GIS-based Travelers Guided Information System

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Abstract

Geographic information system (GIS) offers great opportunities for the development of modern tourism application using maps .In this paper, we propose a tourism information system for supporting the location based service of GIS applications. So this paper implements GIS based information system for Mandalay District and will contain functionality that allows users to point-and-click their location on the map. Our goal is to provide information to travelers and to facilitate travel. Shortest path problems are among the most studied network flow optimization problems. One such application is in the field of GIS routing systems. Due to the nature of routing applications, we need flexible and efficient shortest path procedures, both from a processing time point of view and also in terms of the memory requirements. Dijkstra algorithm is the best shortest path algorithm for networks with non-negative arc lengths. In this paper, we study how to find the shortest path easily and timely by using Dijkstra shortest path algorithm .And our proposed system also provides background information of interesting places in Mandalay. According to our study, travelers can get efficient travelling with minimum distance and background information.

1. Introduction

GIS was acknowledged first by Canada Geographic Information System or CGIS [5].A GIS is a computer system capable of capturing, analyzing, and displaying geographically referenced information; that is data identified according to location. One of the more advanced applications is the introduction of interactive maps using GIS software. GIS software provides functionality that allows for a map to be created and accessed that is more personalized to the user's choices. Searching optimal path is an important advanced analysis function in GIS. In GIS route finding modules, Dijkstra algorithm has been used to carry out its search function. Dijkstra algorithm is probably the best-known and thus most implemented shortest path algorithm. It is simple, easy to understand and implement. Dijkstra algorithm quickly finds the shortest path from a chosen source to a given destination. In fact, Dijkstra algorithm that finds all shortest paths from the source to all destinations is so powerful.

2. Related Work

Shortest path problem has been studied extensively in Network Theory over the past few decades. A number of studies emphasizes on using geographic knowledge and reasoning to solve the problem. Shapiro, which is the latest work in network theory and applications, propose a technique to use level structure of the road network to help searching for a path efficiently. The algorithm will first search for the nearest entry point u to and the departure point v from the source and the destination respectively. After that, it use Dijkstra algorithm to search only the major road to find the path linking u and v. This technique indeed minimizes the time traveling on minor roads and also greatly reduces the search [1].

GIS is used for bringing georeferenced data of geographic location Zlatibor and Zlatar into digital map. In the case study "Tourist destination Zlatibor and Zlatar", GIS has three types of applications in inventory of zoning areas, land uses, protected areas; in analysis application (number and density of hotels, resting houses, clubs, sport facilities such as playgrounds etc); in management /making application,e.g. evaluation of land use plan based on demographic and natural characteristic and planning for capital investment in tourism [10].

Kumar, P.; Singh, V.; Reddy, D present a GIS-based advanced traveler information system (ATIS) for Hyderabad City, in India. This user-friendly system provides comprehensive information about Hyderabad City, such road networks, hospitals, government, bus and railway stations, and tourist places within the city limits [8].

3. Geographic Information System (GIS)

A GIS is a manual or automated system which can store, retrieve, manipulate, and display environmental data in a spatial format [5]. GIS has been commonly used in different fields such as

tourism activities enabling people from different countries and cultures to interact with each other [2]. GIS is a rapidly expanding field enabling the development of applications that manage and use geographic information in combination with other media [10].GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps [9]. GIS is expanding the class of user with the advantage of the friendly user interface environment and various geographical operations, topological analysis [3]. GIS is an information system in order to support decision making for planning and management of land use, transportation, urban facilities and so on.

3.1 Data Model in GIS

The representation of real world phenomena in GIS is in two main types of spatial data representations in GIS - vector and raster. The real world geographic feature ontology have been digitized and given coordinates (rectified) for use in GIS [5].

Raster consists of a matrix of cells (or pixels) organized into rows and columns (or grids). The individual grid cell is basic building block. Every cell can be identified by its row and column position [7]. In this system, raster data model is applied.

Vectors models are representation of real world objects like rivers, buildings .Point is basic building block [5].

4. Shortest Path

Shortest path is a classical research topic. The shortest path problem involves a weighted, possibly directed graph by the set of edges and vertices. The goal is to find the shortest existing path between source vertex, s and any of other vertices in the graph. In the route finding context, the network is the road network. Nodes are road junctions, and arcs are road segments. The length of each arc could be the distance or the travel time between two adjacent junctions [8]. A solution to the shortest problem is sometimes called a pathing algorithm. The most used algorithms for solving this problem are:

- Dijkstra Algotithm
- Genetic Algorithm
- A* Algorithm
- Radius Algorithm
- Bellman-Ford Algorithm

Among these algorithms, Dijkatra Algorithm is one of the most efficient algorithms for solving the shortest path algorithm and can guarantee optimal result [6].

4.1 Dijkstra Algorithm

The first algorithm for solving shortest path length algorithm for solving shortest path length problems was discovered by a Dutch computer scientist named Dijkstra in 1959 [4]. In a network, it is frequently desired to find the shortest path between two nodes. To determine the shortest path, the weight of the path is required. In general applications, the weight is usually the distance of the link between two nodes [4]. The weights attached to the edges can be used to represent quantities such as distances, costs or times. If shortest path find the minimum distance from one given node of a network, called the source node or start node, to all the nodes of the network. In general, the distance along a path is the sum of the weights of that path. Dijkstra's algorithm is one of the most efficient techniques to implement.

```
Dijkstra  (G , w , s )  {
   for ( each u Є V )
        d[u]  =  ∞  ;
        d[s]  =  0  ;
         pred[s]  =  nil ;
        Q  =  ( queue with all vertices )
        While  ( Non-Empty ( Q ) ) {
             u  =  Extract-Min ( Q )
             for ( each v  Є  Adj[u] ) {
                  if( d[u]  +  w ( u ,v )  <  d[v] ) {
                     d[v] = d[u]+ w(u + v) ;
                     Decrease-Key(Q, v, d[v] );
                     pred[v] = u  ;  }
                           }
                      }
                  }
```

Figure 1. Dijkstra algorithm

In Figure1,'G' is graph,' w' is weight (distance), 's' is source, 'Q' is priority queue, 'pred[ ]' is predecessor pointer, 'd[v]' is vertex's(node) distance, 'u' is vertex(node) with minimum distance,' Adj[u]' are all adjacent vertices of the vertex with minimum distance. Assign initially d[s]=0 and all the other d[v] values are set to ∞.The Dijkstra algorithm will process the vertices one by one in some order. Extract-Min( ) extract the vertex with minimum key value(distance) in priority queues. If (d[v]+ w(u,v) < d[v]), then replace the old path <s,…,w,v> with the new shorter path <s,…,w,v> , and then update:
d[v]= d[u] + w(u,v).So finally, d[v] is the length of the minimum path. Decrease-Key( ) decrease vertex's key value to new-key(shorter distance). The array pred[v] is used to build the shortest tree.

5. Proposed system Design

The proposed system has three main portions as shown in Figure 1. They are query process for information ,finding the shortest path by using Dijkstra 's algorithm and creating network topology. In query process, user can choose the interesting places of Mandalay from the map and then view the related information and picture .In searching portion, user need to choose source and destination places from Mandalay map and then the system will generate shortest path , possible ways and distances among interesting places of Mandalay by using Dijkstra's algorithm . In creating network topology, user (administrator) needs to know password for login process. If it success, user can browse a map and create topology and find the distances on the map. Places with their pixel location in X,Y coordinates are stored in database with raster format.

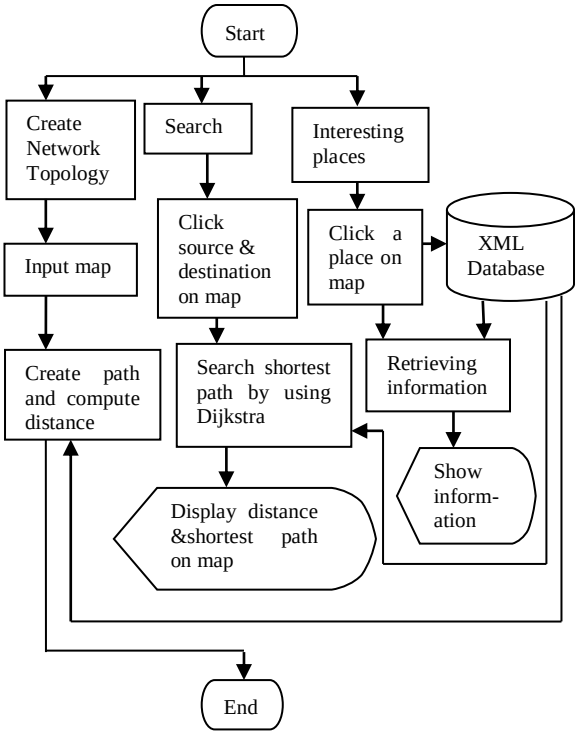

Figure 2. System design

6. Implementation

User must click source and destination places on map to find the shortest path. The result of shortest path is highlighted on the map and the places along the shortest path are also shown.

Figure 3 shows the result of finding shortest path from Mandalay Hill to City Hall (1).The shortest distance from Mandalay Hill to City Hall (1) is 3.04 miles. The shortest path is

Mandalay 0.94 Yadanabon zoological garden

1 Palace 1.1 City Hall(1)

To get minimum distance from Mandalay Hill to City Hall(1), travelers should go through Yadanabon zoological garden and Palace than other places. Dijkstra algorithm computes shortest path according to minimum distances. So the distance among places is predefined. The distance between places is computed according to its pixel locations. The computation for distances is described later in this paper.

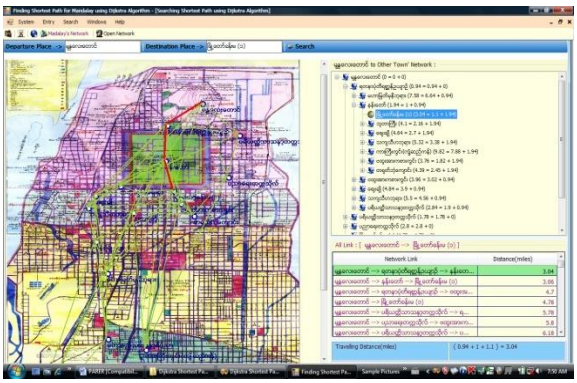

Figure 3. The result of finding shortest path

6.1. Viewing Interesting Places

User can choose "Interesting Places" Form to view the related information of places in Mandalay. The system will display the related information of user's interested place with the picture as shown in Figure4.

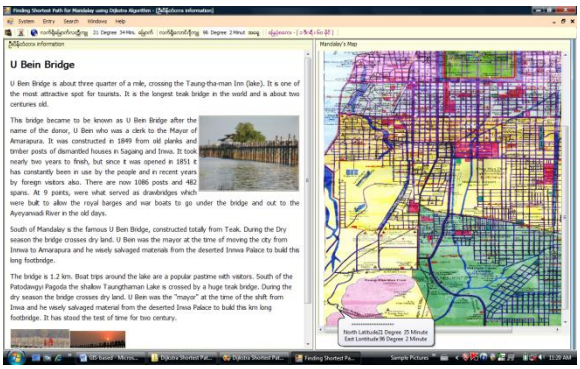

Figure 4. Show related information

6.2. Create Network Topology

The arrangement and connectivity of nodes and links of a network is referred to as its topology. If user wants to create network topology, user can

choose "Create Network Topology" from "System" menu.

An administrator can browse a map to create network topology as shown in Figure 5.

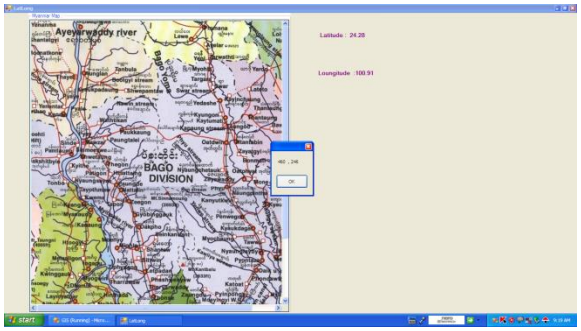

Figure 5. Browsing a map

This system will compute distances and create network on any map at run time according to user definition. In this system,we assume that the distance of two places depend on pixel distance. Pixel format is defined according to real world distance in map. In Figure 5 with (660,860) pixel format, "Pimmana" is situated at (411,13) pixel location. "Taungoo" is situated at (460,246) pixel location.

A (Pimmana) (x_1 , y_1)

(411, 13) pixels

B

C (Taungoo) (x_2 , y_2)

(460, 246) pixels

Calculating distance between two waypoints is defined as the distance measured along a straight line from point (x_1,y_1) to point (x_2,y_2) in Cartesian coordinate system.

$$AC^2 = AB^2 + BC^2$$

$$=(x_2-x_1)^2 + (y_2-y_1)^2$$

$$= (246-13)^2 + (460-411)^2$$

$$AC = \sqrt{56690} = 238.09 \text{ pixels}$$

10 pixels ⟶ 1 mile

238.09pixels ⟶ 23.8 miles

'AC' is the distance from "Pimmana" to"Taungoo". So the distance from "Pimmana" to "Taungoo" is 23.8miles. In this way, the system compute distances according to their pixel location at run time as shown in Figure 6.

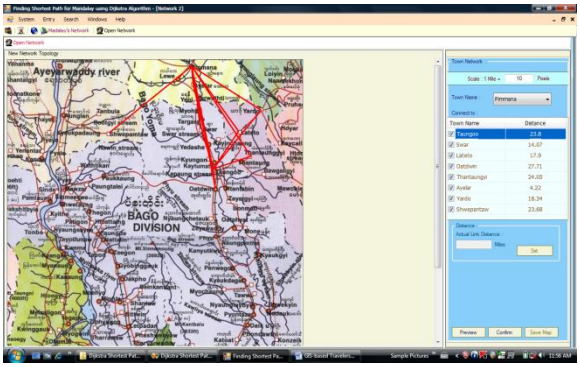

Figure 6. Create network topology

7 .Conclusion

Travel time is among the most important factors that affects attractiveness of transport modes and consequent commuter travel decisions in urban areas. Accurate estimates and comparisons of travel paths and the duration of trips are basic requirements for planners, transportation Industries, and marketing businesses and social scientists. This paper consists of the implementation of a GIS itinerary planner to a traveling network in Mandalay. Our proposed system provides efficient travelling with minimum distance and background information of interesting places in Mandalay. This paper intends to get knowledge for GIS and Dijkstra algorithm.In this system, Dijkstra algorithm is searching that you enter starts at the origin and finds a path to the destination. Currently the map that is produced simply has the routes highlighted that will be used. This system would be a large improvement by minimizing the trip planner's responsibility. In this study: query of geographical data, obtaining the visual and detailed information about the geographical data and network analysis applications were carried out. GIS design and application for tourism and network analysis help users to supply optimum planning for tourism.

7. References

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