Implementation Of Haversine Formula And Best First Search Method In Searching Of Tsunami Evacuation Route

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Abstract : Padang is one of the cities prone to earthquake disaster with tsunami due to its position at the meeting of two active plates, this is a source of potentially powerful earthquake and tsunami. Central government and most offices are located in the red zone (vulnerable areas), it will also affect the evacuation of the population during the earthquake and tsunami disaster. In this study, researchers produced a system of search nearest shelter using best-first-search method. This method uses the heuristic function, the amount of cost taken and the estimated value or travel time, path length and population density. To calculate the length of the path, researchers used method of haversine formula. The value obtained from the calculation process is implemented on a web-based system. Some alternative paths and some of the closest shelters will be displayed in the system.

Keywords : best first search, haversine formula, tsunami evacuation route

1. Introduction
Padang is one of the cities prone to earthquake disaster with tsunami due to its position at the meeting of two active plates. Spreading of population in the coastal area of coastal area also with central government and office. In the earthquake disaster experience in previous years, the city of Padang has a problem in the evacuation of the population. Best-First Search is a graphical search algorithm, which means the search space can be represented as a node connected by a path. In this case, the distance calculations of each point use the haversine method of the formula.

The haversine formula is an equation important in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes.
Based on the above background then the formulation of the problem in this research is how to use haversine formula in designing an android application that can help the community in determining the location of the nearest shelter.
So that the author does not come out of the existing problems and research results can be obtained with good, perfect and directed, the authors limit the scope of the discussion. In addition, given the limited time, cost and the ability of the author, the research takes the restrictions of the problem as follows:
1) This research is only intended to address the problems that exist within the community about the evacuation site.
2) Restricted only to overcome the difficulties of the people in the selection of the closest evacuation routes specifically red zone (coastal territory).
3) Restricted to data obtained in vulnerable areas or 2 km from coastline.
Through the results of this study is expected to produce a capable:

1) Produce an application system that can assist the community in getting information about tsunami shelter nearest to Padang City by using artificial intelligence application of heuristic method.
2) Scientific Publication.

2. Theoretical Basis

**PHP: Hypertext Preprocessor** Is a scripting language that can be embedded or inserted into HTML. PHP is widely used to program dynamic websites. PHP can be used to build a CMS.

**MySQL** (Can be read by mai-es-ki-el or it could be mai-se-kuel) is a database software relation (Relational Database Management System atau DBMS), as well as ORACLE, POSTGRESQL, MSSQL, etc. SQL stands for **Structure Query Language**, defined as a syntax of certain commands or program languages used to manage a database. So MySQL is the software and SQL is the command language. Heuristic search is a strategy to conduct a selective search process and can guide the search process that has the greatest chance of success, but with the possibility of sacrificing completeness. To apply the heuristic search required a heuristic function. The heuristic function is the rules used to obtain the desired solution. This heuristic search can overcome some obstacles that arise in previous methods, such as solving problems that have high complexity.

The heuristic search consists of:
1) Generate and test
2) Hill Climbing
3) Best-First-Search
4) Algorithm A*
5) Simulated Annelaing

In this research, the algorithm used will use Best-First Search heuristic.

The Best-First Search algorithm is a search algorithm that discusses graphs by extending the most promising nodes selected according to the prescribed rules.

Algorithm (T.Sutojo: 2011).

1) Create a stack, initialization, as the root node (first node).
2) When the first node ≠ goal, the node is removed and replaced with its children.
3) Furthermore, the entire nodes in the Stack are sorted by Ascending based on the heuristic function used.
4) When the first node ≠ GOAL, repeat step point b.
5) When the first node = GOAL, find the solution by tracing the path from GOAL to the root node.
6) Done.

The haversine formula is an equation important in navigation, giving great-circle distances between two points on a sphere from their longitudes and latitudes.

\[
\text{jarak} = 2 \times R \times \arcsin \left( \sqrt{\cos(Lat_1) \cos(Lat_2) \sin^2\left(\frac{Lat_1 - Lat_2}{2}\right) + \cos(Lat_1) \cos(Lat_2) \sin^2\left(\frac{Long_1 - Long_2}{2}\right)} \right)
\]

Information: Lat is latitude, Long is longitude, R is radius of earth (radius = 6,371km).

This study used several references from pre-existing studies. Among them is, Shanty Dewi, 2010 with the title research Design Information Application Shelter Transit Transjakarta Search with Breadth First Search Method. Ifatul Faizah, 2010, with Design Router Software Build. Traveling in Malang Using Dijkstra’s Algorithm. Research conducted by Rike Nur Setiyani, 2015, Implementation of Best-First Search (BEFS) Algorithm on Salesman Problem Traveling (Case Study: Tourism Travel In Yogyakarta City), in the study researchers ignore the density of traffic, traffic lights, road width, and obstacles. While research on this paper use these obstacles as a determinant variable heuristic value.
3. Methods
3.1 Types of Research
The type of research that the authors do is research on making the search system of the nearest tsunami shelter search path using heuristic method - best first search. Aims to generate and develop new and useful innovations to help communities in the event of a tsunami.

3.2 Research Sites
This research was conducted at ITP, by analyzing, designing, and building database.

3.3 Design of Context Diagram

![Figure 1. Context Diagram](image)

In Figure 1 above illustrates the outline of the nearest path search application by involving 1 entity only, is the user.

3.4 Input / Output Design
Here is the design of the main form view, where this form will be run in the smartphone browser or directly from user who using android.

![Figure 2. System View Design](image)

4. Results and Discussion
4.1 Entity Relationship Diagram

![Figure 3. Entity Relationship Diagram](image)
4.2 Database Design

1. Database : shelterpadang
   Table : tbl_lokasi

| No. | Field     | Type       | Length |          |
|-----|-----------|------------|--------|----------|
| 1   | Id_shelter| Varchar    | 12     | Primary Key |
| 2   | nama_shelter| varchar  | 25     |          |
| 3   | Latitude  | varchar    | 10     |          |
| 4   | Longitude | varchar    | 10     |          |
| 5   | Jumlah_lantai| varchar | 5      |          |
| 6   | Elevation| varchar    | 5      |          |
| 7   | Jarak_tepian| varchar | 5      |          |
| 8   | Area_evakuasi| varchar | 5      |          |
| 9   | Kepadatan_penduduk| Int |        |          |
| 10  | Lebar_jalan | int    |        |          |
| 11  | jenis     | varchar    | 20     |          |

3. Database : shelterpadang
   Table : tbl_marker

| No. | Field | Type       | Length |
|-----|-------|------------|--------|
| 1   | Id_marker | Varchar  | 12     |
| 2   | fungsi | varchar    | 25     |
| 3   | marker | varchar    | 25     |

| Node | Field          | Type       | Length | Notes          |
|------|----------------|------------|--------|----------------|
| A    | SDN 15         | F          | JL. JAYAPURA II ASRATEK |
| B    | SMK N 5 PADANG | G          | TELKOMSEL |
| C    | SMP N 7 PADANG | H          | STIE KBP |
| D    | SMP N 25 PADANG | I          | PLN BELANTI |
| E    | SMA N 1 PADANG | J          | STIKES ALIFAH PADANG |

Variable =

a. Population density
Table 4. Population Density

| Population density | Value |
|--------------------|-------|
| 1 – 5000           | 1     |
| 5000 ≤ P.D ≤ 7500  | 2     |
| 7501 ≤ P.D ≤ 12.500| 3     |
| 12.501 ≤ P.D ≤ 20.000| 4     |
| P.D ≥ 20.001       | 5     |

b. The width of the road

Table 5. The width of the road

| The width of the road | Value |
|-----------------------|-------|
| W.R ≤ 5 m             | 1     |
| W.R ≤ 7 m             | 2     |
| W.R ≤ 10 m            | 3     |

Population Density in node

Table 6. The width of the road

| Node | Population Density |
|------|--------------------|
| A    | 10000              |
| B    | 12000              |
| C    | 12000              |
| D    | 7000               |
| E    | 12000              |
| F    | 4000               |
| G    | 45000*             |
| H    | 45000*             |
| I    | 45000*             |
| J    | 45000*             |

* If the location is 1 subdistrict & 1 lane, the population density is the same.

F → A = 1.5 km
F → B = 1.7 km
F → C = 1.4 km
F → D = 0.95 km
F → E = 1.3 km
F → G = 0.4 km
F → H = 0.65 km
F → I = 1.9 km
F → J = 0.75 m

heuristic formula of Best First Search

\[ f(n) = g(n) + h(n) \] .................(2)

\[ f(n) = \text{Total Cost needed to reach the node} \]
\[ g(n) = \text{mileage} \]
\[ h(n) = \text{approximate value} \]
Table 7. Result of approximate value

| Node | Variable Density of Population Values | Distancen to F | Width of Road | approximate value (Density of Society + Width of Road)/10 | f(n)=g(n)+h(n) |
|------|---------------------------------------|----------------|-------------|----------------------------------------------------------|----------------|
| A    | 3                                     | 1.5            | 5 m         | 1                                                        | 0.4            | 1.9          |
| B    | 3                                     | 1.7            | 5 m         | 1                                                        | 0.4            | 2.1          |
| C    | 3                                     | 1.4            | 5 m         | 1                                                        | 0.4            | 1.8          |
| D    | 2                                     | 1.0            | 5 m         | 1                                                        | 0.3            | 1.3          |
| E    | 3                                     | 1.3            | 7 m         | 2                                                        | 0.5            | 1.8          |
| G    | 5                                     | 0.65           | 8 m         | 3                                                        | 0.8            | 1.45         |
| H    | 5                                     | 0.4            | 8 m         | 3                                                        | 0.8            | 1.2          |
| I    | 5                                     | 1.9            | 8 m         | 3                                                        | 0.8            | 2.7          |
| J    | 5                                     | 0.75           | 8 m         | 3                                                        | 0.8            | 1.55         |

Table 8. Case

| Shelter          | Address       | latitude    | longitude  |
|------------------|---------------|-------------|------------|
| St. JAYAPURA II  | Lolong        | -0.912987   | 100.356051 |
| PLN Rayon Belanti| Khatib Sulaiman| -0.916874  | 100.360254 |

Result using Haversine Formula:

1 derajat = 0.0174532925 radian
Lat₁ = -0.912987 * 0.0174532925 = -0.015934629 derajat
Lat₂ = -0.916874* 0.0174532925 = -0.01600247 derajat
Long₁ = 100.356051 * 0.0174532925 = 1.751544 derajat
Long₂ = 100.360254 * 0.0174532925 = 1.751617 derajat
ΔLat = - 0.015934629 – (- 0.01600247 ) = 0.000068
ΔLong = 1.751544 – 1.751617 = -0.000073
x = sin²(0.000068 /2) = 1.1506E-09
y = cos(-0.015934629 )*cos(-0.01600247 ) = 0.999745026
z  = sin²(-0.000073 /2) = 1.34528E-09
a = x+y+z= 1.1506E-09 + (0.999745026 * 1.34528E-09 ) = 2.49554E-09
R = 6371
Jarak = 2*6371*arcsin(√ 2.49554E-09 ) = 0.636531216 km
From the table above, so the node to which node H.

5. Conclusions
In this paper use haversine formula to calculate the distance of each node. The heuristic function used in this case takes into account the population around the node as well as the width of the road to be traversed. And also the optimum time obtained based on the density of the population that will evacuate, and the extension of the lane. And numerical calculations are applied to web-based systems. Where users will be able to directly access the system. For the next stage, this application will be developed in other sub-districts and socialized with related parties so as to be able to be implemented in the community. For suggestions from this paper, in order for further research, whether done by the researcher himself or any other researcher, can develop this application for a wider scope such as 1 city of Padang. And made more flexible for other cities.

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