CITY GUIDE SYSTEM BASED ON SPHERICAL LAW AND SHORTEST PATH ALGORITHM

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Abstract: Many tourists and local people are visiting everywhere in Myanmar. The most interesting places are emphasized for touring to them especially Southern Shan State. The city guide system is proposed to apply Spherical law, shortest path algorithm and GPS services for guiding to city. This system is divided by three parts. Firstly, Spherical Law of Cosines is calculated the distances plus earth radius in order to provide the exact distance between current location and destination. Secondly, Dijkstra's algorithm is used the current position point and destination point as input which are retrieved by GPS system to calculate the possible paths between current and destination point. Lastly, this system can display the detailed information like shortest route to help users in navigating places easily and faster. Then, this system is efficient and effective for city directory which help users abilities to locate, navigate and get information about the places such as hotels, restaurants, petrol stations, hospitals, markets, pagodas and etc.

Keywords: Spherical Law of Cosines; Dijkstra's algorithm; GPS services; shortest route

1. INTRODUCTION

The most significant tourism symbol of Myanmar is Southern Shan State. It owns many other potential and charming destinations. Besides the gorgeous landscape, a trip to Shan state also deals with exposure to the unique regional culture richness which comes from so many different ethnic groups [1]. There are many places in Southern Shan State such as Taunggyi, Kalaw, Pindaya, Hopone, as shown in figure 1. For this reason, tourists need to get useful information for touring these cities.

Utilizing tools, for example, aerial photographs and the global positioning system (GPS), the GIS team collects and processes spatial coordinates, topology and dimensions of fixed physical objects such as houses, waterways and streets, and translates the raw data into usable information. Joined with a key vision, this data gives a powerful framework equipped for breaking down complex data in regards to our physical condition. Trained personnel use this information to create digital and paper maps of extraordinary detail, plan for future growth, execute trend modeling, monitor environmental changes, evaluate security and disaster requirements, and efficiently dispatch emergency services.

Dijkstra's shortest path algorithm is applied in city guide applications where the optimal routings have to be found. If the tourists apply in city guide system, they will quickly find the shortest trip.

Mobile devices are increasing day by day. Therefore, the system is developed as an android application, which enables users to navigate places in their phones. All of user will be able to use the application if their phones have Android OS 4.1.2 and above, and they must be able to connect internet using their phones. This application system can provide information of places via popular place categories in Southern Shan State.

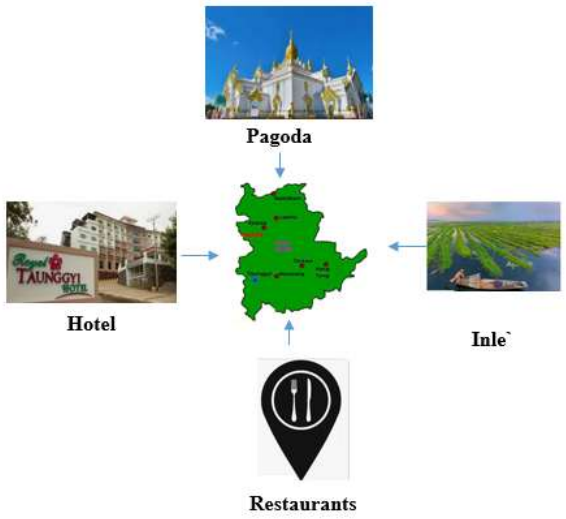

Figure 1. Many Places in Southern Shan State

There are various city directory applications which only display information of places in every city. But these applications cannot provide additional information such as real-time maps, distance between current location and destination, and travel time to these places. So, users (such as local travelers, tourists, etc.) become require a system which can provide the above features. If GPS's accuracy will fail to show the correct user's position sometime, the errors can occur. Therefore, this system adds the new contribution is considered to apply the well - known shortest path algorithm in GPS navigation system.

This system also intends to give precise information of places for visitors, tourists and residents, to increase local visitors and tourist arrivals and to provide easy and instant access in navigation of places. There are a lot of benefits by using this system. The significant benefit is that the tourist arrivals to Myanmar will probably increase.

2. RELATED WORK

Global Positioning System (GPS) in which the accuracy of positioning is very good. GPS is used for tracking your vehicles and keeps regular monitoring. The user's location can be told by this tracking system and this information can be observed from another remote location. It can be beneficial for: parents to look after their children, to track animals in forest, in delivery services and in fire services and COP department [2]. An Android based Mumbai City Guide application is proposed in [3] which designed to process location based continuous query on the road networks. In their system, when someone visits places such as Hotels, colleges, hospitals and schools do not need to hire special person who give guidance. If the information must be accessible on a mobile device with the user customized format, then it's helpful to manage their valuable time effectively and efficiently. Researchers [4] focused on the shortest paths among cities to implement Dijkstra algorithm. In that paper, Node Combination algorithm for finding the shortest paths is used by deleting the node nearest to the start node among cities. The accuracy rate in their system is good. There are many applications that use Google API to solve different problems. But, most of the mobile applications mainly function only with the help of internet. Therefore, there remains an essential for offline applications as well. In other words, the applications connect to the internet intermittently. First Aid Application on Mobile Devices was presented in [5].

The main concept of this android application is to find the nearby hospitals based on the current user location and then list out the nearby hospitals. All the user data is then sent to a server and the nearby hospitals are found out. It even guides the person to a nearby hospital, which uses the Google's API to find the route and also navigate. This is done only when an internet connection is available.

The use of linear algebra to derive the laws of sines and cosines for spherical triangles is demonstrated in [6].

3. PROPOSED SYSTEM DESIGN

The proposed system design is described in figure 2. This system not only the current position in the Dijkstra's algorithm but also Spherical Law from GPS is used in this paper. If the user enters destination, user's data is search by connecting GPS. According to the position, the distance between two cities is calculated. GPS is a satellite based system that is used in navigation, tracking and mapping application. This system uses the concept of GPS in Dijkstra's shortest path algorithm for getting the current position of the nodes in the graph. Then, if the nearest place is known, this system finds the nearest places by calculating two locations of current location and specific location. Lastly the system can display the route information and the nearest places with map.

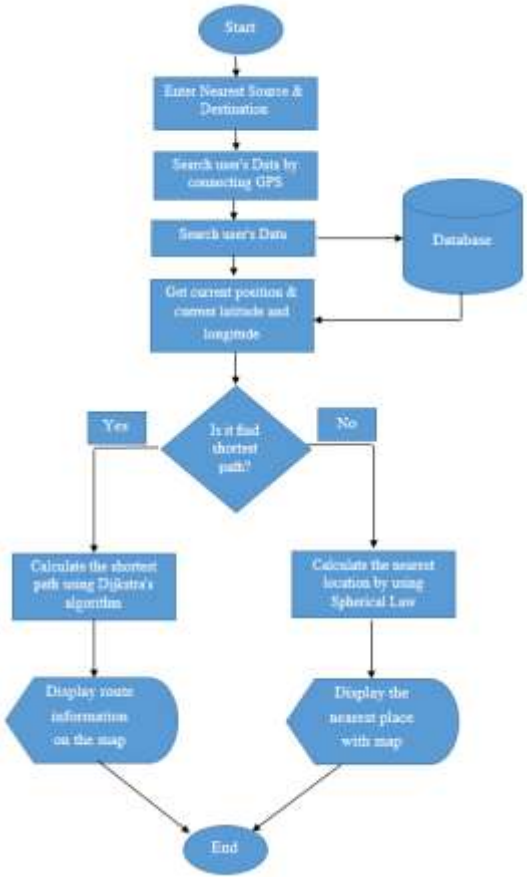

Figure 2. Proposed System Design for City Guide System

4. SYSTEM METHODOLOGY

4.1. Spherical Law of Cosine

The simple Spherical Law of Cosines formula:

$$\cos C = -\cos A \cos B + \sin A \sin B \cos c \qquad (1)$$

where A and B is the angle of the corners opposite to sides a and b, respectively. It can be acquired from concern of a spherical triangle dual to the given one. Besides, it gives well-conditioned results down to distances as small as a few meters on the earth's surface.

The advanced Spherical Law of Cosines formula:

$$d=\text{acos}(\sin\varphi 1.\sin\varphi 2+\cos\varphi 1.\cos\varphi 2.\cos\Delta\lambda).R \qquad (2)$$

where, d= distance between two places.

4.2. Dijkstra's Algorithm

Dutch computer scientist Edsger Dijkstra developed Dijkstra's Algorithm in 1956 and published in 1959. It is based on graph search, the edge and vertex, gives the shortest path between two vertexes.

For a given source vertex the graph, the algorithm can finds the shortest path between that

vertex and every other vertex. It can also be used for finding costs of shortest paths from a single vertex to a single destination vertex by stopping the algorithm once the shortest path to the destination vertex has been determined [7].

The algorithm is represented in brief as below:

$$G = (V, E) \quad (3)$$

where, V and E are a set of vertices and a set of edges.

Dijkstra's algorithm keeps two sets of vertices:

S = the set of vertices whose shortest paths.

V-S = the remaining vertices.

The other data structures needed are:

D = array of best estimates of shortest path to each vertex

P_i = an array of predecessors for each vertex.

The basic mode of operation is:

1. Initial is d and pi,
2. Set S to empty,
3. While there are still vertices in V-S,

(a) Sort the vertices in V-S according to the current best estimate of their distance from source,

(b) u is added, the closest vertex in V-S, to S,

(c) all vertices still relax in V-S connected to u

5. EXPERIMENTAL RESULTS

The user's location on the digital map using a GPS receiver is determined by the real time GPS Navigation system. This application guides the user along the way by giving him/her directions. The user can take a different route and the corresponding shortest route is dynamically recomputed. It is a satellite based system that can be used in navigation to locate the positions anywhere on the earth. This function takes the user's data for current location by GPS receiver. GPS can also be used for creating digitized maps and determining the distance between two locations. After the data is retrieved from the GPS, it should be transformed into appropriate coordinate system and invoke related image files and send the basic satellite image and transmission information such as date, time, longitude and latitude. After transmission of data into longitude and latitude, this system calculates the nearest places using Spherical law of Cosine after received GPS coordinate data of all places.

This system is used to create the current location and the possible places location as a graph data. Based on the graph, the shortest paths from the current place and the nearest places are described using Dijkstra's Algorithm.

The users can easily find places as categories are filtered. It offers ability to display routes to the destination visually for easier navigation in map. The application guides the user to reach the destination. This mainly helps users who tend to explore an unknown region example, Food restaurant, desert, etc.

Shortest path finder is the main process in this work. It finds the path from current location to the selected destination using data from GPS receiver. This can provide not only the nearest location but also the precise routes. This system uses Dijkstra's shortest path algorithm to get the optimal route.

The distance calculation between nodes such as points through route is calculated using Spherical Law of Cosines. Distances to destination from source locations are calculated by Spherical Law of Cosines to get precise distance. The formula is precise because it is calculated based on earth radius. It can be acquired a spherical triangle dual to the given one. Moreover, it gives well-conditioned results down to distances as small as a few meters on the earth's surface. Finally, this system shows the shortest route and possible routes between the current location and the nearby locations on the map.

Figure 3 shows the main page for city guide system. There are four categories in this interface that are GPS, CITY CATEGORIES, MAP NEVIGATION and SETTING. When the user clicks on city categories which is shown in figure 4 is provided the list of different famous places of current city. The map navigation category is provided the current position of the user and also shows the nearest places whatever the user wants. When the user is in a specific location he can get information about this location, hotels or restaurants in that location, the list of locations is displayed. Moreover, the user can show the map to see his location. This system can show famous places of cities which are nearest to the current location of the user. For instance, if the user in Nyaung Shwe city according to their current location, it will show famous places such as Inle` lake, Shwe Inn Tain pagoda etc.

The accuracy of the proposed system is shown in table 1. The proposed algorithm that run on different distance accepted the data. From this result, for example, the path length (25) of our proposed system divided by the path length (20) of Dijkstra algorithm in distance 4500. Therefore, we got 1.0 accuracy in this system. It seems that the shortest path is found easily.

Table 1. Accuracy of proposed system with respect to different distances

Distance	Proposed system	Accuracy
4500	25/26	1.0
5727	50/52	1.0
11210	55/54	1.0
14515	71/75	1.0

Figure 3. Main Page for City Guide System

Figure 4. User Interface of City Categories

6. CONCLUSION

This system easily access in navigations of places for users with effectively and efficiently. Also it can find nearby places and connect the routes to the destination from the user's current location and calculate distances to the destination. This system is effective application for tourists and travelers. This application can give many advantages for travelers and local resident that are able to view the detailed information of places at any time. It can also be used for the other users who want to find the optimal route from the location of an incident to emergency service area during emergency. In future work, this system will provide all Myanmar cities and extend the application functionalities based on the semantic features of roads to provide the shortest route for emergency managers and first responders during mass emergencies.

7. ACKNOWLEDGMENTS

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