Dijkstra Algorithm Implementation to Determine the Shortest Route to Hospital: A Case Study in Magelang District Indonesia

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Abstract. Digital maps are an important tool used to find a place. The use of digital maps is very diverse, including to provide routes from one place to another. The map can also show that the route is heavy with traffic so that another route can be found. However, sometimes maps provide unclear routes so users can get lost. Users will search for the nearest hospital on the map. The map will display all hospitals, but the user must choose the hospital to go to and then follow the suggested route. This is of course very inconvenient if in an emergency you have to find the location of the nearest hospital, so you need an application that can show the exact location of the hospital. The purpose of this research is to determine the shortest route to the nearest hospital so as to save time in an emergency. The method used in this research is using Dijkstra's algorithm. Current location search and the shortest route to the nearest hospital. The calculation results obtained a value of 0.476 km which indicates the shortest route. The application of Dijkstra's algorithm can maximize the use of the map with the shortest route to the nearest hospital.

1 Introduction

Currently the use of digital technology is commonly used because it is practical in its use. This technology utilizes computers and their equipment [1]. One of the applications of digital technology is a digital map which is one of the important tools needed in today's modern life. Digital maps are used to find a place [2]. This application can be accessed using a computer or mobile device. Its utilization is very diverse, one of which is to show routes from one place to another. In addition, digital maps can show that the route to which traffic is very congested, so that other routes can be found [3].

However, maps sometimes provide ambiguous routes so that the user can tersesat [4] [5]. Example: We will search for the nearest hospital, google map will display all hospitals and the user will choose for himself. As shown in Fig. 1. Digital maps are used to find the closest route using Dijkstra's algorithm. This algorithm is used in determining the shortest path from a certain point to every other point on a graph [6].

Previous research on the application of Dijkstra's Algorithm has been carried out by Gunawan et al., has found the shortest path with the smallest weight [7]. Deepa et al focused

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on the basics of providing the shortest route between source and destination nodes [8]. Singh et al use Dijkstra's Algorithm to optimize sea transportation routes[9]. Based on previous research, it can be concluded that Dijkstra's algorithm is an algorithm that can determine routes by choosing the smallest distance from the first location to the specified location quickly and can save time. However, previous studies have not used the latest location determination feature. This feature is really needed for medical emergencies so that patients can be treated immediately. The purpose of this study is to determine the shortest distance route to the nearest hospital in the district and city of Magelang using the Dijkstra algorithm method.

Fig. 1. Map nearest hospital

Table 1. Hospital in Magelang District

<table>
<thead>
<tr>
<th>No</th>
<th>Hospital</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Prof. Dr. Soerojo Psychiatric hospital</td>
<td>Ahmad Yani Street No.169, Kramat Utara, Magelang Utara, Kota Magelang, Central Java 56115</td>
</tr>
<tr>
<td>2</td>
<td>Magelang Islamic Hospital</td>
<td>Jeruk Street No 4A, Kramat Selatan, Magelang Utara, Kota Magelang, Central Java 56112</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Soedjono Army Hospital</td>
<td>Urip Sumoharjo Street No 48, Wates, Magelang Utara, Kota Magelang, Central Java 56113</td>
</tr>
<tr>
<td>4</td>
<td>Tidar Regional public hospital</td>
<td>Tidar Street No 30A, Kemirirejo, Magelang Tengah, Kota Magelang, Central Java 56125</td>
</tr>
<tr>
<td>5</td>
<td>Lestari Raharja Hospital</td>
<td>Sutopo Street No 5, Cacaban, Magelang Tengah, Kota Magelang, Central Java 56121</td>
</tr>
<tr>
<td>6</td>
<td>Gladiool Mother and child hospital</td>
<td>Kenanga Street No 2, Kemirirejo, Magelang Tengah, Kota Magelang, Central Java 56122</td>
</tr>
<tr>
<td>7</td>
<td>Harapan Magelang Hospital</td>
<td>Panembahan Senopati Street No 11, Jurangombo Utara, Magelang Selatan, Kota Magelang, Central Java 56123</td>
</tr>
<tr>
<td>8</td>
<td>Budi Rahayu Maternity Hospital</td>
<td>Urip Sumaharjo Street No. 15, Wates, Magelang Utara, Kota Magelang, Central Java 51253</td>
</tr>
<tr>
<td>9</td>
<td>Merah Putih Regional public hospital</td>
<td>Magelang-Yogyakarta Street Km 5 Mungkid, Danurejo Mertoyudan</td>
</tr>
<tr>
<td>10</td>
<td>Muntilan Regional public hospital</td>
<td>Kartini Street No.13, Muntilan</td>
</tr>
<tr>
<td>11</td>
<td>Aisyiyah Muntilan Hospital</td>
<td>KHA Dahlan Street No. 24, Muntilan</td>
</tr>
<tr>
<td>12</td>
<td>N-21 Gemilang Hospital</td>
<td>Pondok Pabelan Street No. 5, Pabelan, Mungkid, Magelang</td>
</tr>
<tr>
<td>13</td>
<td>Padma Lalita Hospital</td>
<td>Klangon Street Km. 10, Muntilan</td>
</tr>
</tbody>
</table>
2 Method

The method used in this study is Dijkstra's algorithm which is used to find the shortest path and prototyping for system development. Dijkstra's algorithm is used to solve problems in finding the nearest hospital in the Magelang area. Solving problems with Dijkstra's algorithm starts from determining the initial value to the maximum value for each step. Dijkstra's algorithm will provide a solution in determining the fastest route to the hospital with a calculated value. The list of hospitals in the Magelang area is shown in Table 1. The method used in this study is Dijkstra's algorithm which is used to find the shortest path and use prototyping for system development.

2.1 Use case diagram

This system has 2 actors, namely administrators and users. The administrator is responsible for the running of the system. Administrator must login first to use this system. The activities carried out by the administrator are searching for hospital routes, seeking information and managing hospital data that will appear on the map. In addition, Administrators can perform Create-Read-Update and Delete operations on the system, while users can only read them. Users can search for hospital routes and get information like in Fig. 2.

![Use Case Diagram looking for the shortest route](image)

Fig. 2. Use Case Diagram looking for the shortest route

2.2 Activity diagrams

Activity Diagram This application involves 3 components, namely Admin, System and Users. The flow of the system is as follows: Admin accesses the system by entering the user name and password. The system displays the login page and main page. The system searches for the nearest hospital by determining the initial location and looking for the closest route to the hospital using Dijkstra's algorithm as shown in Fig. 3.

2.3 Database Design

The database design in the system is built using EER (Enhanced Entity Relationship). The EER design describes the relationships that occur between tables [10]. Node table and graph table have 1:n one node can have many graphs. The admin table and the node table have a 1:n relationship because one admin can create multiple nodes. The admin table and the graph table have a 1:n relationship because one admin can create many graphs like Fig. 4.
**Fig. 3.** Activity Diagram Finding the location of the hospital

**Fig 4.** EER Hospital location search
3 Result and discussion

Dijkstra's algorithm is used to solve problems in finding the nearest hospital in the Magelang area. Solving problems with Dijkstra's algorithm starts from determining the initial value to the maximum value for each step. Dijkstra's algorithm will provide a solution in determining the fastest route to the hospital with a calculated value. Fig. 5 shows that there are many routes to get to the hospital.

Fig. 5. Route to the location of the hospital

Following are the steps to determine the closest route to Gladiool Mother and child hospital using Dijkstra's algorithm calculations:

3.1 The first step

There are many routes that are interconnected and have different distances. Fig. 6 is a directed graph that is used to solve the problem of determining the shortest distance by calculating the nearest node [11]. The graphical data is used to represent the map in Fig. 7.

Fig. 6. Determination of nodes on the map

Determination of the closest route is done by calculating the DJisktra algorithm as follows:

a. Specifies the starting point and destination on the map.
b. Choose the smallest weight or distance from each connected node.

c. Do it until the node reaches the destination

![Graph with weighted nodes and connections]

**Fig. 7.** Node and distance determination

### 3.2 Step Two

Use Dijkstra's Algorithm to solve the shortest distance problem on a directed graph. A graph is defined as a set pair \((V, E)\), \(V\) is a non-empty set of vertices or nodes and \(E\) is a set of edges connecting between vertices.

\[
V = \{v_1, v_2, \ldots, v_n\} \quad (1)
\]

\[
E = \{e_1, e_2, \ldots, e_n\} \quad (2)
\]

or

\[
G = (V, E) \quad (3)
\]

First, the starting point is A, the next point is A to F or A to B. The result is that point A to B has the smallest distance with 0.133 km. Second, from point B there are two points, namely B to C or B to E. Point B to E is the next point, because to go to point H, point C must go through points D and E which have a distance weight of \(B+C+D+E = 0.133+0.182+0.183+0.082 = 0.580\) km, while point B+E = 0.133+0.245 = 0.378 km. See **Fig. 8**.

![Graph with weighted nodes and connections]

**Fig. 8.** Next node determination

Third, from point E go straight to the end point, namely point H with a distance of 0.98 km (**Fig. 9**). Fourth, the shortest distance from point A to point H is shown in **Table 2**. From the starting point (Node A) then to Node B because it has less distance, then to node E, and finally to the destination node (node H).
Home view route search and list of hospitals. The admin menu display has 3 sections, namely hospital data, nodes and graphs. The first is hospital data containing the determination of hospital points in the Magelang area which is input by the admin. Admin can add, edit and delete hospital data. The node function is to add the first location point by the admin. Lastly, graph, graph has a function to calculate the distance from the starting point that has been determined by the node and then displayed on the route search page as shown in Fig. 10.

![Fig. 10. Admin menu view](image-url)

User home view

a. List of hospitals

In the Fig. 11 application display, there is information about the list of hospitals and information related to hospitals such as the opening hours of the hospital, the location of the hospital and the history of the hospital.

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**Table 2. Closest distance**

<table>
<thead>
<tr>
<th>V(Node)</th>
<th>A</th>
<th>A-B</th>
<th>B-E</th>
<th>E-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarak</td>
<td>0</td>
<td>0.133</td>
<td>0.245</td>
<td>0.098</td>
</tr>
</tbody>
</table>

\[
V=(A, B, E, H) \\
V= 0.133+0.245+0.098 \\
= 0.476 \text{ km}
\]
b. Route Search

The route search step is carried out by determining the starting point using GPS or the admin has determined the starting point. The system will determine the nearest hospital by determining the starting point node to the destination hospital. The closest route will be generated based on calculations using Dijkstra's algorithm. For example, in Fig. 12, determining the starting point using GPS, the starting point is at UNIMMA, then the destination point is Tidar Hospital.

Based on the results of the implementation and testing that has been carried out, the results of finding a route to the hospital are discussed as follows: The user searches for a hospital by determining the initial location. Next, the system will look for the closest location to the hospital from the initial location. Then draw a line using the line tool on the map from the
initial location point to the destination hospital then right-click twice a hospital route will appear which has been calculated using Dijkstra's algorithm. After the route has been determined, the time and distance calculation will appear. Dijkstra's algorithm in this system uses longitude and latitude so that the location of the hospital is indicated correctly. This is in line with research conducted by Syarifudin [12] with the addition of more complete hospital information, the initial location of which can be accessed from anywhere. The system that was built is more effective than the previous system because in previous research, many routes had to be chosen, so faster calculations were needed.

4 Conclusion

Dijkstra's algorithm looks for the shortest route by always looking for the smallest weight of several designated routes. Based on the calculation of the shortest distance, the A-B node distance is 0.13 km, the B-E node distance is 0.245 km and the E-H node distance is 0.098 km, so that the A-H distance is 0.476 km. The smallest weight value is the shortest route shown. This algorithm shows the exact route without having to filter again, which of course can save search time, especially in emergency situations.

References


