Cities Guide System Using Spherical Law

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DOI: 10.29322/IJSRP.8.11.2018.p855
http://dx.doi.org/10.29322/IJSRP.8.11.2018.p8355

Abstract- This paper presents how to apply spherical law of cosine and GPS nature services in real life. And it shows one system which can easily locate, navigate and display detailed information of specific shops to users. The system also displays additional useful information such as route distance and travel time between current location and destination. To provide distance between current location and destination, Spherical Law of Cosines which calculates distances plus earth radius to provide precise distances has been used in the system. The system is developed to help users in navigating places easily and faster. Detailed information (such as shop's name, address, and phone numbers) and geographical locations (latitude, longitude) are needed for developing the system. It is a system for city directory which help users abilities to locate, navigate and get detailed information about the places located in cities. The places provided in the system are Hotels, Restaurants, Petrol Stations, Hospitals, Markets and Pagodas.

I. INTRODUCTION

Using tools such as aerial photographs and the global positioning system (GPS), the GIS team gathers and processes spatial coordinates, topology and dimensions of fixed physical objects such as buildings, rivers and roads, and translates the raw data into usable information. Combined with a strategic vision, this data provides a powerful system capable of analyzing complex information regarding our physical environment. Trained personnel use this information to create digital and paper maps of extraordinary detail, plan for future growth, perform trend modeling, monitor environmental changes, assess security and disaster requirements, and efficiently dispatch emergency services.

Nowadays, smartphone uses have been increasing dramatically since 2012 as the smartphones become cheaper and smarter. So that the system is developed as an android application, which enables users to navigate places in their smart phones. For the users, they will be able to use the application if their smart phones have Android OS 4.1.2 and above, and users must be able to connect internet using their phones.

Tourist arrivals and local visitors are also increasing in Myanmar, especially in Shan State which is one of the main states in Myanmar. So that this system has been developed for the need of information for tourists and local travelers. This application provides information of places via six popular place categories in Taunggyi, the central city of Shan State.

There are many city directory applications in Myanmar which only displays information of places (city directory) 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. Therefore, this system is intended 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. . By developing the system, tourist arrivals to Myanmar will probably increase.

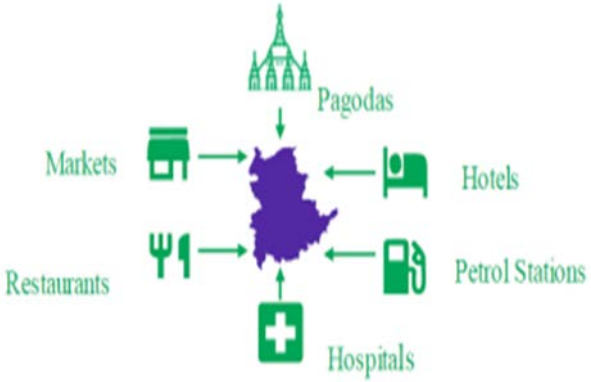

Figure 1. Places for Cities Guide System

II. RELATED WORK

There are typically two types of navigation software available. The first type of software is developed by Global Positioning System (GPS) or Navistar system in which the accuracy of positioning is very good, however, they are commercial and come at a cost. These maps are updated in user's devices but are generally not optimized to run on user's devices. The second type of software is developed by various ISP or portal operator. Here, various functionalities and flexibility are optimized for user's devices. In this category, Google Maps provides API compatibility with several platforms including Android [1]. The second category is no doubt preferable, which provides us with the right API for developing software.

This application is primarily developed for visually-impaired persons for navigation and also to aid people, who have been kidnapped in relocating to their original destination from an unknown place. Studies indicate that there are approximately 10 to 11 million blind and visually impaired people in North America and about 15 million people in India. These numbers are on the rise and there is no doubt of the fact that this number is quite alarming. As many of these people have difficulty knowing where they are, coupled with the fact that they are mostly disoriented, supplemental guidance is very important [2]. The application developed uses Google's direction API to download route information data based on the points selected by the administrator. The application saves these points in the database. To download the available paths in the vicinity, user needs to refresh the application. Location-based paths will be displayed i.e., only the paths near the user's location will be displayed. The paths will be updated whenever Google makes any modifications in its servers. As the maps are not downloaded, instead guidelines in the form of text instructions are downloaded. Hence the application requires very less mobile data. This Application tracks user's movements using GPS and magnetic sensors which are built-in for every smart phone. For visually impaired users, voice and vibration feedback is given whenever necessary i.e., when the user is away from prescribed path or has to maneuver up ahead. User can also record his path in one way and the application guides him on the same path on the return journey. This is useful when a person goes to an unknown place say the forest or gets kidnapped. Our app using this recorded path can guide the user to the point where he started. Since the application doesn't have a map loaded for navigation, the battery consumption is less. It needs only less battery consumption for identifying user location and adding new locations using GPS [3]. 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 is a need for offline applications as well. In other words, the applications connect to the internet intermittently.

First Aid Application on Mobile Devices was presented in [4]. 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. Friend Finder Navigation Application was also presented in [5]. This application applied the GPS data of each and every user and stored them in a cloud database. For each user, it calculated the distance between every other user to find out the nearest person. All this were done on the server side. So the internet is a must for the application to function properly.

In both Friend Finder Navigation Application [5] and First Aid Application on Mobile Devices [4], the distance calculation is done considering both the locations to be on a straight line. In fact, the amount of distance required to travel is not nearly same as the result provided using this algorithm. E.g., consider a path which is a circle. One user is 0 degrees and the other to 180 degrees. A radius of the circular path is 10 meters; therefore the diameter is 20 meters. Now based on the algorithm the distance is 20 meters but the distance to travel on the path is approximately 62 meters. See, the distance is off my 42 meters which area glaring error. In our application, the distance is calculated by dividing the path into several near straight line paths called steps as done by Google. So the distance calculated, which is a sum of lengths of all these small steps, is almost the original distance.

The navigation system [6], which served the same purpose as our application, the location of the user is determined by the help of cell network providers. The positioning is not stable and errors are so huge. In our application the user's location is iden0tified with the help of GPS. So the position is pretty accurate. The path between source and destination is determined by the application manually by using various algorithms. But in our application the path is obtained from Google i.e., it is optimized and there is less burden is on the CPU of the user's device.

Spherical trigonometry was dealt with by early Greek mathematicians such as Menelaus of Alexandria who wrote a book that dealt with spherical trigonometry called "Spherica" [7]. The subject further developed in the Islamic Caliphates of the Middle East, North Africa and Spain during the 8th to 14th centuries. It arose to solve an apparently simple problem: Which direction is Mecca [8]? In the 10th century, Abu alWafa al-Buzjani established the angle addition identities, e.g. sin (a + b), and discovered the law of sines for spherical trigonometry. Al-Jayyani (989-1079), an Arabic mathematician in Islamic Spain, wrote what some consider the first treatise on spherical trigonometry, circa 1060, entitled "The Book of Unknown Arcs of a Sphere" in which spherical trigonometry was brought into its modern form [9]. This treatise later had a strong influence on European mathematics. In the 13th century, Nasir al-Din al Tusi (1201–74) and alBattani, continued to develop spherical trigonometry. Tusi was the first (c. 1250) to write a work on trigonometry independently of astronomy. The final major development in classical trigonometry was the invention of logarithms by the Scottish mathematician John Napier in 1614 that greatly facilitated the art of numerical computation—including the compilation of trigonometry tables [10].

III. PROPOSED CITIES GUIDE SYSTEM

The detailed explanation of proposed system design is shown in Figure2. For example, a user wants to know nearest restaurants based on his current location. The user has to tap restaurant category and find nearest button. The system firstly gets the current latitude and longitude of user, and then retrieve latitudes and longitudes of the places stored in database. After retrieving data from database, the system finds nearest restaurants by calculating two locations of 11 current location and specific restaurant. Second, the system sends location data of restaurants to Google map API. Google Map API sent back map data to the system. Then the system displays three nearest restaurants to user on Google map in the system. Also, if the user taps the rest category, the process will be the same to process described above.

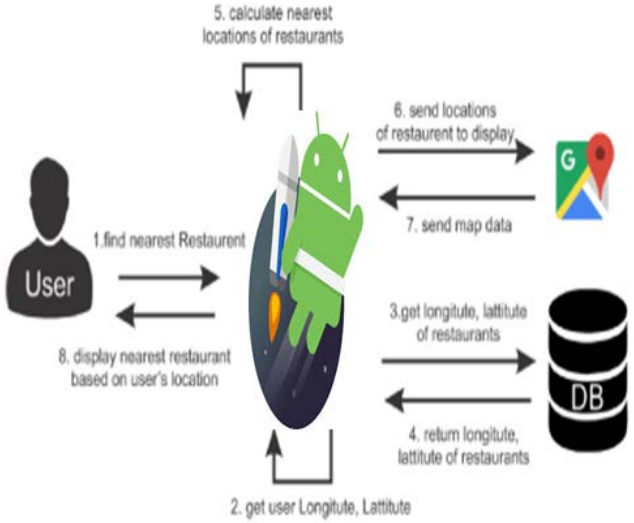

Figure 2. Proposed System Design for Cities Guide System

IV. SYSTEM FUNCTIONALITIES

The system functions at the user end are described as the followings:

1. Find nearest places based on user's location.
2. Receive user's GPS data through a connected GPS.
3. After the data is fetched from the GPS, it should be transformed into appropriate coordinate system and invoke related image files.
4. Send the basic satellite image and transmission information such as date, time, longitude and latitude.
5. Calculate nearest places using Spherical law of Cosine after received GPS coordinate data of all places.
6. Show the nearest places with map based on user's location.

A. Bits and Pieces together

In this approach combine all your researched information in form of a journal or research paper. In this researcher can take the reference of already accomplished work as a starting building block of its paper.

Jump Start

This approach works the best in guidance of fellow researchers. In this the authors continuously receives or asks inputs from their fellows. It enriches the information pool of your paper with expert comments or up gradations. And the researcher feels confident about their work and takes a jump to start the paper writing.

B. Category Filter

The Places (Search) API allows you to filter results when you can determine relevance by a specific location or by a location area. Users can easily find places as categories are filtered. In this application, it has only filtered six types of places due to limitations.

C. Route Connector

It provides ability to display routes to the destination visually for easier navigation in map using Google Direction API. 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.

D. Distance Calculation

Places in results have a distance field indicating the distance from the user's location or from an explicit reference point to the place. An explicit location context in the request provides the location from which the distance is calculated. 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.

The simple Spherical Law of Cosines formula:

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

Where A and B are the angles of the corners opposite to sides a and b, respectively. It can be obtained from consideration of 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.

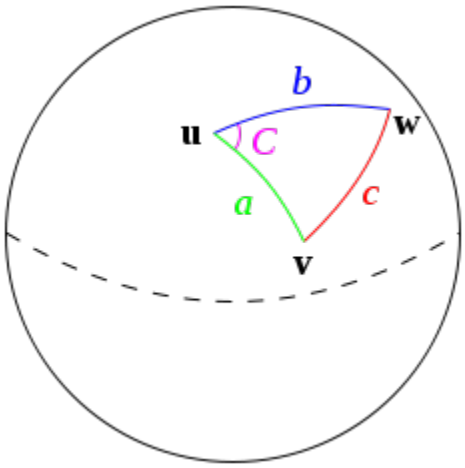

Figure 3. Spherical Triangle solved by the law of cosines

Advanced Spherical Law of Cosines formula:

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

Where, d= distance between two places, φ1= Latitude of location1, φ2= Latitude of location 2, Δλ= Longitude of location2 – Longitude of location 1, and R= Earth Radius (6371Km).

E. Nearest Location Finder

Using Nearest Location Finder, you can easily locate the Airports, Library, ATMs, Banks, Hotels, Restaurants Shops and many other places near you. Users will be able to find nearest shops from their location whenever they want. It is a very useful feature for those who are very new to the cities.

V. CONCLUSION

The system provides instant and easy access in navigations of places for users. It also provides finding nearby places and connects routes to the destination from the user's current location and calculating distances to the destination. It is sure that the system is a convenient application for tourists and travelers. Not only travelers have advantages but also resident will be able to view detailed information of places at any time if they use the system.

The system has a few limitations. They are;

- The system can only display six categories of places.
- The data scope in the system is only for one State, we want to increase data scope for the whole country.
- The information provided in system only has six categories and need to be extended more categories.
- The database is not in real-time database. If real-time database is provided in the system, users will get more updated information. So that it is necessary to implement online database to the system in the future.

ACKNOWLEDGMENT

I would like to thank all person who directly and indirectly contributed towards the success of this paper for the support, encouragement, useful suggestions, valuable guidance and help in preparing this paper.

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