Indian Journal of Science and Technology, Vol 9(45), DOI: 10.17485/ijst/2016/v9i45/99707, December 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Offline Navigation: GPS based Location Assisting System

M. Prathilothamai, Prashant R. Nair, R. Alakh P. Singh and P. N. S. Aditya

Department of Computer Science and Engineering, Amrita School of Engineering Coimbatore
Amrita VishwaVidyapeetham, Amrita University, Coimbatore - 641112, Tamil Nadu, India;
m_prathilothamai@cb.amrita.edu, prashant@amrita.edu, CB.EN.U4CSE13408@cb.students.amrita.edu,
CB.EN.U4CSE13442@cb.students.amrita.edu

Abstract

Objectives: We have developed an Offline Navigation Android[1] application especially for the visually impaired people, the application also features a module through which the user, if lost track or has been abducted can reach back to the original location without the use of the internet. **Methods/Statistical Analysis:** We have used Google's direction API[2] for the route data, using this data the application guides the user with the help of Global Positioning System and Magnetic sensor. The main uniqueness of this application is, it works without the internet and consumes less battery charge. **Findings:** The developed application uses the data from the direction API (i.e., JSON format text) for navigating without displaying the map instead by reading out instructions, showing just direction and giving vibration feedback if deviating from the path. Thus the application differs from a typical navigation application. **Application/Improvements:** The developed application has a unique functionality for retracing a user's path, and also consumes less space and computation compared to other navigation applications.

Keywords: Google Directions API, GPS, GSM, Magnetic Sensor, Offline Navigation, Retracing, Visually Impaired

1. Introduction

Offline navigation as the name states is navigation without the use of the internet. Nowadays people use smartphones to carry out almost all the important day to day tasks in which, one of them are navigation. More and more mobile content is available and now some of the phone manufacturers include a map or navigation software. Many applications are emerging based on location-based services, navigation and map services[3]. It would be ideal to have an application which could do all the functions that a conventional navigation application does without using a lot of mobile data and having less battery consumption. In our application, not only GPS but also magnetic sensors are used to guide the people more accurately. People show much interest in mobile devices rather seeking information from traditional Information sources[4].

There are typically two types of navigation software available. The first type of software is developed by Global Positioning System (GPS) or Navstar 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[5]. 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

*Author for correspondence

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[6]. 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[7].

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.

In[8] (First Aid Application on Mobile Devices), the main concept of the 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.

In[9] (Friend Finder Navigation Application) the application uses the GPS data of each and every user and stores them in a cloud database. For each user, it calculates the distance between every other user to find out the nearest person. All this is done on the server side. So the internet is a must for the application to function properly.

In both Friend Finder Navigation Application[9] and First Aid Application on Mobile Devices[8], 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[10], which serves 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 identified 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.

Our application supports only outdoor navigation and not indoor because GPS utilized in our application has less efficiency indoors. But using the system proposed in Naviterier – Indoor Navigation System for visually impaired[11], indoor navigation is possible. In this system QR codes are installed at several places in the building. The users need to scan them so that the application can determine their current position and provide them guidance. Using Bluetooth and Wi-Fi[12], further more simplifies the users job i.e., need not go to the QR code and scan it. This process is more efficient but increases cost of installation.

The indoor navigation can also be achieved using RF transmitter, a user module in waist belt and an application installed in the user's Android mobile phone as proposed in RF Based Talking Signage for Blind Navigation[13]. Nowadays mobile phones having plenty of sensors[14], using that human beings physical status will be identified

that will be helpful in plenty of applications like person tracking, health monitoring, road-traffic conditions, etc.

2. Use Cases

The application mainly serves visually impaired people who cannot view a map. This application uses text instructions to guide the user which will be read out facilitating a blind user to navigate. A normal user can also use this application. And this is mainly helpful for a user who gets internet connection less frequently i.e., he can download the required routes and use them without any worry about internet connection.

Figure 1. Homepage.

3. Key Features

3.1 Retrace-Ability

This is one of the main features of the application. The user can record his movements, by pressing a button in the application. Using this recorded data, the application guides the user to reach the destination. This mainly helps users who tend to explore an unknown region e.g.,: Forest, desert, etc. All this is done without any internet.

3.2 Turn by Turn Voice Navigation Offline

The developed application assists the users with respect to navigation to the respected destination with step by step voice guidelines and vibration feedback whenever necessary. As the targeted users are visually impaired, this feature will be quite useful.

3.3 Ease of Access

This application can be used by both normal users and by turning on the talk back accessibility in android, this application can also be used by visually impaired. The information presented is optimized so even a basic user can understand.

3.4 Users are Provided with Latest Information

The routes are updated with latest information given by Google, whenever the user refreshes the application.

3.5 Low Battery and Mobile Data consumption

The application uses mobile data only to download routes in the form of JSON text, the actual map is not downloaded there by reducing data consumption. The developed application only uses GPS service and magnetic sensor for guiding the user, so the battery consumption is also very less.

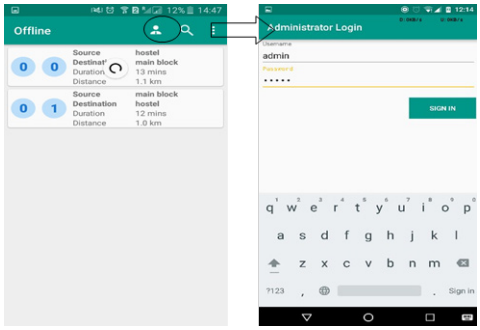

Figure 2. Admin login page.

4. Screenshots

4.1 Homepage

Figures 1 and 2 shows Start Screen that provides the first point of communication where users can interact with the application. This screen provides basic information about the available source and destination with the total time and total duration taken.

4.2 Administrator Login Page

An administrator is a person who manages or controls the software, by adding or deleting the location points. Here in Figure 3 administrators can login to add new points, delete or manage them accordingly. In this app, the circled portion shows the icon to get admin access.

Username and password is required to add and/or delete locations.

4.3 Deleting or Adding Locations

Figure 4 shows how the admin can mark a point on the map and save it by pressing the small pop up window. The admin can also manage the points by pressing the top right button. He can also delete the points if the locations of the places are changed. All these locations are being managed by the server.

4.4 User Tracking Activity

Figure 5 (left side) shows how when the user refreshes, newly added points will be downloaded and displayed on the screen. Pressing on any one of the desired paths will lead to another activity shown in Figure 5 (right side) which gives guidelines to the user to reach their destination in offline.

User guidelines are given in offline i.e. internet is not required. Circle in the screen shot indicates how close the user is to the destination. When the user is not on the right path, then circle is displayed in red color.

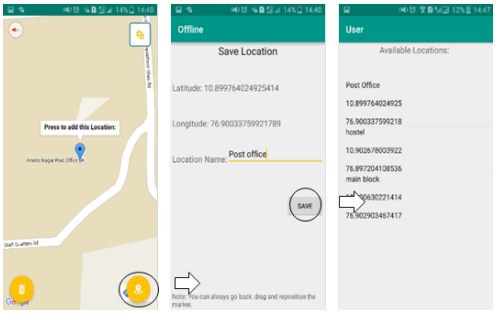

Figure 3. Administrator management activity.

5. Description of Major Process Involved

Administrator first selects the points based on the requirements made. The points get stored in the database online. The server then organizes these points as source and destination. Each and every point acts as both source and destination. For e.g., if there are 3 points then there will be 6 possible routes. Formula: For n points n*(n-1) routes are possible. Admin can also manage the points (delete, update, etc). The data downloaded when user refreshes is in JSON format and required information will be extracted and saved locally. All the available routes are listed before user for selection. On selecting a particular route the data corresponding to it is retrieved from the local data base and utilized for navigating the user. The path from source to destination is a list of geographic points; these points are divided into several steps. The current location of the user is obtained from the device GPS. Using polyutil library the application determines if the user is on route or not and gives the vibration feedback if deviating from it. According to Google each step has a guideline and based on which step user is currently on, the instruction is set. It reads out the instruction whenever the user needs to maneuver or even speaks out on the press of a button. Based on distance completed and total distance to reach the destination a percentage and a percentage completion circle is shown to user to give him an over view of his journey. From the locations added by administrator nearest location within 200 m is shown to user to give him an idea of his position. The application uses magnetic sensor to point towards the direction in which the user has to move to reach the destination. The retrace-ability function of the application retrieves the path saved by user. This path is again divided into small steps. The user's current GPS location is obtained and the step he is on is found out. Using the magnetic sensor the application points towards next step so that user can move towards that direction[15]. Voice guidance is also given based on the data provided by magnetic sensor and also by continuously calculating the distance from the current location to the destination point.

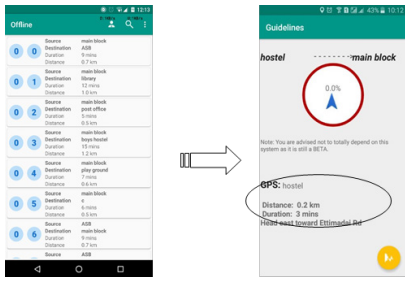

Figure 4. Guidelines for user.

6. Developing Cost of Software

The cost for developing the software is very less when compared to other offline navigation application available. The only cost is to host a server and to pay for direction API provided by Google. All the other methods are available online, we just need to extract the required data and manipulate it accordingly.

7. Security and Privacy Implications

The mode of this application is offline and saved in locally, thus eliminates the possibility of data getting corrupted or affected by malicious software. The app is developed in android and all the updates can be downloaded from Google play. The data used for navigation is received from Google's direction API which is not saved in the online database, but is requested only when the user the refreshes the application. Therefore, the data is not tampered with in anyway.

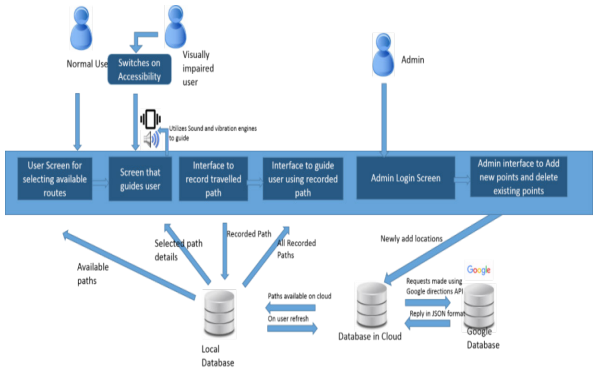

Figure 5. System architecture.

8. Potential for Extensibility

The only limitation yet is the data received from GPS provider or network provider. The performance of the GPS based navigation will be degraded in the attenuated signal environments and reflected conditions. To improve the reliability of GPS navigation two types of sensor fusion are proposed in[3] which is, integration of GPS with other GNSS including GLONASS and integrations of GPS with low cost INS. The working of the application is totally independent of internet. In case of GPS unavailability, the user cannot navigate. In the future, we are also planning to use navic India's very own GPS to navigate users with better precision and also release this application on IOS and Windows platform.

9. Conclusion and Future Work

This application is built to assist the visually impaired people to reach their destination offline. This application also provides the facility to record the path and give guidelines to retrace their movement to the origin. It is helpful for kidnapped people who are left out in an unknown place or if someone is lost in a forest. Also, the application can guide a user by vocal output and vibration feedback which is highly helpful for visually impaired. In future work, for visually impaired people if any obstacles are there in their path, we have a plan to build a chip that will be integrated into their walking stick to sense the obstacles in advance and give navigation guidelines accordingly.

10. Acknowledgment

We acknowledge Computer Society of India (CSI) for funding us to complete this project.

11. References

1. Android. Available from: http://developer.android.com/guid/basics
2. Google directions API. https://developers.google.com/maps/documentation/directions/intro
3. Dai Z, Knedlik S, Ubolkosold P, Zhou J, Loffeld O. Integrated GPS navigation for civilian vehicles challenging environment. IEEE Germany; 2007.
4. Tjostheim I, Fesenmaier DR. Mobile devices as substitute or supplement to traditional information sources: city tourists, mobile guides and GPS navigation. Information and Communication Technologies in Tourism; 2008.
5. Lai YC, Han F, Yeh Y H, Lai CN, Szu YC. A GPS navigation system with QR code decoding and friend positioning in smart phones. 2nd International Conference on Educational Technology and Computer (ICETC); Tawan. 2010.
6. Ran L, Helal S, Drishti MS. An integrated indoor/outdoor blind navigation system and service. 2nd IEEE Annual Conference on Pervasive Computing and Communications (PERCOM'04); USA. 2004. p. 23.
7. Getting IA. Perspective navigation-the global positioning system. IEEE Spectrum. 1993; 30(12):36–8.
8. Surachat K, Kajkamhaeng S, Damkliang K, Tiprat W, Wacharanimit A. First aid application on mobile device. World Academy of Science, Engineering and Technology. International Journal of Computer, Electrical, Automation, Control and Information Engineering. 2013; 7(5):1–6.
9. Navin D, Waghwani W, Jayaraman R, Umesh B, Waghmare W. Friend finder navigation android application to meet new people around. IRJET. 1892; 2(7):68–73.
10. Deb P, Singh N, Kumar S, Rai N, Naidu PAS, Iyengar CHSN. Offline navigation system for mobile devices. IJSEA. 2010; 1(2):1–23.
11. Vystrcil J, Mikovec Z, Slavik P. Naviterier- Indoor navigation system for visually impaired. Parague: Czech Technical

University in Prague Karlovo nam. Prague Czech Republic; 2012. p. 1–4.
12. Agarwal R, Vasalya A. Bluetooth navigation system using Wi-Fi access points. International Journal of Distributed and Parallel Systems. 2012; 3(2):1–8.
13. Aswathy VR, Dilraj N, Rao S. RF based talking signage for blind navigation. IJCI. 2015; 4(2):1–9.
14. Ali S, Khusro S. Mobile phone sensing: a new application paradigm. Indian Journal of Science and Technology. 2016; 9(19):1–42.
15. Google directions API. Available from: https://developers.google.com/maps/documentation/directions/intro