Trip Planning Query for Bagan Using the Partial Sequenced Route Algorithm

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Abstract

Trip planning query represents an important class of queries in Geographic Information System (GIS). Trip planning has some important features that include selection of points of interest (POIs), path routing, and trip time. In this paper, path routing is used to systematically make the trips for both tourists and local people who visit to Bagan. Users can visit a number of POIs of categories that include pagodas, restaurant and hotel in Bagan. The trip planning system of Bagan is implemented by using the Partial Sequenced Route (PSR) algorithm. The proposed system helps tourists and local people to search the route of trip based on user-interested categories with the minimum road network distance in real world. The system also finds a meeting place for two users in different location.

Key words: *Trip Planning Query, Location-based services, route Search, meeting place*

1. Introduction

In today's digital world, there are many location-based mobile guide applications to point out the route for the trips, to track movements, to find the famous places, to know the current location and what is around you. Such applications make the user's life easier through offering a real-time guidance. Any information that includes location can be used in GIS. Moreover, GIS has been demonstrated as technology that can effectively solve location problems. Location-based service (LBS) in GIS is a great potential application for the mobile communications. Finding the location of the mobile phone is one of the important issues of the modem mobile communication system. The user's current location can be obtained by using positioning technologies. In this paper, users can get the route information for the trip that starts from user location to famous places. This trip planning system is focused on the Bagan region.

Bagan is an ancient city located in the Mandalay Region of Myanmar. It is the capital of the first Myanmar Empire and one of the richest archaeological sites in South-east Asia. Bagan is one of the famous tourist attraction place due to containing many ancient pagodas. Moreover, Bagan region is the site of the densest collection of Buddhist pagodas in the world. In addition, that site shows the development in architecture and design over several centuries. To systematically visit to many tourist-interested nearest famous places in Bagan, tourists are requiring the Location-based Services. Moreover, they can have the route problem due to the densest collection of many pagodas. So, this location-based mobile guide is developed by using the Partial Sequenced Route (PSR) algorithm in this paper. In this system, both foreign and local people can search the trip routes based on the POI categories (i.e; pagodas, restaurant and hotel) in Bagan.

The organization of paper is as follows. Section 1 introduces the location-based mobile guide for Bagan. In section 2, the related works are presented. Section 3 presents the methods for the trip planning query. Section 4 describes the design of the proposed system. Section 5 presents spatial database. Section 6 describes experiments and results. The last section is section 7, and there is conclusion.

2. Related Work

In this section, the previous works related to the trip planning queries and the sequenced routes, are reviewed.

Chen et al. [1] have proposed a generalization of the trip planning query, called multi-rule partial sequenced route (MRPSR) query. MRPSR is used to find the partial sequenced route. MRPSR enables trip planning which can fulfill all the user-defined travelling rules. But, if the set of rules is not a directed acyclic graph, algorithm reports cycles in the set of travelling rules. The MRPSR can only picks a single POI in each category, and can't search the multiple POIs in each category.

In [2], Sharifzadeh et al. have presented "The Optimal Sequenced Route (OSR) Query". The light optimal route discovers (LORD) is used to find the optimal sequenced route and is light to use memory. The constant threshold value (T_c) and the variable threshold value (T_v) are used to limit the search space. But, LORD iteratively builds and maintains the partial sequenced route in the reverse sequence. Finally, it returns a route with the minimum length passing through a set of POIs in a particular order from the source location of a user, where both order and type of POIs are specified by the user. But, it is not suitable for the real-world application because it uses Euclidean distance.

Li F, Cheng D et al. [3] have described "On Trip Planning Queries in Spatial Databases". Nearest Neighbor (NN) algorithm is used to plan a trip in both Euclidean distance and road Network. The goal of NN algorithm is to find the best trip (route). The problem of algorithm expands the point that is closest to the last point in the partial trip without considering the end destination. The algorithm can't plan a trip with the sequenced order of the user-defined categories.

3. Trip Planning System

Nowadays, there are a number of online trip planning systems that make it possible to automatically generate a selection and routing plan for visiting Points of Interest (POIs) that satisfy the tourist personal interests. Tourists who visit to a city or region during a trip, are not possible to visit every POIs available that exist in that particular area during a constrained travel time and budget. Thus, they have to plan their trips by selecting some POI categories that they more interest. To satisfy the tourists' needs, more sophisticated tourism information technologies are required.

The tourism sector is one of the world's most important economic sectors, and the increasing popularity of mobile devices presents an opportunity for developing mobile tourism services. Today, there is a vast variation of different mobile solutions already developed to support travelers before, during and after the trip, for instance in a form of city attractions, sightseeing, exhibition or museum guides. However, majority of these solutions focus either on recommending tourist attractions or on providing some tourist services. In this paper, the mobile guide application is developed to point out the route for the trip based on the tourism personal interests in Bagan Region.

3.1. Location-based Services

Location-based services (LBSs) are the information, entertainment or security services, which are accessible with mobile devices through the mobile network and which use information on the geographical position of the mobile devices. Because LBS are largely dependent on the mobile user's location, the primary objective of the service provider's system is to determine where the user is. User's location can be obtained by using positioning technologies, such as satellite positioning (GPS), cellular network positioning, and WLAN stations. The location can be expressed in many different ways, such as latitude and longitude, or address. In this system, the user's current location is used with latitude and longitude. And, the trip is started from that location.

3.2. The Partial Sequenced Route

The Partial Sequenced Route query enables a user to plan a trip which starts from the current location, goes through a sequence of points-of-interest (POIs), and ends at a destination location. Given n disjoint sets of POI category $\{C_1, \ldots..,C_n\}$, each containing a number of POIs, the PSR query is to search for a route that satisfies the following three requirements:

1. The route will traverse through at least one POI in each category that the user selects;
2. The total traveling distance is minimized;
3. The route conforms with the user-selected categories

3.2.1 The Nearest Neighbor-based Partial Sequence Route (NNPSR)

The Nearest Neighbor-based Partial Sequence Route (NNPSR) uses the nearest neighbor search (incremental network expansion) to find a nearest point of interest. The POIs of each category can be found by simply expansion the path from one junction node to the next until the nearest POI on road segments is reached. The search is terminated when a specified POI number of categories has been found. The NNPSR network model not only finds out the nearby categories but also indicates the sequenced

route to be travelled by the user. Finally, a POI sequence route of categories is obtained for a trip with the minimum network distance. The result sequence route is presented by highlighting the areas of interest on the map display.

3.2.2. Nearest Neighbor Search in the Road Networks

The nearest neighbor search in the road networks is an important query type in LBS and has many real life applications, such as map services. A nearest neighbor (NN) query is defined as finding the closest neighbor with the minimum network distance to a query point.

Given a query location and a set of static POI categories on the road network, the NN search finds the nearest object from the query location. The incremental nearest neighbor query searches the neighbor POIs by gradually enlarging the search area of road network from the query location.

4. Proposed System

The proposed system is deployed on an Android operating system which is an open source technology.

Design of the System

- If the route is searched for trip, the system finds the sequence route based on the user-selected categories from user's current location by using NNPSR Algorithm. And the system points out the route for the trip not only in details but also on map.
- If the meeting place is searched, the system searches the meeting place for two users in different location. And the meeting place, the user location and friend location are showed on map.

For route searching, there are three categories (pagodas, restaurants, hotels) which the user can select for trip. In the start, users can choose first and second priority of categories they interest. And then, PSR algorithm is implemented. Data from the spatial database are used to implement PSR algorithm. Finally, the route is displayed on the map. The system architecture is shown in Figure 1.

For meeting place, Aggregate Nearest Neighbor (ANN) queries is used to find a meeting place for two users in different locations. ANN queries developing from NN queries are the relatively new query type in spatial database and return a meeting place that minimizes an aggregate distance with respect to a set of query points. Because of the multiple query points, ANN queries are much more complex than NN queries.

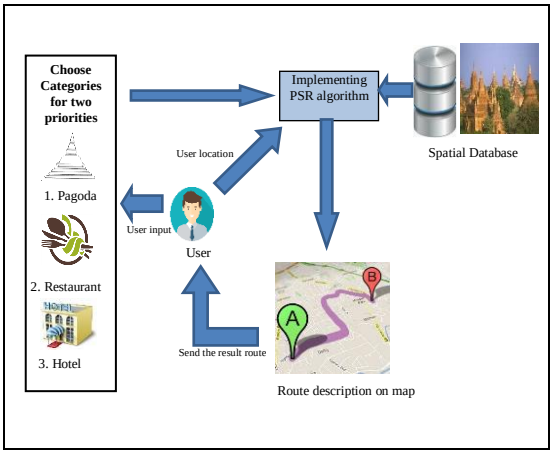

Figure 1. System Architecture

5. Spatial Database for the System

A spatial database is a database that is enhanced to store, query and access spatial data or data that defines a geometric space. These data are often associated with geographic locations and features, or constructed features.

In the spatial database, a road network can be modeled as an undirected weighted graph G = (V, E, W), where V is the set of vertices (junction nodes), E is the set of edges (road segments) between two nodes in V. And, W associates each edge to a positive real number. Interesting objects (i.e; POIs) are located on edges e Є E. So, the junction nodes, road segments, and points-of-interest (POIs) (i.e; Pagodas, restaurants and hotels) with their attributes are stored in spatial database for the trip planning of the proposed system.

5.1 Creating Database

To create the database, the data are collected from Bagan City only. This mobile tourist guide is implemented with the spatial database of New Bagan, Old Bagan, Nyaung U, Myin Ka Bar, West Pwazaw Village, Minnanthu Village and Aung Myay Thar Quarter. Firstly, about 461 POIs are collected for three categories of famous places. And, about 986 junction nodes and 1652 road segments are collected to implement the road network. The distance is measured with kilometer scale.

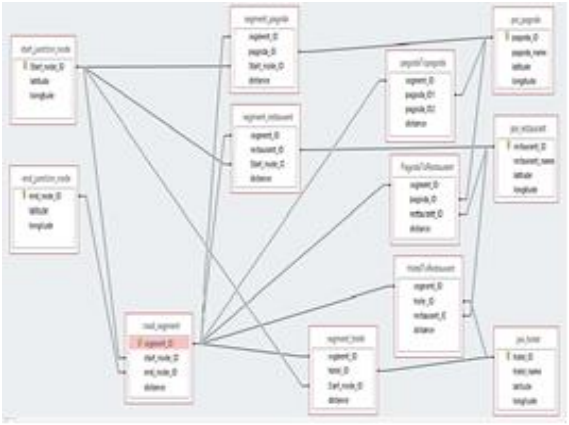

Figure 2. Database Design

In this system, the database contains the twelve tables named 'start_junction_node', 'end_junction_node','road_segment','poi_pagoda','poi_restaurant','poi_hotel','segment_pagoda','segment_restaurant','segment_hotel','PagodaToPagoda','PagodaToRestaurant'and HotelToRest aurant'.The database design is shown in Figure2.

Set $L_{route} = \emptyset$ and $q = S$;
Add the user-selected categories of C into L_{zero} ;
Add the number of POI for each user selected categories into P_{no} ;
while $L_{zero} \neq \emptyset$ **do**
P = $\emptyset$;
for each $C_i \in L_{zero}$ **do**
P = C_i.P ∪P ;
end for
while $P_{no} \neq 0$ **do**
Identify the road segment n_i n_j covering q;
Find all the POIs in P on n_i n_j ;
if there exists at least one POI in P on n_i n_j then
Update P_{NN} with the POI p_k with the smallest $d_N(q, p_k)$;
$d_{Nmax} = d_N(q, p_k)$;
Else
$P_k = \emptyset$, $d_{Nmax} = \infty$;
end if
Q =< (n_i , $d_N(q, n_i)$), (n_j , $d_N(q, n_j)$) >;
De-queue the node n in Q with the smallest $d_N(q, n)$;
while $d_N(q, n) < d_{Nmax}$ do
for each non-visited adjacent node n_k of n do
Find all the POIs in P on the road segment n n_k ;
Update P_{NN} from the POI p_k with the smallest network distance found so far ;
Update d_{Nmax} with $d_N(q, p_k)$;
En-queue (n_k , $d_N(q, n_k)$) in Q;
end for
De-queue the node n in the updated Q with the smallest $d_N(q, n)$;
end while
$L_{route} = L_{route} \cup P_{NN}$;
$q = P_{NN}.L$;
$P_{no} = P_{no}$ -1 ;
Update P_{no} ;
end while
Remove $P_{NN}.C$ from L_{zero} ;
Update L_{zero} , P_{no} ;
end while
return L_{route}

Figure 3. The pseudo code for Nearest Neighbor-based Partial Sequenced Route query (NNPSR)

Symbol	Meaning
C	The set of all the user selected categories
P	A set of POIs
Q	The priority queue
S	The starting point of a NNPSR query
q	The query point of a nearest neighbor query
n	Junction node
POI	Point of Interest
P_{no}	The number of POI in each category
d_{Nmax}	Distance to restrict the search space
$P_{NN}.C$	The category of a POI P_{NN}
$P_{NN}.L$	The location of a POI P_{NN}
C_i	A POI category
$C_i.P$	All the POIs of a category
L_{zero}	the user selected categories with a zero count
L_{route}	A list of the POI sequence of a trip plan
P_{NN}	The query result of a nearest neighbor query
$d_N(x, y)$	The network distance between points x and y

Figure 4. Symbolic Notations

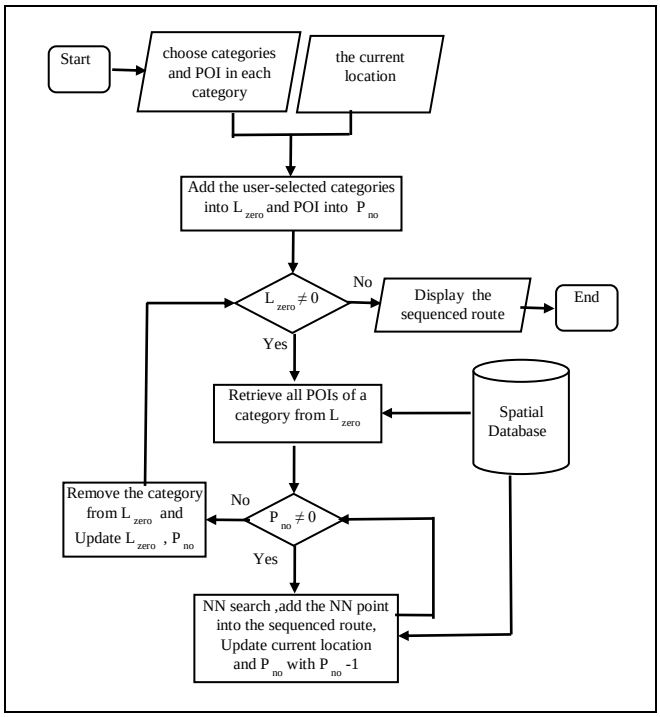

Figure 5. System Flow Diagram of the system

6. Experiments and Results

To use this proposed system, users need to own android phone with the operation system version 4.0 at least and to install the trip planning application. After installing the application in user's android phone, if phone's GPS location is off in the start of system, the message will appear to open GPS location to know the user's current place. Figure 6 shows the message to turn on device location.

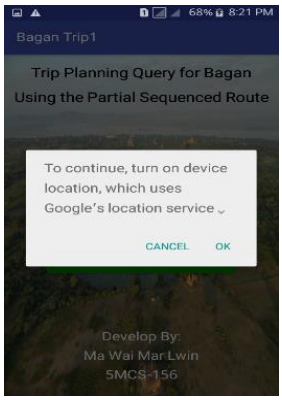

Figure 6. Message to open GPS

Figure 7. Home Page

After opening the GPS location, welcome page or home page of the system will appear as shown in Figure 7. When the user clicks the "SEARCH LOCATIONS" button, the page will appear to choose route or meeting place as shown in Figure 8.

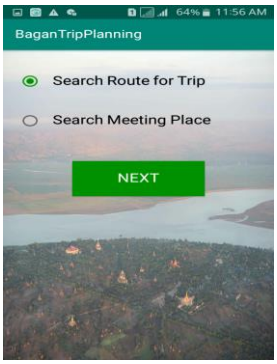

Figure 8. Selection of route or meeting place

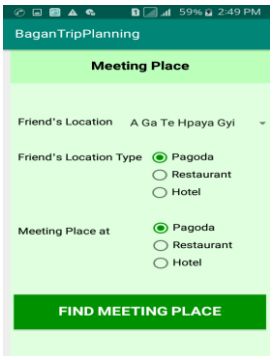

Figure 9. Selecting friend's location and type

If "Search Meeting Place" button is selected, the system shows the page to choose meeting place at ,the friend's location and type as shown in Figure 9. After choosing, midpoint is calculated for two users and a meeting place that is near to midpoint is searched in spatial database. And, three point of friend's location, user location and meeting place is displayed on map as shown in Figure 10.

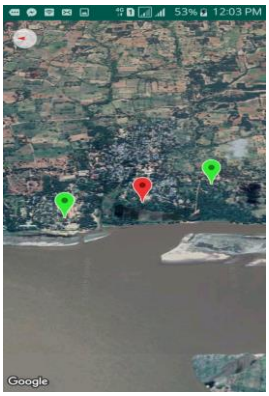

Figure 10. Meeting Place

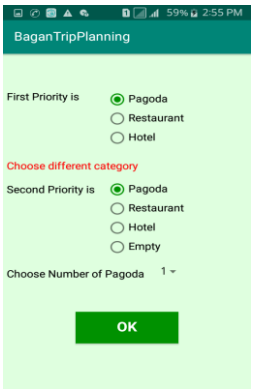

Figure 11. Notification Message

If "Search Route for Trip" button is selected, two priorities of categories for trip can be selected. First priority includes three radio button of Pagoda, Restaurant, and Hotel. Second priority involves four radio button of Pagoda, Restaurant, Hotel and Empty. If first priority equal to second priority, the notification message will appear to differently choose as shown in Figure 11. If the user selects "Empty" radio button in second priority, the route of first priority is only showed on map.

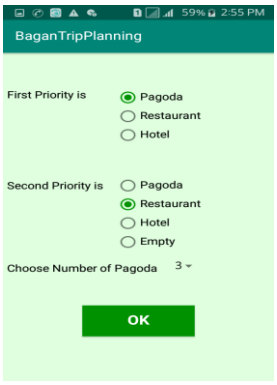

Figure 12. Selecting Categories

Figure 13. Route for trip

If the user selects "Pagoda" radio button, the number of 1-5 pagodas can be selected in spinner box as shown in Figure 12. User's location is latitude 21.191643 and longitude 94.895026. And, user selects 3 pagodas as first priority and restaurant as second priority in Figure 12. So, the route of 3 pagodas and one restaurant that starts from user location is displayed on map as shown in Figure 13.

7. Conclusion

The route-guidance mobile application for the trip planning system is developed in this research. This system can find a meeting place based on the user's current location and friend location, and can search a route for the trip which starts from the source location to the nearest famous places based on the tourism personal interests. Moreover, users can also review the meeting place and the route for the trip not only in details but also on map. By using this mobile guide, both tourists and local people can plan their trips to systematically visit to famous places in Bagan.

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