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Finding optimal route information and network analysis for emergency service

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ABSTRACT

If the fire breaks out, it's important to realize that the fire truck is reached to the right place being on fire with the right way as soon as possible. In this proposed system, the NN Query method will be used to know the nearest fire station from the place being fire if the fire news comes to the station. Fire stations name, fire stations type, fire station address and latitude and longitude are stored in the spatial database. After getting the closed fire station, A* algorithm is used to calculate the optimal path. The shortest and the best way to go to the point is shown on drone map. The drone map of Meiktila region is used to create a base map in this paper.

Keywords— *GIS, Service area analysis, Shortest path analysis, A* algorithm, Drone Map, NN Query*

1. INTRODUCTION

GIS has been used in several areas such as retail site analysis, transportation [3], emergency services, fire petrol station mapping, and health care planning for the measurement of physical accessibility etc. The shortest path problem is a problem of finding the shortest path or route from a starting point to a final destination. [3] We use graphs to represents the shortest path problems, it is a mathematical abstract object. It contains sets of vertices and edges. Edges connect pairs of vertices. It is possible to walk by moving from one vertex to other vertices along the edges of a graph. The graph can be a directed graph or an undirected graph. [4]The lengths of edges are often called weights. Weights are normally used for calculating the shortest path from on point to another point. In order to represent a map we can use a graph, where vertices represent fire stations and edges represent routes that connect the fire stations.

The problem of identifying the shortest path along s road network is a fundamental problem in network analysis, ranging from route guidance in a navigation system to solving spatial allocation problems. There are a number of algorithms that can be used to determine the shortest route between two nodes in a network. Among them, A* algorithm and Dijkstra's algorithm are more efficient. Dijkstra's algorithm determines the shortest route between the source node and every other node and A* algorithm much like Dijkstra's based on heuristics strategy. The remainder of the present paper is organized as follows Section 2 describes the basic representative network structure. Section 3 describes the applied methods A*algorithm and related function for this system. Section 4 briefly explains system design and development. Section 5 discusses how to do experiment with the proposed system on Meiktila downtown region. Finally, section 6 presents the conclusion of the proposed system.

1.1. The objective of the system

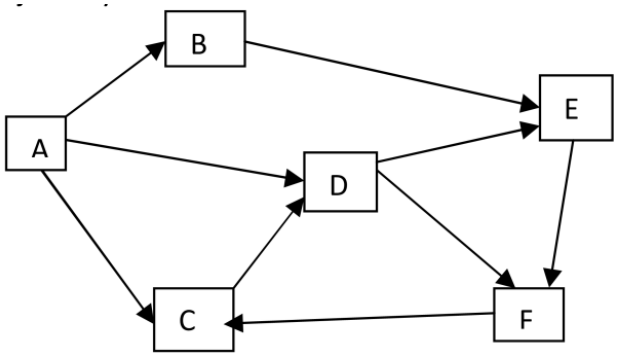
Sometimes the fire truck can't be reached to the location of the fire in the needed time, such as the distance from the fire station to the incident place is far or the traffic to the place. If the fire truck just only arrives at the point being fired, human lives and properties will be rescued in time. The firefighters provide emergency medical care and prevent the spread of fire in the building.

2. ROAD NETWORK REPRESENTATION

A public road network is composed by some nodes in this paper, the links connecting two nodes and routings. Define a public road network as G, G= {N, E, R}, where N= {1 ≤ I ≤ n} denotes the set of all nodes, and n is the number of nodes; the origin node and the destination node is O, D respectively. E= {1 ≤ e ≤ m} is the set of all transit links, and m is the number of links; R={ 1 ≤ r ≤ u } is the set of all bus lines and u is the number of links. In this paper, an algorithm employs two functions that relate fire stations and fire truck routes. The system uses the distance on the road network as the cost in this paper.

2.1. Adjacency matrices

In this paper, we present the connectivity among locations in transportation networks with adjacency matrices. We designate each location in the network a unique number. The value of a cell $M_{i,j}$ of an adjacency matrix M is set to the number of direct ways that we may travel from a location I to j. The following example, Figure 1 illustrates how we represent a simple road network with an adjacency matrix T and distance matrix.



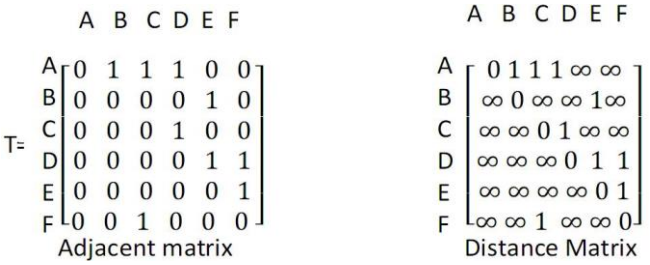


Fig. 1: Example fire stations route and its adjacency matrix and distance matrix

2.2. Distance Matrices

Given a weighted graph that represents a street network, a problem instance consists of a number of sources and destinations located in the graph. For these set of nodes, we want to know the distances from all sources to all destinations. Hence the result of such an M×N query is a matrix of distances. An entry of this distance table denotes the distance from the source corresponding to the current column, to the target corresponding to the current row.

2.3. Drone Map

The drone map is used as a base map in this paper. The drone map can be used offline, without an internet connection, in a number of ways. The Drone map is a much better resolution about 60 times than the satellite map. Its accuracy is x, y, z, even if wrong information, max-length might be 5 cm to 10cm and current data is up to date. As the drone map's resolution is good as well as the accuracy.

3. SYSTEM METHODOLOGY

It contains four parts: NN Query Algorithm, A* Algorithm, A* Algorithm Steps and Heuristic Function.

3.1. NN Query Algorithm

```
Input: Spatial Dataset
Output: Query Results based on ordering
Input Parameters: longitude, latitude, distance from dataset
begin
While (dataset value. next())
{
For each Object in Dataset
Input belong to N number of objects
For (int i = 0; i <= n; i++)
{
NN query result = select current location, preferred
location, distance based on choosing category;
NN query Indexing Result: select (category,
distance) order by distance;
}
}
End
```

3.2. A* Algorithm

A* algorithm is a computer algorithm that is widely used in pathfinding and graph traversal which is the process of plotting an efficiently directed path between multiple points, called 'node'. The system can be used pathfinding Algorithm. Pathfinding is the plotting, by a computer application, of the shortest route two between two points. Pathfinding is closed related to the shortest path problem, within graph theory, which examines how to identify the path that best meets some criteria(shortest, cheapest, fast, etc.,) between two points in a large network. A* algorithm is the building of a "closed list" to record areas already evaluated, an "OPEN list" to record areas adjacent to those already evaluated, and the calculation of distance traveled from the "start point" with estimated distance to the "goal point". The heuristic used to evaluate distances in A* is:

$$f(n)=g(n) + h(n) \quad (1)$$

Where -g(n) is the cost of the path from the starting node to any node n, and -h (n) is the heuristic estimated cost from any node n to the goal

3.3. A* Algorithm Steps

1. Create a search graph, G, consisting solely of the start node, n_0. Put n_0 on a list called OPEN.
2. Create a list called CLOSED that is initially empty.
3. If OPEN is empty, exit with failure.
4. Select the first node on OPEN, remove it from OPEN, and put it on CLOSED. Called this node is n.
5. If n is a goal node, exit successfully with the solution obtained by tracing a path along the pointers from n0 to n_n in G. (The pointers define a search tree are established in step 7).
6. Expand node n, generating the set, M, of its successors that are not already ancestors of n in G. install these members of Max successors of n in G.
7. Establish a pointer to n from each of those members of M that were not already in G (i.e., not already on either OPEN or CLOSED). Add these members of M to OPEN. For each member, m, of M that was already on OPEN or CLOSED, redirect its pointer to n if the best path to m found so far is through n. For each member of M already on CLOSED, redirect the pointers of each of its descendants in G so that they point backward along the best path found so far to these descendants.
8. Record the list OPEN in order of increasing f(n) values
9. Go to step 3.

3.4. Heuristic Function

Heuristic search has been widely used in both deterministic and probilistic planning. The heuristic function can be used to control A*'s behavior. Euclidean distance is a common method for h(n).

$$\text{Distance}=\text{sqrt}(dx^2+dy^2) \quad (2)$$

- x_2 = coordinates of the goal location
- x_1=coordinate of the current location
- y_2=coordinate of the goal location
- y_1=coordinate of the current location
- dx=|x2-x1|
- dy=|y2-y1|

If h (n) is always lower than to the cost of moving from n to the goal, then A* is guaranteed to find a shortest path. If h(n) is exactly equal to the cost of most of moving from n to the goal, then A* only follow the best path and never expand anything else, making it very fast. If h(n) is sometimes greater than the cost of moving from n to the goal, then A* is not guaranteed to find the shortest path, but it can run faster. At the other extreme, if h(n) is very high relative to g(n), then only h(n) plays a role and A* turns into Best-First-Search.

4. SYSTEM DESIGN AND DEVELOPMENT

In this paper, the fire stations information for Meiktila downtown regions such as fire stations name, fire stations type, latitude, and longitude position are stored in the spatial database. Time complexity in A* algorithm is O (n log n); n is the number of the node. This system can be used without an internet connection.

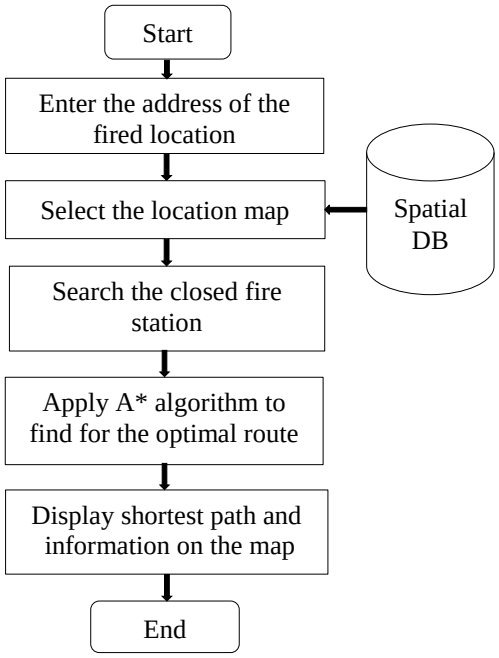


Fig 2: Flow diagram of the proposed system

4.1. Data Collection

4.1.1. Base Map

It is the first and important step towards the completion of the project. For this work Meiktila distinct (20º 50´ 09.4250" N and 95º 50´ 00.4688"E) is considered as the study area which is situated in the Mandalay Division of Myanmar. Toposheet of Meiktila distinct is obtained from the "Department of UAV Research Myanmar Aerospace Engineering University" having traced and scanned, which is considered as the base map (Figure 3)

Fig 3: Toposheet of Meikila City

4.1.2. Fire Stations Information

The fire stations information can be obtained by visiting the desired fire stations and taking the important information about the facilities provided the specialty of fire stations etc., The attribute data like name of fire stations, contact number specialty, type, address etc., need to be stored in the separate database. The data required is in the form of spatial and attribute data. Spatial data required is the road network and the fire stations. This spatial data is obtained through the process of digitizing a base map of the Meiktila region.

Attributes taken for Fire Station such as Name, Address, Type, Contact number were collected by surveying of each fire stations (Table 1).This paper cover Meiktila downtown region. This system tern to the next fire stations information for Meiktila district.

Table 1: Fire Stations Information

Id	Longitude	Latitude	Fire Station Name	Type	Address
1	95º20´52.39"E	20º52´09.04"N	Station 1	District Fire Station	Between the streets 3 and 4; North of PyiTharyar Quarter
2	95º18´53.44"E	20º51´06.25"N	Station 2	Township Fire Station	The east of Market Quarter, The First Road
3	95º23´16.56"E	20º52´20.55"N	Station 3	Area Fire Station	AungZeyar, The old high way road of Ygn-mdy
4	95º20´52.24"E	20º52´34.92"N	Station 3	Area Fire Station	AungSan Quarter, beside Meiktila-KyaukPadaung high way road
5	95º21´15.06"E	20º52´38.15"N	Station 3	Area Fire Station	TheeGyone highway road, and Beside Ygn-Mdy high way road
6	95º20´50.65"E	20º52´53.10"N	Station 4	Fire Station	Big Market, beside the old high way road of Ygn-Mdy
7	95º20´41.02"E	20º52´40.8"N	Station 4	Fire Station	3 rd street of Meiktila Industrial zone, beside Ygn-Mdy highway road

4.2. Georeferencing of Toposheet

Georeferencing process allows registration of the digitized Toposheet on the earth surface [10]. This is a very critical stage as the accuracy of the map depends upon georeferencing.

4.3. Mapping of Fire Station

In this step, the coordinates of the Fire Station is taken by doing a field survey. And based upon that coordinates the Fire stations are placed on the map as a point feature.

4.4. Creation of Personal Geodatabase

Geo-database has been created by integrating actual positions of the fire station with the fire station data collected as shown in Figure 4.

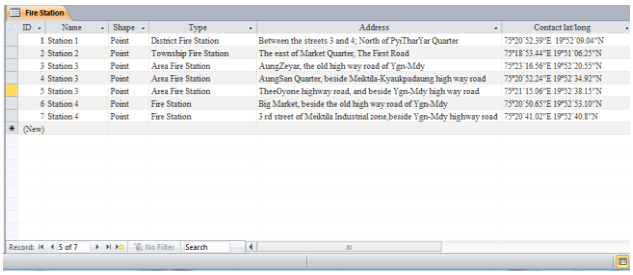


Fig. 4: Geospatial Database

5. EXPERIMENT

In this paper, the proposed system is tested on Meiktila downtown region, road network. After the data collection, it is important to locate it on the map. The Fire Station location is carried out using the ArcGIS tool. After Fire Station location is done it is important to draw a roadmap. It is also using the ArcGIS. The Fig (3) shows the Toposheet of the Meiktila region. When creating a network routing system, specific spatial data were collected for the accurate completion of the network. For example, a complete road network, where all the roads within the network are connected, is significant because it allows connection throughout the system.

5.1. Network Analysis

ArcGIS network Analysis is a powerful extension of ArcGIS that provides network-based spatial analysis including routing, travel directions, closest facility, and service area analysis. ArcGIS network Analyst enables users to dynamically model realistic network conditions including turn restrictions, speed limits, height restrictions, and traffic conditions at different times of the day.

For the Network analysis and finding the shortest path, we use the A* algorithm. ArcGIS Network Analyst allows you to solve common network problems, such as finding the best route across a city, finding the closed Fire Station or facility, identifying a service area around a location, or choosing the best facilities to open or close.

A* algorithm is a graph search algorithm that solves the single-source shortest path problem for a graph with non-negative edge path costs, producing a shortest path tree. This algorithm is often used in routing and as a subroutine in other graph algorithms. For a given source vertex in the graph, the algorithm finds the path with the lowest cost between that vertex and every other vertex.

5.2. Creation of map for Fire Stations

Based upon the coordinates taken by using GPS Fig (5), locations of the Fire Stations are mapped accurately on a map. Fig shows the map created using geodatabase and the location of the Fire Station.

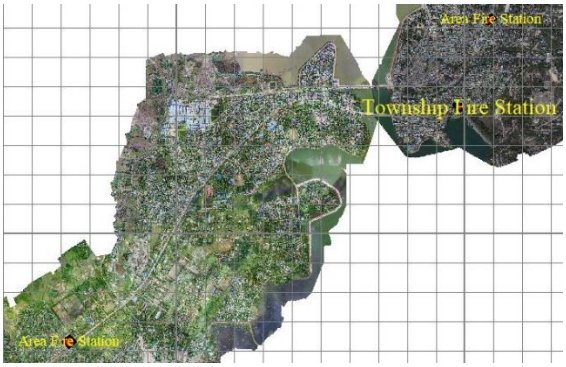


Fig. 5: Map Created Using Geodatabase

5.3. Creation Shortest path

Fig. 6: Shortest Path between Two Locations

The system will generate the shortest path between two locations by calculating the distance based on road length. This will help the user to reduce the traveling time to reach a particular fire station [12]. Fig shows the shortest distance from area fire station.

5.4. Service Area Analysis

The system can point out the area where the locating of fire by using drone map. If the injured being in the place may be found, the drone map can search the nearest hospital clinic in that place shown in Figure 7.

Fig. 7: Service Area Analysis

6. CONCLUSION

In that study, the shortest path can be found the fire station from the fire station from the user location. The ArcGIS and A* algorithm will be used for implementation in the drone map. Network Analysis is carried out for all the network related problems. This will help the user to find the shortest path from their location to the Fire Stations. Using drone map, the closed present can be searched /found immediately and may reduce the travel time dramatically.

7. REFERENCES

[1] Amrapali C. Dabhade, Dr. K. V. Kale, "GIS-Based Health Care Information System for Aurangabad City", International Journal of Engineering and Innovative Technology (IJEIT) Volume 4, Issue 1, July 2014.

[2] Kang-Tsungchang, Introduction to Geographic information system (Fourth Edition), Tata McGraw Hill Private Limited.

[3] Ajay D. Nagne, Dr. BhartiW.Gawali, "Transportation Network Analysis By Using Remote Sensing And Gis A Review", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622, Vol. 3, Issue 3, PP.070-076, May-Jun 2013.

[4] Usman Ado Kibon and M. Ahmed "Distribution of Primary Health Care Facilities in Kano Metropolis Using GIS (Geographic Information System)", Research Journal of Environmental and Earth Sciences, Volume 5 Issue 4, PP.167-176, 2013.

[5] LELLA Wilfred Kouassi Camille, LIU Fujiang, N'gottaN'guessan, WANG Shun,"Applied GIS in the location of a petrol station in Abidjan city, Cote d'Ivoire", IEEE, 2010.

[6] Aurangabad, Maharashtra, Sited on Jan 2014 http://en.wikipedia.org/wiki/Aurangabad,_Maharashtra

[7] Mohamad Taufik Lokhman, Abdul Rauf Abdul Rasam, AbdMalekMohd Noor, "Reforming Health Care Facility Using Geographical Information System", IEEE Control and System Graduate Research Colloquium (lCSGRC), 2012.

[8] Tao Peng and Xiaowen Wang, "A Mobile-based Navigation Web Application: Finding the Shortest-time Path based on Factor Analysis", June 2012.

[9] Ke Huang, Mingqing You, "GIS-Based Environmental Health Management Information System", 2nd Conference on Environmental Science and Information Application Technology, 2010.

[10] Holia, Mehfuza, V. K. Thakar, Image Registration For Recovering Affine Transformation Using Nelder Mead Simplex Method For Optimization, International Journal of Image Processing (IJIP) 3.5: 218, 2005.

[11] ArcGIS information accessed on Oct 2013 http://resources.arcgis.com/en/help/gettingstarted/articles/026n00000014000000.html

[12] Roozbeh Shad, Hamid Ebadi, Mohsen Ghods. "Evaluation of Route Finding Methods in GIS Application", International Journal of Computer Applications (0975 – 8887) Volume 53– No.10, September 2012.

