Implementation of A* Algorithm in Determining the Shortest Path on Graph

[1] Nadya Andhika Putri, [2] Andysah Putera Utama Siahaan
Faculty of Science and Technology, Universitas Pembangunan Panca Budi, Medan, Indonesia
Email: [1] nadyaandhika@dosen.pancabudi.ac.id, [2] andiesiahaan@gmail.com

Abstract: *A* algorithm according to the inventor of a mathematical scientist Abu Abdullah Muhammad bin Musa al-Khwarizmi The Inventor of Algorithms is a greedy algorithm that is used to solve problems in determining the shortest path. This problem is often implemented in the form of a graph. Graph theory is a subject that is old but has many expectations to date. Graphs are used to discrete and relationship between these objects. The visual representation of the graph is to state that the object is declared as a circle. By using the shortest route determination application using A* algorithm, the application is suitable to be used to determine the optimization on the shortest route. However, it depends on the problems faced. Using this algorithm method will help efficient time search using processes that are mostly random, and produce good solutions at fast speeds.*

Keywords: *Shortest Route, Al * Algorithm*

1. INTRODUCTION:

Artificial Intelligence is a branch of Science using machines to solve complex problems more humanely. It is usually done using analogy of human intelligence, and its application as an algorithm known to computers. In other words, there is nothing more and more efficient than dependent, which affects how the behavior of artificial intelligence is manifested. AI is usually issued with Computer Science but also related to things such as Mathematics, Psychology, Observation, Biology, Philosophy, and others. The ability to combine knowledge from all of these fields will ultimately be beneficial for progress in efforts to create artificial intelligence. Another understanding of artificial intelligence is part of a computer that makes computer machines do work like and services that humans do. At the beginning of its creation, the equipment only functioned as a counting tool. But along with the times, computer games are increasingly dominating human life. The computer is no longer just as a calculating tool, more than that, a computer is needed to be empowered to do everything that can be done by humans. In the problem of determining the shortest route that requires a long time, the system needed can be used to determine the location and determine the position to be searched. The search technique used to determine the shortest path is blind search and heuristic search. Find out what can be done better than heuristic search results, but search results are more varied and faster. One of the shortest path search methods included in heuristic search is the A* algorithm. It is heuristic values that are used as a basis for calculating costs that will determine the closest mileage to reach the destination with the closest mileage.

2. THEORIES:

2.1 Artificial intelligence

Artificial Intelligence (AI) is a technique and science to make a machine smart, especially for computer programs. Intelligence in question is intelligence like that of humans so that a computer can take action to solve problems with thoughts like a human [1]–[3]. The research objectives of AI include reasoning, knowledge, planning, learning, processing natural language, perception and the ability to mobilize and manipulate objects. General intelligence is one of the long-term goals of AI. It has created a large number of tools to solve difficult problems in the computer field. The field refers to computer science, mathematics, psychology, linguistics, philosophy, neuroscience, artificial psychology, and other fields [4]. AI is a part of computer science that makes computer machines do work as humans do. Computers are only functioned as a calculating tool, but along with the development of the times, the computer becomes a companion to human life. Computers are no longer only used as a counting tool; computers can do everything that humans can do [5].

Humans can be intelligent in solving all problems in this world because humans have the knowledge and experience gained from experience. The more provision of knowledge possessed by someone, the abler to solve problems [6]. Humans are also given the reason to do reasoning, drawing conclusions based on the knowledge and experience they have. Without having the ability to reason well, people with a wealth of experience and knowledge will not be able to solve problems correctly. Likewise, the ability to reason is excellent, but without the provision of adequate knowledge and experience, humans will also not be able to solve problems correctly. Computers must also be equipped with knowledge and have the ability to reason to act like and as good as humans. AI offers several methods to equip computers with intelligence so that the computer can become a smart machine [7]–[10].

2.2 A Algorithm*

An Algorithm is one of the most important things to build a good system. In artificial intelligence courses and algorithmic strategies, the use of A* or A star algorithm is often used to solve specific problems. A* is one algorithm that can be used to determine the total minimum trajectory costs and also when the right conditions can provide optimal solutions [11]–[13]. The workings of this algorithm are almost the same as the best first search algorithm but modified with the heuristic function. The A-star algorithm requires two queue models such as open queue and closed queue. Modification of the heuristic function of the A* algorithm can make predictions on each node created. This step is done to make it easier for the algorithm to determine the next steps that are expected. The following equation is the formula used to determine the closest distance using the A* algorithm.

$$f(n) = g(n) + h'(n)$$

Where:

f(n) = function of evaluation
g(n) = costs incurred from the initial state to node (n)
h'(n) = estimation of costs incurred from state n or node (n) until reaching the destination.

If h = h ', then the search process has reached its goal (goal).
If g = h '= 0 then f' random, which means the system cannot be controlled.
If g = k, k is a constant and is usually 1, h '= 0, which means the system uses the best first search technique.

H '(n) is the distance between two coordinates determined based on Euclidean distance. The following equation is the formula that is used to determine the distance between points [14].

$$h'(n) = \sqrt{(x2 - x1)^2 + (y2 - y1)^2}$$

This method can be symbolized by the function f '(n) as an approach to the function f (n) where the function f (n) is the actual evaluation function of the node (n). In many cases, it is much better if a function is defined as a combination or number of two or more components, such as g (n) and h (n). The function g (n) is a measure of the costs that have been incurred from an initial state to the node (n). The result of the g (n) is not the result of the estimation but the sum of the costs of implementing each rule that is carried out along the best path that has been determined by the heuristic function that goes to a node.

For the function of h (n) is a measure of additional costs that must be removed from the node (n) until it reaches the destination. For the record, the function of g (n) cannot be negative because if it is negative, then the path that reverses the cycle on the graph will look better with the more extended number of passes [15].

3. METHODOLGY:

This section will discuss the coordinate used. The coordinate will be mapped as many as 26 pieces (A-Z). Each coordinate has a different position and does not collide with each other. The following table describes the coordinate positions that will be used in this study.

Table 1. Coodinate

[A] to [B] = 18	[H] to [A] = 27	[N] to [K] = 47	[U] to [T] = 16
[A] to [H] = 27	[H] to [C] = 30	[N] to [O] = 45	[U] to [V] = 29
[B] to [A] = 18	[H] to [I] = 35	[N] to [S] = 50	[U] to [W] = 21
[B] to [C] = 26	[I] to [C] = 20	[O] to [N] = 45	[V] to [F] = 18
[B] to [D] = 28	[I] to [H] = 35	[O] to [P] = 33	[V] to [G] = 25
[C] to [B] = 26	[I] to [J] = 33	[O] to [T] = 54	[V] to [U] = 29
[C] to [D] = 40	[I] to [L] = 47	[P] to [O] = 33	[V] to [W] = 25
[C] to [H] = 30	[I] to [X] = 26	[P] to [Q] = 20	[W] to [T] = 25
[C] to [I] = 20	[J] to [E] = 23	[P] to [R] = 57	[W] to [V] = 25
[C] to [X] = 17	[J] to [G] = 35	[P] to [S] = 47	[W] to [W] = 0
[D] to [B] = 28	[J] to [I] = 33	[Q] to [P] = 20	[X] to [C] = 17

[D] to [C] = 40	[J] to [L] = 64	[Q] to [R] = 68	[X] to [E] = 13
[D] to [F] = 21	[J] to [X] = 20	[Q] to [S] = 41	[X] to [I] = 26
[E] to [F] = 28	[K] to [L] = 83	[R] to [P] = 57	[X] to [J] = 20
[E] to [G] = 21	[K] to [M] = 52	[R] to [Q] = 68	[Y] to [K] = 32
[E] to [J] = 23	[K] to [N] = 47	[R] to [T] = 35	[Y] to [L] = 68
[E] to [X] = 13	[K] to [Y] = 32	[S] to [M] = 64	[Y] to [M] = 42
[F] to [E] = 28	[K] to [Z] = 41	[S] to [N] = 50	[Z] to [K] = 41
[F] to [G] = 23	[L] to [I] = 47	[S] to [P] = 47	[Z] to [T] = 40
[F] to [V] = 18	[L] to [J] = 64	[S] to [Q] = 41	
[G] to [E] = 21	[L] to [K] = 83	[T] to [O] = 54	
[G] to [F] = 23	[L] to [Y] = 68	[T] to [R] = 35	
[G] to [J] = 35	[M] to [K] = 52	[T] to [U] = 16	
[G] to [V] = 25	[M] to [N] = 24	[T] to [W] = 25	
	[M] to [S] = 64	[T] to [Z] = 40	
	[M] to [Y] = 42		

Each coordinate has one branch, and there are also more than one. Each coordinate is two-way. The following figure is the result of the coordinate formation with predetermined positions and branches.

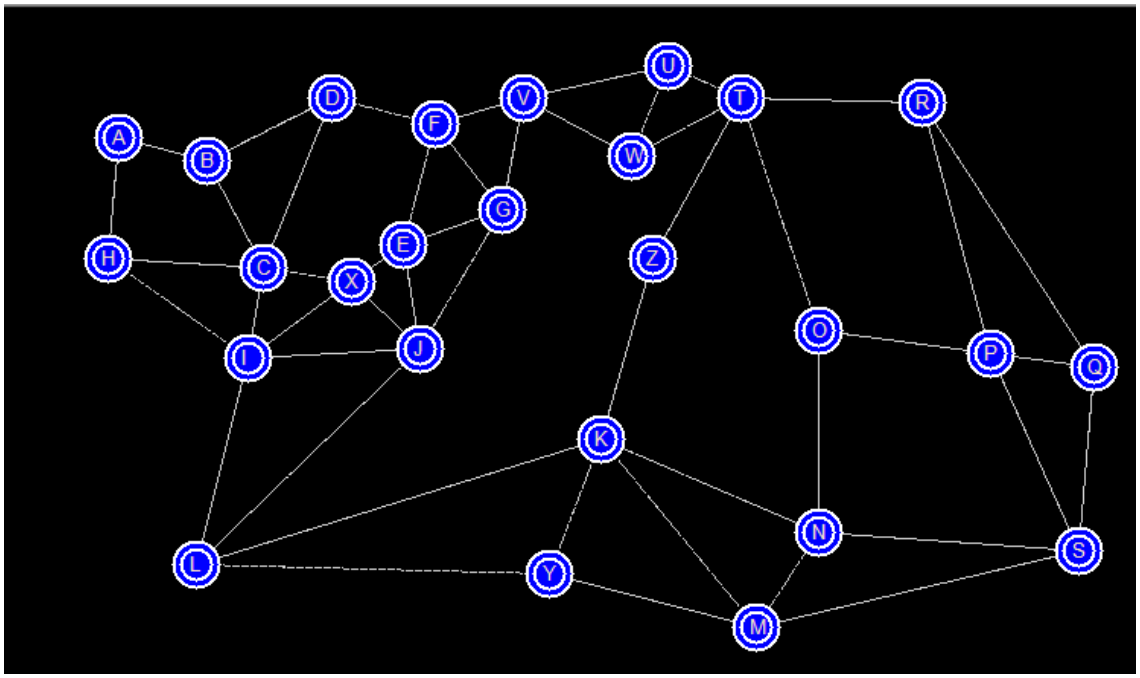

Figure 1. Graph based on coordinate points

4. RESULT AND DISCUSSION;

The following test is to determine the shortest route from A to Z. Each node that moves to the next node cannot return to the original node because it will result in a continuous search. Although the next node is the shortest node, if the node is from the previous node, then the next node must look for other nodes that have not been visited.

```
Source          = 0
Destination     = 25

Node B          = 152
Node H          = 191
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```
Next Node      = B

Node A         = 170
Node C         = 161
Node D         = 124

Next Node      = D

Node B         = 152
Node C         = 161
Node F         = 103

Next Node      = F

Node E         = 131
Node G         = 110
Node V         = 85

Next Node      = V

Node F         = 103
Node G         = 110
Node U         = 56
Node W         = 65

Next Node      = U

Node T         = 40
Node V         = 85
Node W         = 65

Next Node      = T

Node O         = 94
Node R         = 75
Node U         = 56
Node W         = 65
Node Z         = 0

Next Node      = Z
```

The calculation results above get the route used to move from position A to Z. The weight of the resulting distance is 170. The resulting route is A - B - D - F - V - U - T - Z.

Without Heuristic Function

```
==========================
[A] to [B] = 18
[B] to [D] = 28
[D] to [F] = 21
[F] to [V] = 18
[V] to [U] = 29
[U] to [T] = 16
[T] to [Z] = 40
```

Result: [A] to [Z] = 170

```
With Heuristic Function
=======================
[A] to [B] = 18 + 152
[B] to [D] = 28 + 124
[D] to [F] = 21 + 103
[F] to [V] = 18 + 85
[V] to [U] = 29 + 56
[U] to [T] = 16 + 40
[T] to [Z] = 40 + 0

Result: [A] to [Z] = 170 + 560
```

5. CONCLUSION:

Based on the results of testing and the design of the shortest route search using A* algorithm, there are some conclusions. The shortest route search allows the process of visiting from one point to another will be faster and more regular. The A* algorithm used in the shortest route search process is constructive and easy to understand and use by users. Distance information in each point becomes clearer and can be adjusted to the needs in the future.

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