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A* ALGORITHM FOR SEARCH OF ROUTES NEAREST IN THE GENERAL TRANSPORTATION

[a]Febri Ramanda, [b]Eko Sediyono, [c]Catur Edi Widodo

[a]Magister of Information System, Diponegoro University, Semarang, Indonesia.
[b]Faculty of Information Technology, Satya Wacana Christian University, Salatiga, Indonesia.
[c]Faculty of Science and Mathematics, Diponegoro University, Semarang, Indonesia.
E-mail: [a]febri2345@gmail.com, [b]ekosed1@yahoo.com, [c]caturedwidodo@fisika.undip.ac.id.

Abstract

The increasing need for transportation in Semarang City is causing traffic congestion problems. The determination of transportation routes selection is very important because it can affect the quality of public transportation services. One of the public transportation modes in Semarang City is Semarang BRT (Bus Rapid Transit). The problems that occur in BRT transportation, the selection of BRT routes is long routes so that it can affect consumer interest, time and distance traveled, and operational costs. The purpose of this study is to apply the A algorithm for search of routes nearest on BRT routes, so this research is expected to help minimize operational costs, time and distance traveled. This study employs the data of the Semarang City Transportation Agency, specifically the V corridor BRT routes. The results showed that the A* algorithm was more optimal than the Best-first search algorithm because the A* algorithm obtained 4 nodes of the nearest routes, while the best-first search algorithm obtained 5 routes nodes. Besides, the A* algorithm with time and distance parameters, the A* algorithm is 35 minutes faster than the normal route is 60 minutes and the best-first search algorithm is 45 minutes.*

Keywords: A, BRT, Routes, Transportation.*

INTRODUCTION

Transportation as a basic industrial service of national economic development. The scale and quality of transport determine the rapid needs of the community. The accuracy and accessibility of smart transportation networks are important to study topic by paying attention to people's lives and the development of an area or country, refers to how easy it is to get access to the destination [1].

Public transportation services provide many benefits to the general public but lately, public transportation has begun to be abandoned by consumers, because it is easier for consumers to have their vehicles and the opening of several new access roads that shorten the distance. This new road access makes transportation routes ineffective and inefficient, because of the longer travel times and the longer distances and the urban areas that are far more developed than before [2].

Semarang is one of the major cities in Indonesia with heavy traffic and often the experience of traffic congestion. As a result of congestion in Semarang City, the quality of transportation BRT services also reduced. Impact of BRT lane congestion which initially according to the schedule of arrival and departure was also disrupted so it takes traffic engineering, one of them using information technology.

Artificial intelligence (AI) is the understanding and application of human intelligence, intelligent behavior and the law of intelligent behavior. Its main task is building intelligence information processing theory, then design a computer system that can show some similar human intelligence actions [3]. In AI there are many algorithms including A*, breadth-best search, and general and test.

A* is a path planning algorithm the most famous, which can be applied to the matrix or configuration space topology. A* algorithm using a combination of heuristic search and search based on the shortest [4]. A* algorithm has been used in the field of mobile robots with general task navigation for mobile robots is to navigate in an indoor environment. In this research, the robot is asked to do the task of determining the exact location on the map or arriving at a certain place without a collision [4]. In subsequent studies, the A* algorithm can be also implemented in a racing game that determines how the search to locate and determine the best path [5]. The A* algorithm also has been used in the game Flow Free Color (similar strategy game chess board using a certain size). A* gives good results on the search for solutions but using the depth-first search tree [6]. The A* algorithm has been applied in several cases including Pacman games using navigation mesh A* which produces the best solution for searching the shortest path [6]. The racing game simulation by applying the pathfinding algorithm to determine the path of a car racing game can save the most resources in the game [5]. The game of car racing using dynamic pathfinding A* algorithm connects the dynamic pathfinding algorithm and the A* algorithm can be implemented in a racing game. A* Algorithm to get better results on empty tracks and race tracks that have obstacles [7]. The design of the robot path based on the improvement of the A* algorithm through two different resistance distributions, a comparison experiment for the A* algorithm shows the operating efficiency of the A* algorithm is better [8]. Pathfinding of 2D & 3D real-time strategy games with A* algorithm for multilayers has a very smooth path, calculating obstacles before processing so that time complexity is better [9]. The A* algorithm has time-efficient for robot path planning. The A* algorithm saves more time for path searching, the distance between the source and the obstacles that are passed by the robot [10]. The A* algorithm in real-time strategy games based on unity3D. A* can't only be applied in the search for the shortest path on the game map but is generally applied in chess games with complex spaces [11].

In previous studies, A* has been applied in several fields including games and robots. In this study, A* was applied in the field of transportation, especially public transportation (BRT). This study aims to implementation of A* to search for the nearest routes of BRT service to obtain the estimated travel time and distance is optimal.

Based on these problems, this study using the A* algorithm to find the closest BRT routes so that in this study it is expected to be used as input and strategy in determining the optimal BRT routes. This will have an impact on improving the quality of public transport services.

MATERIALS AND METHODS

Artificial Intelligence

Artificial intelligence (AI) is the understanding and application of human intelligence, intelligent behavior and the law of intelligent behavior. The main task of building intelligent information processing theory, and then design some computer systems have some which can show some of the human intelligence [3], the AI has a lot of methods including methods of best-first search, breadth-first search and A*.

A* (A Star)

An improvement from the best first search method by modifying the heuristic function. A* will minimize the total cost of the track. In the right conditions, A* will provide the best solution in optimal time [12].

$$G(n) = \sqrt{{X_n}^2 + {Y_n}^2} \quad (1)$$

$$H(n) = x\,(target) - x(n) + |Y(target) - Y(n)| \quad (2)$$

$$F(n) = G(n) + F(n) \quad (3)$$

Explanation:

f(n)* = evaluation function.
g(n)*= costs that have been incurred from the initial state to the state *n.*
h(n)*= estimated the cost to arrive at a destination starting from *n.*
Thus it can be said that :

a. If h*=h means the tracking process has arrived at a destination.
b. If g=h*=0, than *f* random, meaning the system can be controlled by anything.
c. If g=k (ordinary constants 1) and h*=0 means the system uses *a breadth-first search.*

In A* algorithm, 2 queues are also needed, that is :

a. Open, which contains nodes that have been raised, already has a heuristic function but has not been tested.
b. Close contains nodes tested [12].

The steps of the A* algorithm are as follows :

1. Set : Open = {S}, and closed ={}, with S is the selected node as the initial state.
2. Do it if open is not empty:
   a. Search for node n of Open where the value is f(*n*) minimal, then place n on closed.
   b. If *n* is the destination node, exit, success.
   c. Expand node *n* to its children
   d. Do it for every *n*, that is *n*’

i. If not open or closed yet.
   1. Enter *n*’ to open, then set backpointer from *n*’ to *n*.
   2. count it :
      a. h(*n*’)
      b. g(*n*’) = g(*n*) + c(*n*,*n*’) is the cost of n to n’, and
      c. f(*n*’) = g(*n*’) + h(*n*’)

ii. If *n*’ there are already open or closed and if g (*n*’) smaller (for the new version *n*’ the new one) then.
   1. Discard the old version n’
   2. take n' in open, dan set back pointer from n' to n

RESULT AND DISCUSSION

In this study using map data from the Semarang City transportation department for transportation modes. The following is a map of the routes traveled by the modes of transportation shown in Fig. 1.

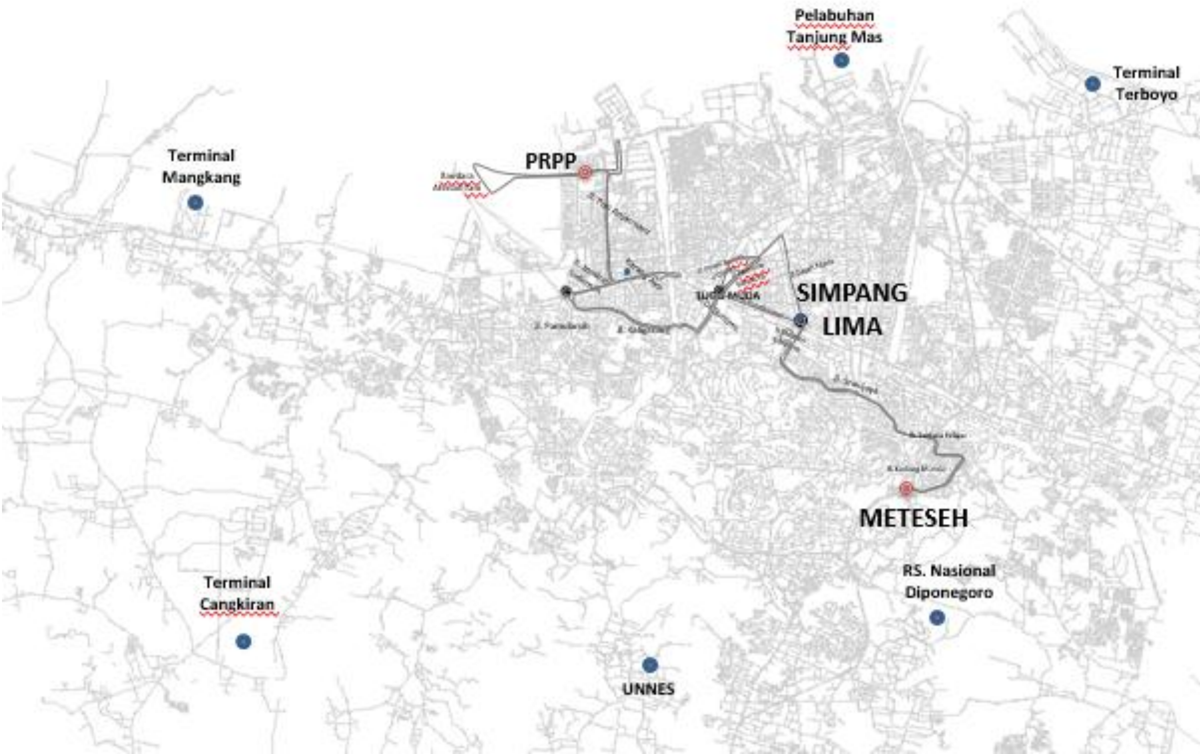

Fig. 1. Map mode transportation

Fig. 1 explains the V corridor map. The starting point is from PRPP and the endpoint is in Meteseh. The path covered includes. PRPP (Yayasan terang Bangsa) – JL. Puri Anjasmara –Tugu muda – Simpang 5 – Jl. Raya solo jogja – Jl. Prof Soedarto – Dinar Mas Residence Victoria Long Corridor Routes V 20,2 km with travel time 60 minutes.

From Fig. 1, the steps to determine the shortest path with A* as follows:

The first step :

Fig. 1 divided into small sections. In this study, the transportation routes map becomes 42 parts (according to the needs), as shown in Fig. 2. Referring to Fig. 2 for 42 columns. Give a number in each column in the table. Blue is the starting point, red is the end/end point, and green is the obstacle.

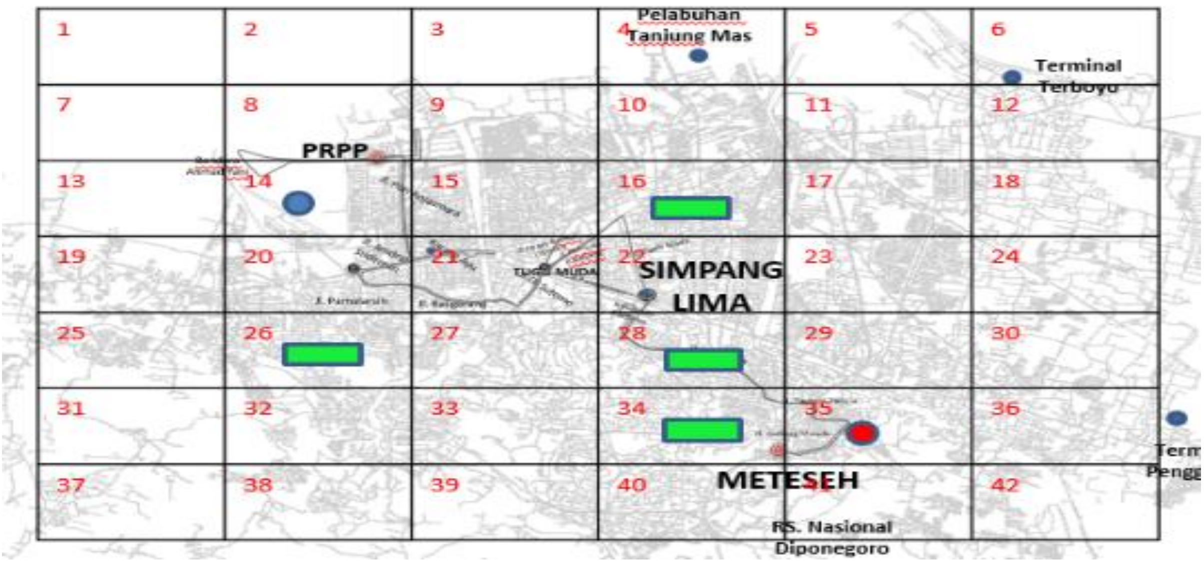

Fig. 2. The simple area used.

To simplify the calculation a simple area screen is taken, as shown in Fig. 3.

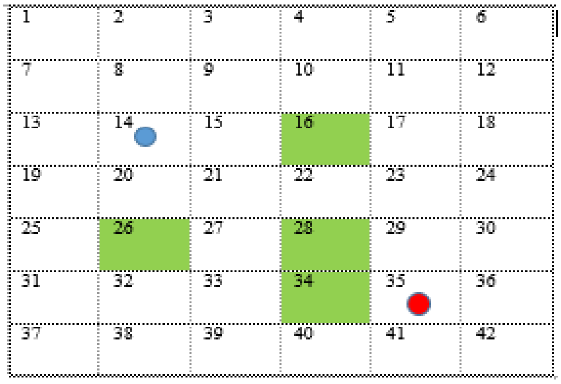

Fig. 3. Simple area screen

Node data
H=Value (Heuristic)
G=Value (Movement Cost)
F=Value (G+H)
Parent (A node to reach this node)
List
Open list
List of nodes that need to be checked
Close list
List of nodes that have been checked

Star Area

Target

From Fig. 3 made a normal map of the routes (V corridor routes) is made as shown in Fig. 4.

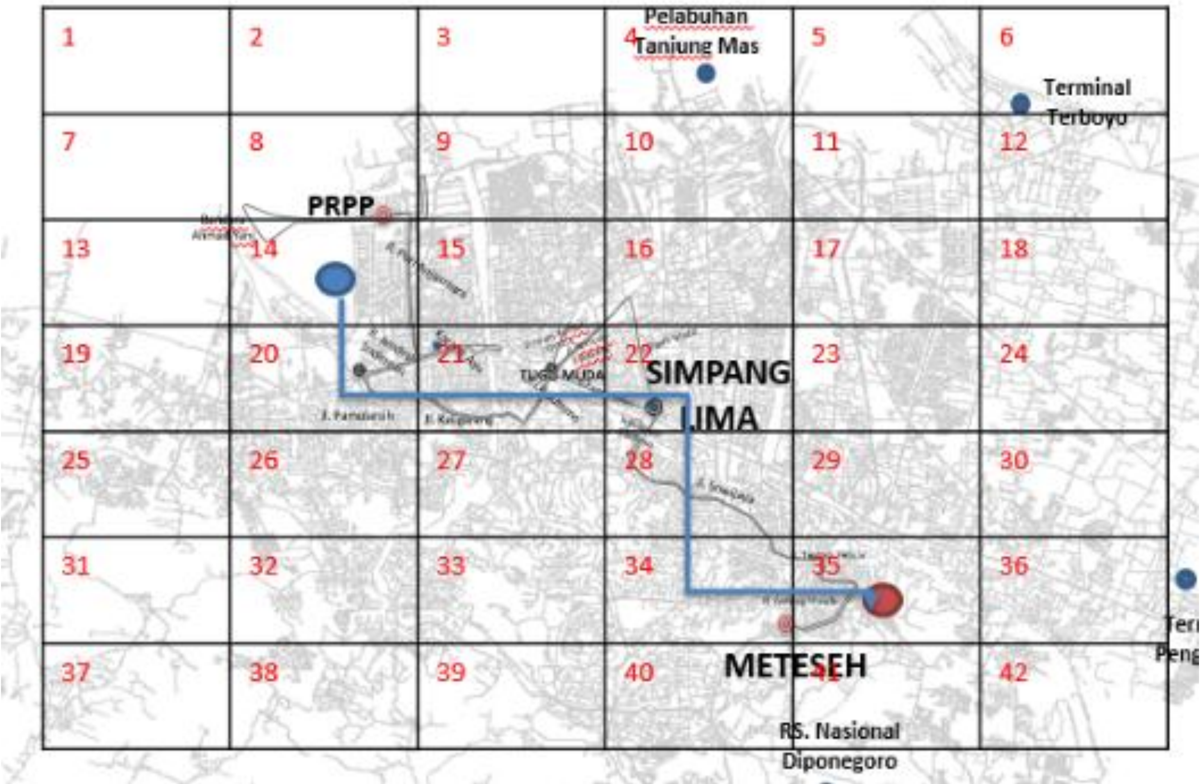

Fig. 4. Normal routes

Second step:

Provide value g h f based on equations 1,2 and 3 so the following values are obtained:
Node 1 coordinate (1,7):

G1 $=\sqrt{\mathbf{1^2+6^2}}$
$=\sqrt{\mathbf{1+36}}$
$=\sqrt{\mathbf{37}}$
=6,0

H1 = |7-1|+|7-6|
=6+1
=7

F1 =6,0+7
=13

After calculating the results obtained as shown in Fig. 5.

1	2	3	4	5	6
7 G=6,0 H=7 F=13	8 G=6,3 H=6 F=12,3	9 G=6,7 H=5 F=11,7	10	11	12
13 G=5,0 H=8 F=13	14	15 G=5,8 H=6 F=11,8	16	17	18
19 G=4,1 H=8 F=12,1	20 G=4,4 H=8 F=12,4	21 G=5 H=7 F=12	22	23	24
25	26	27	28	29	30
31	32	33	34	35	36
37	38	39	40	41	42

Fig. 5. Calculation of nodes

From each value, the decision is taken by taking a step with the value *f* the smallest one.

Third step:

After the first move is complete, the next step is done 1 and 2. So that the results obtained from the value *f* small (routes node) as shown in Fig. 6.

1	2 G=7,2 H=5 F=12,2	3 G=7,2 H=4 F=11,2	4 G=7,2 H=3 F=10,7	5 G=8,3 H=2 F=10,2	6
7 G=6,0 H=7 F=13	8 G=6,3 H=6 F=12,3	9 G=6,7 H=5 F=11,7	10 G=7,2 H=4 F=11,2	11 G=7,8 H=3 F=10,8	12 G=8,4 H=2 F=10,2
13 G=5,0 H=8 F=13	14	15 G=5,8 =6 F=11,8	16	17 G=7,0 H=3 F=11	18 G=7,8 H=3 F=10,8
19 G=4,1 H=8 F=12,1	20 G=4,4 H=8 F=12,4	21 G=5 H=7 F=12	22 G=5,6 H=6 F=11,6	23 G=6,4 H=5 F=11,4	24 6=7,2 H=4 F=11,2
25	26	27	28	29 G=5,0 H=6 F=11	30 G=6,7 H=5 F=11,7
31	32	33	34	35	36
37	38	39	40	41	42

Fig. 6. Calculation node

After getting the calculation results, the closest distance from the start point to the endpoint in the column 14,15,22, and 29, So the closest path is through the path Jl. anjasmara – Simpang Lima – Sriwijaya – Kedung Mundu with a distance of 14.5 km with a travel time of 35 minutes. After obtaining the results from A*, the following is a comparison picture of normal and A* routes as shown in Fig. 7.

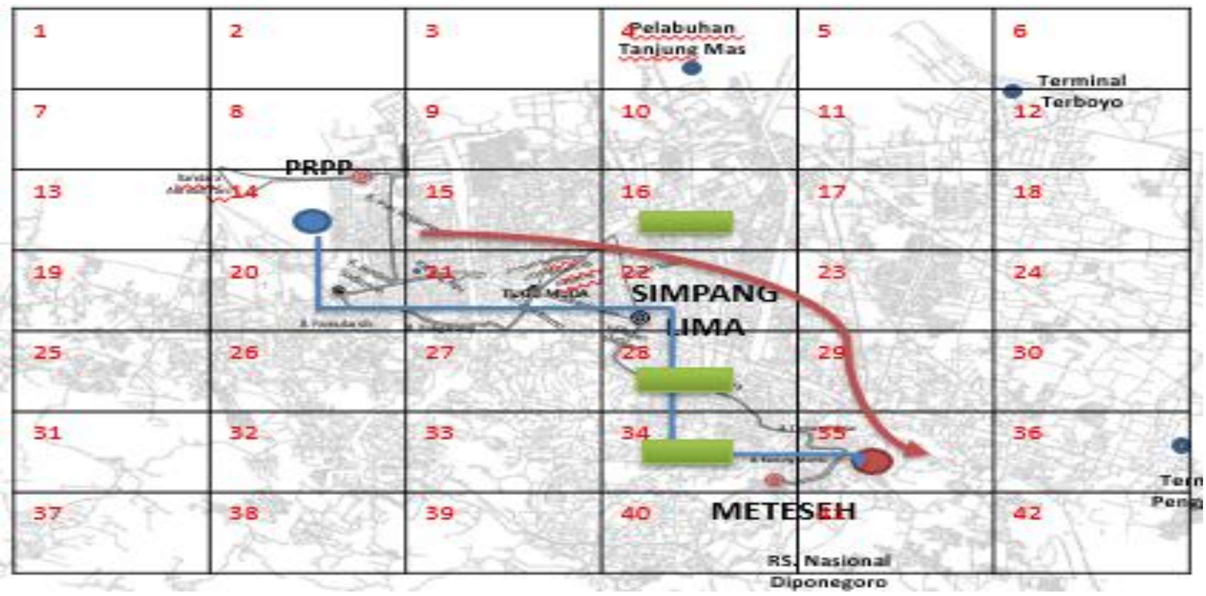

Fig. 7. Comparison of routes A* and normal routes.

Based on Fig. 7 blue arrows indicate the normal path BRT as much 5 node that is 20, 21, 22, 28, and 34 bypassing Jl. Purianjasmara – Tuga muda – Simpang 5 – Jl. Raya solo jogja – Jl. Prof soedarto with mileage 20,2 kilometers and 60 minutes travel time. Whereas the red arrow indicates the path that uses the A* algorithm as many times 4 node that is 15, 22, 23, and 29. By passing Jl. Puri anjasmara – Simpang 5 – Sriwijaya – Jl. Kedung Mundu, with a distance of 14.6 km and travel time of 35 minutes.

Test of A* algorithm is compared with the best-first search algorithm as shown in Fig. 8.

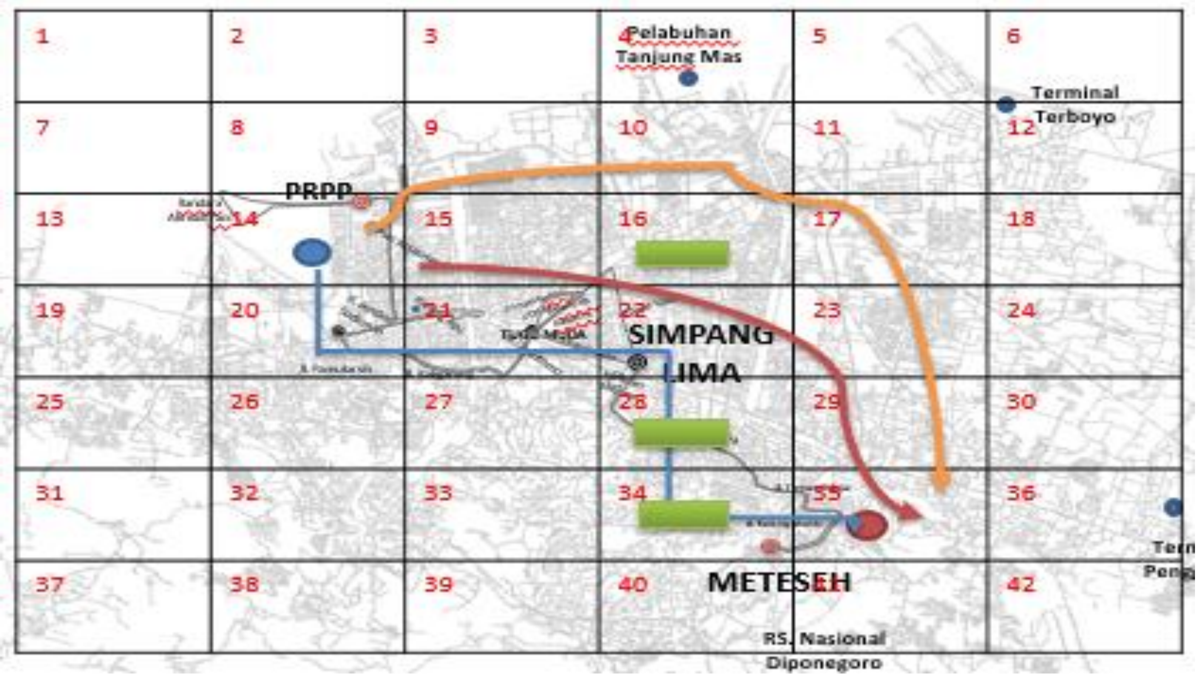

Fig. 8. Comparison of A* and Best-first search.

Based on the Fig. 8 orange arrows show the path Best-first search algorithm as much as 5 node that is 9, 10, 17, 23, and 29. By passing Jl. Pantura – Jl. Raya Genuk – Jl. Woltermonginsidi – Jl. Fatmawati – Jl. Kedung mundu with a distance of 16 km and 45 minutes. Determination of the best-first search node is based on the smallest H value.

Based on Fig. 8, the comparison between normal routes, best-first search algorithm, and A* algorithm as shown in Table 1.

Table 1. Measurement of algorithm performance.

	Route normal	BFS (best-first search)	A*
Amount node	5	5	4
Traveling time (minutes)	60	45	35
mileage (km)	20,2	16	14,5

Based on Table 1, so the comparison between the normal routes and the best-first search algorithm has a longer travel time and distance, than the best-first search algorithm even though it has the same number of nodes. This is because in normal routes there are obstacles such as lanes Solo Jogyakarta, obstacles in the form of climbs and roads Jl Prof Soedarto congestion which is quite long, while the overall performance of the A* algorithm is faster and optimal than the best-first search algorithm. Therefore the A* algorithm can be used to determine the best routes.

CONCLUSION

In this research, A* can't only be applied to the case of AI games and mobile robots, but this study applies the A* on transport in particular BRT. Based on the results of research on the implementation of the A* algorithm to search on transport routes nearby

BRT can be concluded that the A* algorithm has optimal performance in finding the nearest routes. So it can be concluded A* in the case of BRT routes search of nearest transport have optimal results with 4 nodes, whereas normal routes and BFS (Best-First Search) have 5 nodes for routes search.

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