Optimal Route Finding for Famous Places in Mandalay by using A* Method based on GIS

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Abstract

Geographic Information System (GIS) is a computer system capable of capturing, analyzing, and displaying geographically referenced information; that is, data identified according to location. Geospatial information system provides strong decision support for users in searching optimal route, finding the nearest facility and determining the service area. Searching optimal path is an important advanced analysis function in GIS. This system is intended to develop the Geographic Information System (GIS) of interesting places in Mandalay City providing an interactive point and click map feature. This system will be used raster model and give the latitude and longitude of location point and attribute information from the using map. This system will serve as a searching algorithm to find the shortest path by using A method in complicated mapping situations.*

1. Introduction

Geographical Information System (GIS) is an automated information system that is able to compile, store, retrieve, analyze and display mapped data and provides a set of "tool" or computer programs that allow the user to perform a specific set of operations on map and attribute data [1].

The abilities distinguish GIS are as follow. This system allows the user must click the start and destination places on map that can be easily to search the shortest route on map and display the shortest route(s) in latitude/ longitude map of Mandalay with highlight route and related information. In addition, the interactive map feature of the GIS can provide for retrieving information user must point and click on map.

This system is intended to present optimal route finding system for Mandalay. This system use A* algorithm in the informed methods. A* algorithm expand node with an evaluation function of the form f(n)=g(n)+h(n), g(n) is the cost to reach the node and h(n), estimated cost to the goal from n and f(n), estimated total cost of path through n to the goal. This algorithm is used to find the optimal route for interesting places in Mandalay City map in a short time and to easily know the interesting places in Mandalay.

2. Geographic Information System (GIS)

Geospatial information system (GIS) provides strong decision support for users in searching optimal route, finding the nearest facility and determining the service area. Searching optimal path is an important advanced analysis function in GIS. In present GIS route finding modules, heuristic algorithms have been used to carry out its search strategy [2].

Geographical Information System (GIS) incorporates an elaborate way of capturing, analyzing and visualizing geo-relevant phenomena. GIS is used to digitally reproduce and analyze the feature present on the earth surface and the events that take place on it. It is designed to work with data reference by spatial/geographical coordinate.

GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies [3].

2.1 Raster Model

Two types of spatial data structures, vector and raster, are commonly used to store and represent geographic information. In this paper, raster data structure is used. This system will be used raster model and give the latitude and longitude of location point and attribute information from the using map.

Raster data can be images (raster images) with each pixel (or cell) containing a color value.

Additional values recorded for each cell may be a discrete value, such as land use, a continuous value, such as temperature, or a null value if no data is available. While a raster cell stores a single value, it can be extended by using raster bands to represent RGB (red, green, blue) colors, color maps (a mapping between a thematic code and RGB value), or an extended attribute table with one row for each unique cell value. The resolution of the raster data set is its cell width in ground units [4].

In a raster representation, a matrix or rectangular array of cells is used to represent geographic information. Where image data are stored in a raster representation, cells are termed picture elements, or pixels. Where other spatial data are stored as a raster representation, the cells are termed grid cells. In either case, the grid is organized into rows and columns that are referenced to a common origin. Each pixel is assigned a value representing a geographic phenomenon such as elevation, land use, or population density. The raster structure is also used in image data such as scanned maps and aerial photographs, or satellite imagery. In the case of image data, cell values typically represent reflectance or brightness as opposed to geographic entities [4].

3. A* Algorithm for the Shortest Path Problem

The most widely-known form of best-first search is called A* search. It evaluates nodes by combining g(n), the cost to reach the node , and h(n), estimated cost to the goal from n. f(n)=g(n)+h(n) .f(n), estimated total cost of path through n to the goal. To find the cheapest solution, a reasonable thing to try first is the node with the lowest value of g(n)+h(n). A* search is both complete and optimal. The optimality of A* is straight forward to analyze if it is used with TREE-SEARCH. In this case, A* is optimal if h(n) is an admissible heuristic_ that is, provided that h(n) never overestimates the cost to reach the goal. An admissible heuristic is the straight-line distance h_{SLD}. Straight-line distance is admissible because the shortest path between any two points is a straight-line. So, the straight-line cannot be an overestimate [5].

A* search is one kind of heuristically informed search strategy. A* search maintains the set open of so-called open nodes that have been generated but not yet expanded. This method always selects a node from open with minimum estimated cost, one of those it considers “best”. This node is expanded and cost of some node n with an evaluation function of the form f(n)=g(n)+h(n). A* is guaranteed to return an optimal (minimum-cost) solution (it is also said to be admissible) [6].

In this paper we propose the structure of the A* algorithm.

Algorithm 1 A* algorithm [7]

function A*(start, goal)

```
var closed = the empty set
var q = make queue (path (start))
while q is not empty do
    var p = remove _rst (q)
    var x = the last node of p
    if x in closed then
        continue
    end if
    if  x = goal then
        return p
    end if
    add x to closed
    foreach y in successors(x) do
        enqueue(q, p, y)
    end foreach
   return failure
end while
```

3.1 How to find the shortest route of Mandalay Kandawgyi to Shwenandaw Monastery

The user must choose initial and goal nodes in the system. And then, its searching is starting. In A* search, if the expanded tree node is arrival waypoint, the system will display the result of the goal. If the result is not goal, compute h_{SLD} value of all child nodes. And selects the minimum h_{SLD} child node and compares with the target node. If the comparison node is null, call recursively A* search with minimum h_{SLD} child node as root and root as comparison node. If not, that selects minimum h_{SLD} child node of comparison node. Then the system compares two minimum h_{SLD} nodes. After that, the system calls recursively A* with minimum h_{SLD} child node as root and the other with comparison node. If the system meets its goal, compute minimize distance.

Before finding the shortest path Mandalay Kandawgyi to Shwenandaw Monastery, must be calculate Heuristics Straight-Line distance (h_{SLD}) values to Shwenandaw Monastery. h_{SLD} is straight line distance value between target node to other nodes. As shown in Table.1 is Heuristics Straight-Line distance table from Shwenandaw Monastery to other waypoints. A* algorithm replace this values as h(n) into the equation. In this system, there are 18 nodes (interesting places) in Mandalay City.

Mandalay city is located between start latitude 21 degree 54 minute and end latitude 22 degree 01 minutes (North Latitude). Between start longitude 96 degree 03 minutes and end longitude 96 degree 08 minutes (East Longitude). Scale miles of Mandalay city is 43.6 square miles.

Table 1. Heuristics Straight-Line Distances to Shwenandaw Monastery

No	Interesting Places	H*sld* value	Latitude and Longitude
1	Shweinbin Monastery	459.82	21'45"N 96'2"E
2	Mahamuni Pagoda	462.75	21'41"N 96'3"E
3	Mandalay Kandawgyi	578.05	21'38"N 96'2"E
4	Mandalay University	358.48	21'43"N 96'4"E
5	Aungdawmu Pagoda	166.7	21'48"N 96'4"E
6	Sedona Hotel	144.12	21'49"N 96'4"E
7	Mandalay Hill	114.8	21'58"N 96'4"E
8	Kuthodaw Pagoda	49.7	21'56"N 96'4"E
9	Sandamuni Pagoda	45.86	21'55"N 96'4"E
10	Shwenandaw Monastery	0	21'54"N 96'4"E
11	Mandalay Hill Resort Hotel	114.68	21'56"N 96'4"E
12	Yadanabon Zoo	144.68	21'56"N 96'4"E
13	Shwekyinmyin Pagoda	287.25	21'50"N 96'3"E
14	Golden Place	152.68	21'52"N 96'3"E
15	Swan Hotel	151.77	21'49"N 96'4"E
16	Railway Station	277.04	21'48"N 96'3"E
17	Mahasetkyathiha Pagoda	361.59	21'48"N 96'3"E
18	Zay Cho Market	333.32	21'49"N 96'3"E

The following figures show the implementing of A* search. Source node is defined by Mandalay Kandawgyi and target node is Shwenandaw Monastery. In A* search, the nodes expand closest to the goal. f(n)=g(n)+h(n). g(n) is the cost to reach the node and h(n) is the estimated cost to the goal from n. f(n) is estimated total cost of path through n to the goal.

(a) The initial state

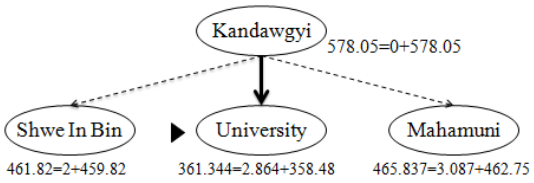

Figure 1. Initial State of A* Search

In this initial state, start expands from the source node as shown in Figure 1. f(n) of Mandalay Kandawgyi is 578.05, g(n) is 0 and h(n) is 578.05. After the initial state, must choose minimum distance waypoints. Mandalay Kandawgyi to Shwe In Bin Monastery is 461.82. Mandalay Kandawgyi to Mandalay University is 361.344. Mandalay Kandawgyi to Mahamuni Pagoda is 465.837. In all waypoints Mandalay University is minimum distance. So algorithm expands from Mandalay University to the other nodes.

(b) After expanding Mandalay University

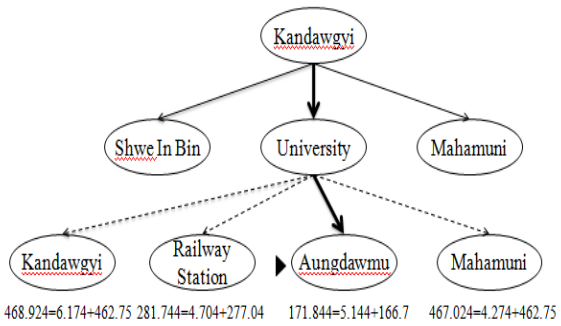

Figure 2. Expand from Mandalay University

After expanding Mandalay University, A* algorithm get from Mandalay University to Mandalay Kandawgyi is 468.924. Mandalay University to Railway Station is 281.744. Mandalay University to Aungdawmu Pagoda is 171.844. Mandalay University to Mahamuni Pagoda is 467.024. In all waypoints Aungdawmu Pagoda is minimum distance. So algorithm expands from Mandalay University to the other nodes as shown in Figure 2.

(c) After expanding Aungdawmu Pagoda

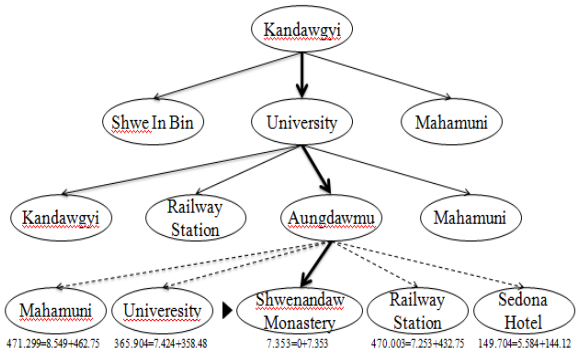

Figure 3. Expand from Aungdawmu Pagoda

After expanding Aungdawmu Pagoda, A* algorithm reach Shwenandaw Monastery as shown in Figure 3.

Shortest Path from Mandalay Kandawgyi to Shwenandaw Monastery,
Mandalay Kandawgyi ➔ Mandalay University ➔ Aungdawmu Pagoda ➔Shwenandaw Monastery

Distance – 7.353 miles

4. System Design

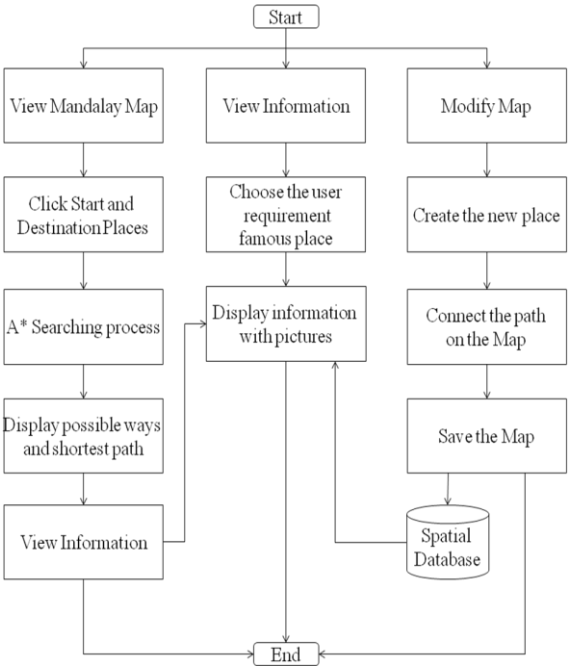

Figure 5. System Design

In this system, there are three main portions. They are query process for retrieving information, finding the shortest path using A* algorithm and modifying the map. In retrieving information portion, user can choose the requirement information in menu form and then view the related information and picture. In searching portion, user can double click on a famous place on map. This system will be generated possible ways and shortest path by using A* algorithm. In modify map portion, the user need to know password for login process. If it success, user can create/add place on latitude and longitude Mandalay City map and modify the connected ways with distance of new place on the map. After that, user can preview and save the process to the system.

5. Implementation

The user must click start and destination places on the map. And then the search button on the tool bar can perform to show the tree structure of A* search on possible track and can view the value of straight line distance to target place and shortest path on the map respectively.

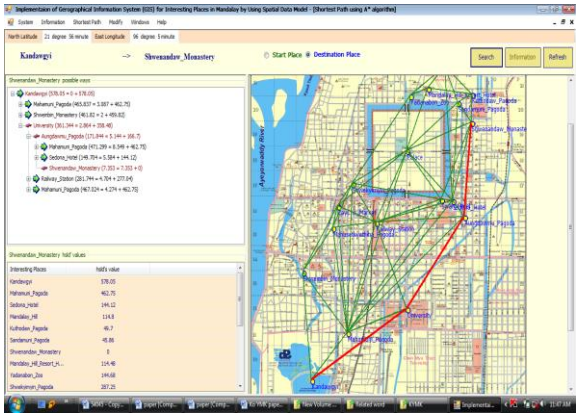

Figure 6. View the Shortest Path Form

Figure 6 is View the Shortest Path and Information Form. The distance between nodes is marked by miles. Source place defined by Mandalay Kandawgyi and destination point Shwenandaw Monestory. If the user can view information of interesting place double-clicks a famous place on map, the system will be displayed about the information of the place.

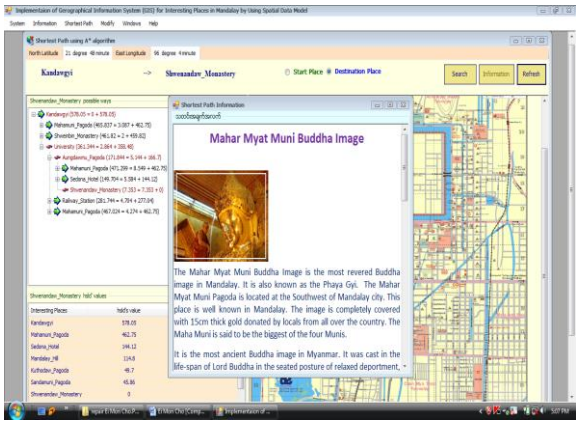

Figure 7. View the Information Form

In Figure 7 represent, if the user can view information of interesting places on the existing Mandalay map by using double click on map.; the system will be displayed about the current position of latitude and longitude value, information of famous place and picture of famous place as shown.

If the user need to know the requirement information, must be choose the menu script. The system also displayed the detail information as shown in Figure 8.

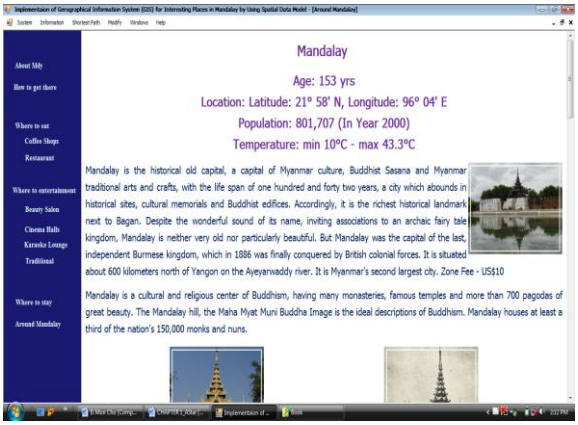

Figure 8. View the Information Form

The administrator can create the new location of the interesting places on the existing Mandalay map by using one left click on map. Then the administrator can type the interesting place's name in the interesting place name input box as show in Figure 9.

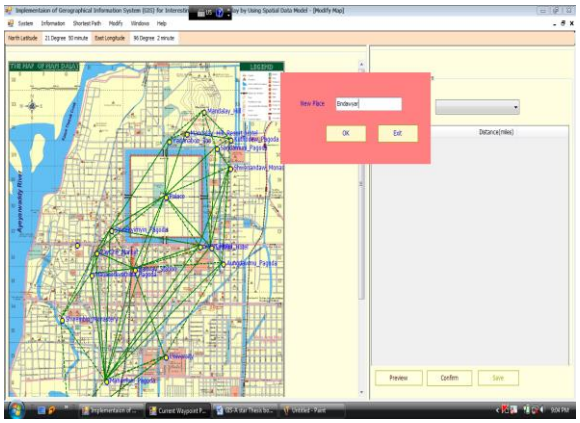

Figure 9. Add/Update places in Mandalay Map Form

Then the interesting places settled on the existing Mandalay map, the system allowed the administrator to connect the interesting places each other by the administrator desire. If the administrator can choose the waypoint's name in the waypoint name input box, this waypoint marks with waypoint name as shown in Figure 10.

This system displayed the new waypoint, latitude and longitude on the exiting Mandalay Map. And then the system atomically calculates distance. After adding the interesting place completely, the administrator can see the preview of the map. Then, the map can be confirmed from the confirm button, and saved the map in current interesting place location by the use of save button.

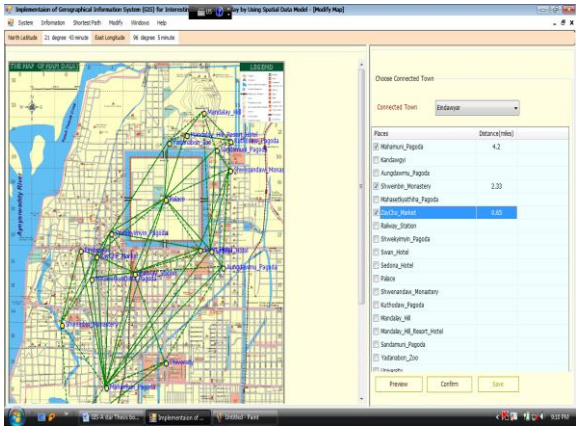

Figure 10. Modify Map Form

6. Conclusion

Geographical Information System (GIS) provides strong decision support for a user in searching optimal route, finding the nearest facility and determining the service area. Searching optimal path is an important advanced analysis function in GIS. Geospatial information system (GIS) provides strong decision support for users in searching optimal route, finding the nearest facility and determining the service area. Searching optimal path is an important advanced analysis function in GIS. In present GIS route finding modules, heuristic algorithms have been used to carry out its search strategy. This system is intended to present Optimal Route Finding system for Mandalay. This system use A* algorithm in the informed methods. A* search algorithm is used to find the optimal route. This search algorithm is both complete and optimal because A* search algorithm can search optimal route and other possible way from source to destination. So A* algorithm is very suitable for this system. Implementation of the system in the major interesting places would be of great help to the travelers and tourists. This algorithm is used to find the optimal route for interesting places in Mandalay City map in a short time. The goal of this system is to explore different design issue associated with map based itinerary planning tools. This technique can be implemented to easily know the interesting places in Mandalay. This searching algorithm is both complete and optimal.

7. References

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