

Indoor navigation and monitoring system for smart devices

[Science](#), [Computer Science](#)



A location-based functionality allows android mobile device users to access various services like getting current location information and gives route towards the desired destination on the map and navigate. Nowadays many users depend on it when they want to visit any unknown places. But when a user visits inside the large building and due to limitations of GPS signals inside they cannot find their exact location and also a route to any particular place inside building they have not visited before and it even get more difficult for visually impaired and physically disabled to independently navigate who cannot see or speak. In this project, we present system in which we develop an application for android mobile phones where the user can get location information inside the large infrastructure and also allow selecting the desired place inside building on any floor and with voice-based directed route navigation feature. For higher accuracy of user location, Wireless modules and onboard sensors of mobile phone will be used. Also to develop a web interface for surveillance purpose where an administrator can monitor the users in real-time presence inside that particular building with their precise location with the room they are in and the floor they are on.

Introduction

Navigation has been major part of life and that may be for various reasons and many purposes like work, education, and in personal life. It included traveling from one place to another that may be known or unknown and various tools evolved over century's right from traditional paper based map towards hiring a guide to solve this problem. With the evolution of technology which enabled seamless connectivity, communication over network and data transfer over cloud and smart devices like smart phone,

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wearable's etc., for these devices various map-based applications were developed using Satellites.

Nowadays, users heavily utilize mobile devices to request location search services. Using which user can search for various places around the world and get their information and path to reach towards it. Using a satellite for multi-purpose like weather and other features using camera which captured the earth images and map edit from top view. In this map application, different places from continents, countries, cities were available, and which enabled user to get path in order to reach destination and also to show traffic and compute shortest path along the roads. Around millions of places are mapped on these web-mapping services with approx accuracy we call it as co-ordinates in form of longitude and latitude. Because of GPS it has added an advance feature of tracking movement of user in real-time on map and it uses internet and networks like (2G/3G/4G) for better accuracy and improvement of real-time location systems. Also, competitors like Google Map added a voice-based feature which helped visually impaired people to get direction while navigating. But because of GPS limitation it was not able to track user in indoor environment, though user stay inside building or infrastructure spend more time than that of outside environment. This map data is stored on large database and continuous modification takes place as satellites are continuously getting changes on earth. Using cloud services, it allows providers to enable millions of users to access this location data and navigate along it and continuously track the user. As this project is built in pervasive computing domain, which enables devices to sense the movement

of user using inbuilt sensors and it helped for better accuracy. Due to crucial things happenings, there has been difficulty in monitoring users when they are inside any large infrastructures like malls, hospital and hotel. In such case, privacy-preserving about private place is really important, which could not be affordable made it accessible to unknown mobile users.

Most of the people are equipped with mobile devices which create new opportunities for a variety of compelling applications in indoor spaces, such as, in-building guidance and navigation. Today's technological market and gadget culture allow for the realization of such indoor services with the omnipresence of sensor-rich mobile devices in indoor environments. Mobile devices can measure a variety of signals, such as wireless, sound and light, all relative to known locations in space (e. g., cell-towers, Wi-Fi Access Points (APs) or beacons).

Privacy and confidentiality are critical for the wide adoption of indoor location services because users have always been concerned about sharing their location data. It starts out by rigorously classifying academic services as well as industrial IIN services based on a multi-dimensional taxonomy we introduce, which includes localization, crowd sourcing, privacy and modeling.

Chiaki Takahashi first reports an initial feasibility study results of iBeacons for indoor positioning systems to be used for augmented audio reality navigation systems. We report the location accuracy achievable with a limited number of iBeacons placed inside a room, using the radio reception intensity from these iBeacons. On the other hand, indoor navigation has

been receiving continuing interests because of the increase in the number on mobile terminals, such as smart phones, with navigation capabilities. Most existing navigation systems rely on the screens. It is well known that staring at small screens while walking can be dangerous. Accordingly, we have been trying to replace screen guidance with audio while still preserving the presentation of the surrounding auditory scene to the user, i. e. augmented audio reality navigation systems.

In the paper “ DISHA: An Indoor Navigation System for the Visually Challenged”, system design is implemented for visually handicapped peoples for navigation. The long-term goal is for a portable, complete system that will allow visually handicapped peoples to travel irrespective to assistance of guides. The system, as it exists now, consists of the following functional components: assistance for determining the user’s location in the building, a detailed map of the interior of the building, and the user interface. By pressing keys on his/her mobile unit, directions concerning position, orientation and navigation can be obtained by the portable system that can prompt them acoustically over a text-to-speech engine. The system offers a portable, low cost and user-friendly solution to problems of mobility faced by the visually handicapped. The system is based on a state of the art, robust technology and therefore has the potential to develop as a de facto standard for all future building construction.

Other researches present a comprehensive survey of numerous IPSs, which include both commercial products and research-oriented solutions.

Evaluation criteria are proposed for assessing these systems, namely

security and privacy, cost, performance, robustness, complexity, user preferences, commercial availability, and limitations. We compare the existing IPSs and outline the trade-offs among these systems from the viewpoint of a user in a PN. The position information enables location-based protocols for user applications. Personal networks (PNs) are designed to meet the users' needs and interconnect users' devices equipped with different communications technologies in various places to form one network. Location-aware services need to be developed in PNs to offer flexible and adaptive personal services and improve the quality of lives. Some position-based indoor tracking systems have been used in hospitals, where expensive equipment needs to be tracked to avoid being stolen, and the patients can get guidance to efficiently use the limited medical resources inside complex environments of the hospitals. Indoor navigation systems are also needed in a large public area to provide position indications for the users.

Outdoor navigation

In Outdoor Navigation, GPS is used for navigation. Earth surface is mapped with virtual co-ordinates i. e. latitude and longitude. With the help of this latitude and longitude every point on the earth is located. Outdoor Navigation is very popular as it shows path from source to destination to the end user who is known or unknown to the route. In the later part of normal or advance life peoples were using the paper maps and the analogue compass for navigation. As the man was developing, new technologies were invented.

Nowadays, digital devices are used for location finding. The digital devices like mobiles, laptops, PDA's, Etc. are provided with modern and advance digital maps, which are useful for easy to understand for normal users. There are many developers who are working on Outdoor navigation systems like Google's Google Maps, Microsoft's Bing Maps and Apple's Maps Connect Etc. They give a user-friendly view for displaying maps as well as navigate from one place to another. But the Outdoor navigation uses GPS which has some disadvantages with respect to indoor navigation. GPS does not work inside the buildings. So, the indoor navigation needs some different technique to overcome the drawback of outdoor navigation.

Indoor navigation

Indoor navigation is a concept of enrouting through buildings. There are various building structures which are too complex and difficult to memorize for normal person, with the help of the indoor navigation anyone can easily navigate to anywhere in the building without worrying about the complex structure. People spend 80-90% of their time in offices, shopping malls, hospitals and airports. Indoor navigation is not yet fully developed instead it is in beta phase. Up till it lacks in accuracy for the current location of device or user. Indoor navigation does not use the GPS as it will not work inside the buildings instead it uses beacons, wi-fi, or any other radio frequency device. Also, Indoor navigation system can help the physically disabled peoples especially visually impaired users can get benefited with INS. In future INS can be embedded on canes of blind peoples, wheelchairs, etc.

Proposed system architecture

In our system we are using divide and conquer strategy to exploit distributed processing. In this technique, we are using some functions of previous module into next module. In that Project, we propose an indoor Navigation and Monitoring System. This system provides building structure and floor plan to user and also route of that event. Admin store or update all information regarding Building and floor POI's. Then user can see the floor plan information like POI on their mobile phones.

Admin Module: Admin store or update all information regarding Building and floor POI's. User Module: In this module, the users are able to access the system or they are able to see floor structure, select particular POI's and see route of selected destination on API.

Localization

GPS is a very efficient technique for localization. It is globally accepted and used. GPS satellites are distributed above the earth's atmosphere, every device with GPS chip can be connected to number of satellites at time. More satellites mean more accuracy. GPS uses the triangulation methodology in which more than three satellites are connected and the algorithm calculates the location on the basis of latitude and longitude. In indoor navigation instead of GPS more than three radio frequency devices are used mainly beacons and wifi access points. Signal strengths of every RF device is compared the approximate location of device is calculated.

Finger printing

Fingerprinting is a method of analyzing the input i. e. RF devices signal strength, sensor data of mobile phone and then it defines the location data for respected place or path. Before navigation the system must be trained to get the location. Fingerprinting is a way of doing the same. In this project, we implemented logger function for fingerprinting, in which the administrator or any user can improve the accuracy by walking on the path and the training data will be stored into the database. In the actual scenario this data is matched with the current user data and the approximate location is displayed on the interface.

Navigation (hardware sensor & software implementation)

In indoors user can have to visit anywhere inside the building. The navigation mechanism draws the path to the destination and user has to follow it.

Hardware requirements for navigation system are a mobile phone with accelerometer, compass and gyroscope sensors. While walking many factors makes the navigation to be successful. Our system captures user's location based on the logged data from the database, sensor data from the phone to detect that user is walking rotating and also if he is moving upstairs or downstairs.

Dijkstra's algorithm

Dijkstra's algorithm is a label-set algorithm that divides network POI's into three types: not labeled POI's, temporary labeled POI's and marked POI's. Firstly, we initialize all the POI's to become the not labeled POI's, then transfer the POI's that connect to the shortest path POI's into temporary

labeled POI's in the process of searching, and mark the POI's, which are the nearest POI's to the source point and selected from the temporary labeled POI's, into marked POI's each cycle, until we find the target POI's, or all POI's become the labeled POI.

RSSI

In our project, we use Wi-Fi access points, smart phone with inertial sensors like gyroscope, accelerometer, compass, etc. Received signal strength indication (RSSI) is a measurement of the signal power received by wi-fi chip embedded into an android device. In our project for RSSI technique we are using access points to receive strength and using that we collect training data set.

For accuracy we use triangulation method. When we collect sample point, location coordinates are stored according to latitude and longitude. All the sample data collected and stored in database. For that purpose, we use Couchbase as a database system.

This method is helpful when user request the destination location, then with help of the training data set system will give path to reach the destination with respect to current location.

Usage scenario

This system is very helpful for availing the use of existing web-mapping technology for implementing building structure, assigning POI and end-user are beneficial for easy navigation inside indoor environment.

- User

In this system, user is one of actor which may be either authorized or unauthorized. Here user can select destination and navigate along the route inside the building with help of voice-based instruction.

- Administrator

In this module, Administrator has authority to allow access for Building Authorities to use existing eco-system for their infrastructure and useful for their visitors/customer

- Architect

In this module, building structures are added floor wise into system with their Point of Interest (POI) and joining the nodes using web interface is done by Building Architect.

- Building Authority

In this system, User can be monitored in real-time by authority.

Voice-based module

It is mainly used for physically disabled peoples or blind peoples. In the voice-based navigation process, user speaks in a microphone and inputs are taken. The control of the input audio signal is done at the system level.

Different operations are performed at different levels on the input signal such as Pre-emphasis, Framing, Windowing and Acknowledgment (Matching) of the spoken word. The speech recognition system consists of two distinguished phases. The first one is training course, while, the second one is referred to as testing stage. During training stage, speaker needs to give

tests of their samples to prepare the framework. During recognition phase, speaker has to coordinate with existing database and gives correct match.

CONCLUSION

We proposed a system for solving indoor positioning problem and to overcome limitation of GPS and with the proposed algorithms and techniques which enables users to find an exact route to places inside the infrastructure and navigate, using existing mobile phone sensors and camera for visually impaired people and to monitor users inside the environment.