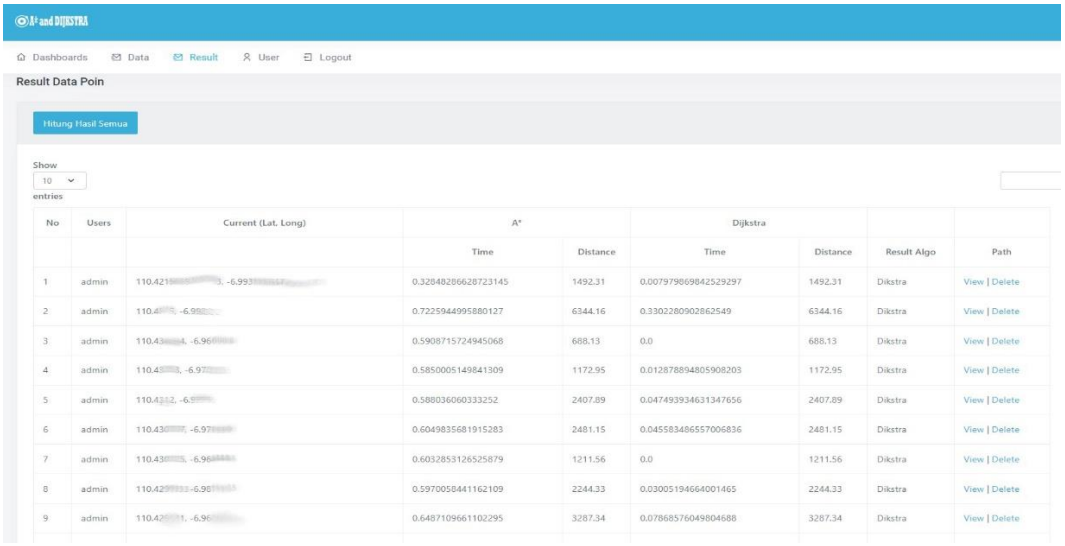


Figure 3. Algorithm Calculation Results on the System

CONCLUSION

Based on the results of research conducted in a comparative analysis of calculating the shortest path using Dijkstra's algorithm and A* algorithm to map the area of Telkomsel BTS towers in Semarang, Central Java. Based on the results of the system test using the black box texting method, the system design that has been made has been successfully implemented on the system properly, this can be seen from the results of the system functionality test by getting all the cases tested successfully running as expected.

Based on the results of an analysis of 82 test data that was carried out by comparing the calculation of the distance between the Dijkstra and A* algorithms to map the Telkomsel BTS tower area in Semarang, Central Java, it was found that the Dijkstra algorithm was more efficient to use than the A* algorithm. The parameters used to determine the results are distance and running time. Validation is carried out by calculating with the system between the user's location and 82 test data or the location of BTS towers in the city of Semarang. The results of the validation carried out explained that the system was running according to the functions made and the results of the calculations carried out by the system were appropriate.

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