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Real Time Indoor Navigation System

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***Abstract*: Nowadays, a large number of ubiquitous mobile applications has increased the interest in indoor location-based services. Some indoor localization solutions for smartphones exploit radio information or data from Inertial Measurement Units (IMUs), which are embedded in most modern smartphones. In this work, we propose to fuse Wi-Fi Receiving Signal Strength Indicator (RSSI) readings, IMUs, and floor plan information into an enhanced particle filter to achieve high accuracy and stable performance in the tracking process. Compared to our previous work, the improved stochastic model for location estimation is formulated in a discretized graph-based representation of the indoor environment. Additionally, we propose an efficient filtering approach for improving the IMU measurements, which is able to mitigate errors caused by inaccurate off-the-shelf IMUs and magnetic field disturbances. Moreover, we also provide a simple and efficient solution for localization failures like the kidnapped robot problem. The tracking algorithms are designed in a terminal-based system, which consists of commercial smartphones and WiFi access points. We evaluate our system in a complex indoor environment. Results show that our tracking approach can automatically recover from localization failures, and it could achieve the average tracking error of 1.15 m and a 90% accuracy of 1.8 m.**

***Keywords*: Inertial Measurement Units (IMUs), Wi-Fi, Received Signal Strength Indicator (RSSI), Particle Filter, Indoor Localization.**

1. Introduction

An indoor positioning system (IPS) is a system used to locate objects or people inside a building using lights, radio waves, magnetic fields, acoustic signals, or other sensory information. There are several commercial systems on the market, but there is no standard for an IPS system. Indoor positioning systems use different technologies, including distance measurement to nearby anchor nodes (nodes with known fixed positions, e.g. Wi-Fi / Li-Fi access points or Bluetooth beacons), magnetic positioning, dead reckoning [2]. They either actively locate mobile devices and tags or provide ambient location or environmental context for devices to get sensed. Existing navigation systems can be broadly classified into two major categories, indoor and outdoor. Most outdoor navigation techniques use satellite based navigation systems as GPS, GLONASS, etc. to locate an object in any outdoor area. Such techniques work well in open spaces with a clear line of sight to the satellites, but may not perform well in an indoor environment, as the signals get scattered and attenuated by physical objects.

2. Literature survey

Over the past few decades, indoor navigation systems have been a very popular subject of research. A Dead-Reckoning localization technique is proposed in [1]. Dead-reckoning is the process of calculating the current position, with the help of previously calculated positions and thereby advancing that position based upon known or estimated data. It is very complicate to execute and manually not feasible for even average system. In an LED based navigation system [2], external devices such as receivers (e.g.: smartphone camera) transmitter is to be used which consists of an LED- as light source and Arduino UNO– as microcontroller. It's hectic to place these transmitters on various locations and also cost inefficient. A navigation system based on Radio Frequency (RF) [3] uses an algorithm called Echolocation that examines the ordered sequence of nearby reference nodes (nodes with known locations) to determine the location of the unknown node (node with unknown location). [4] The study of indoor navigation using Wi-Fi which uses GPS as base location finder and Wi-Fi to give accuracy. [5] Uses Beacons replacing Wi-Fi to give better range of coverage but is costly to implement. [6] Navigation using Augmented Reality used same functionality as Wi-Fi but give a different GUI but is complex to implement. [7] Visible Light Communication is a communication method where visible light within a particular frequency range is used as the medium of communication. It again requires hardware which makes it costly. [8] RFID is an acronym for "radio-frequency identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves.

3. Proposed system

A. *Objectives*

- To implement a system to measure the distance of user on each Wi-Fi point.
- System provides every specific time interval of location details to user. With the help of longitude and latitude.
- Deploy the system on real time environments.
- Improve the location accuracy of user with minimum time complexity.

B. Problem statement:

In the proposed work to design and implement a system that can be provide floor base user location tracking and recommending system under the Wi-Fi as well GPS on own grid.

C. Project overview

Indoor Atlas is used in proposed system. Indoor plan infrastructure is to identify the campus indoor structure. The application server is responsible for identifying the policy corresponding to a particular location and performing the necessary action. Indoor Location based services is used to specify the current location tracking indoor position helps to navigate the users. Conference, seminars, symposium information are described by college event information. Apart from this, it notifies the user if he comes near the library or the seminar hall. Indoor Atlas MapCreator for Android is used to create maps to test the indoor navigation and also to record the sensor data. Indoor plan infrastructure is 2D plan for constructing the indoor structure of the college. Indoor plan infrastructure is main requirement for indoor location tracking system. Based on the infrastructure to develop the indoor application on the android platform. It is used to find the indoor location.

D. Project methodology

The software packages used for implementing the system use Android SD and languages used in the proposed system are php in server side, .net in client side. Android is an operating system based on Linux with a Java programming interface. The Android Software Development Kit (Android SDK) provides all necessary tools to develop Android applications. This includes a compiler, debugger and a device emulator, as well as its own virtual machine to run Android programs. Android Software Development Kit (Android SDK) with Eclipse ADT is used for client side or for main application implementation. SDK 19 is used to develop the application. Initially, home page will be displayed in the application. When the user inside the campus, can view their current location. The user request the desired location in the map application. It shows the current and desired location with floor details. Using this application, user can know staff and event details. The user can request the staff or event details to the server.

E. System architecture

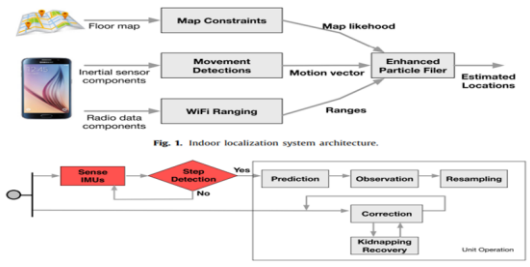

Fig. 1. System architecture

4. Results and discussion

In recent years with the help of Google maps, location searching becomes a new trend, when people are not aware of their location. Google maps provide lots of functionalities like showing any location, alternative path from any location to other location and estimates time to reach the location. But it is not well developed for indoor navigation. It is very difficult to find and get shortest path from current location to any location inside university like entrance gates, departments, canteen, library, playground and parking lots etc. for the new admitted students and visitors. To reduce this pain inside the campus, implement the campus indoor location tracking system on android platform has been designed, implemented and tested successfully in this work. This application provides shortest route guide for users from his/her own location to desired location and event updates with its proper place. API is the navigation module to conclude the location of user. Indoor location tracking system is implemented in Indoor Atlas Android SDK where the floor structures are placed on the outdoor map of the institution. Each single floor details are placed in it, to prepare the Indoor plan infrastructure map. Now the user can view their source position in the indoor plan. During the time, API key will generate at server side. With the help of API key, can implement the coding part in client side. Indoor location-based search (LBS) is growing as a natural extension of location-based search and marketing. Location-based services (LBS) provide personalized services to the mobile clients according to their current location. People can track own location and also navigate from one location to another location very easily.

A. Algorithms

GRA based network selection method can be performed by using following steps:

- *Step 1:* Classify the network parameters (smaller the better, larger the better).
- *Step 2:* Define upper and lower bound of parameters.
- *Step 3:* Normalize the parameter.
- *Step 4:* Calculate grey relational coefficients (GRC).
- *Step 5:* Ranking the networks according to GRC values.

B. Triangulation

- *Input:* User Longitude U[Li], Latitude U[Lt], WiFiid list wID[k].
- *Output:* current weight of each wID with location details
- *Step 1:* Track the current C=U [Li][Lt]
- *Step 2:* Calculate each wifi id distance from C using below formula

$$w(x) = \sum_{n=1}^{w} (D[n])$$

- *Step 3:* identify the WiFi id.

- *Step 4:* check the location with LBS server location details and provide the label to user's location.
- *Step 5:* Return the user's location with floor id

C. Evaluation and selection Algorithm

- *Step 1:* Classify the network parameters (smaller the better, larger the better).
- *Step 2:* Define upper and lower bound of parameters.
- *Step 3:* Normalize the parameter.
- *Step 4:* Calculate grey relational coefficients (GRC).
- *Step 5:* Ranking the networks according to GRC values using below formula.

$$GRC_i = \frac{1}{[(\sum_{j=1}^{k} W_j |S_i^*(j) - 1|) + 1]}$$

5. Conclusion

In this work we introduced the primary technologies used in indoor localization systems. Both commercialized products and research prototypes are discussed. System for pedestrians is proposed in this system. The system integrates a traditional PDR system with SRP adaptive drift calibration at access control points and a particle filter map matching algorithm. The information derived from SRP subsystem enables PDR to offer drift-free tracking and by taking advantage of existing access control systems, it offers a natural way to integrate user interactions at no additional cost. The map constraints, introduced by a simplified particle filter with LTR mechanism, further enhance the accuracy and keep the computation complexity acceptable for real-time processing on mobile devices with limited resources. The long-term experiment verified the robust and reliable tracking of the proposed system with 0.13% final position error with respect to a total travelled distance of over one kilometer. Moreover, the accurate tracking performance is independent of travelled distance and the system covers both corridor and rooms of indoor environments, offering a more practical way for pedestrian navigation. Future work will focus on extending the system to support different ways of carrying the smartphone during walking. Also, a more comprehensive system will be studied combining both outdoor and indoor environments to provide seamless tracking of the pedestrians.

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