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Indoor Tracking Using Wi-Fi Routers on a Smartphone

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Abstract: ***Wireless location finding is one of the key technologies for wireless sensor networks. GPS is the technology used but it can be used for the outdoor location. When we deal with the indoor locations GPS does not work. Indoor locations include buildings like supermarkets, big malls, parking, universities, and locations under the same roof. In these areas the accuracy of the GPS location is greatly reduced. Location showed on the map in not correct when the GPS is used under the indoor environments. But for the indoor localization it requires the higher accuracy sp GPS is not feasible for the current view. And also when the GPS is used in the mobile device it consumes a lot of the mobile battery to run the application which causes the drainage of the mobile battery within some hours. So to find out the accurate location for indoor environment we use the RSSI- based trilateral localization algorithm. The algorithm has the low cost and the algorithm does not require any additional hardware support and moreover the algorithm is easy to understand. The algorithm consumes very less battery as compared to the battery consumption of the GPS. Because of these this algorithm has become the mainstream localization algorithm in the wireless sensor networks. With the development of the wireless sensor networks and the smart devices the WIFI access points are also increasing. The mobile smart devices detects three or more known WIFI hotspots positions. And using the values from the WIFI routers it calculates the current location of the mobile device. In this paper we have proposed a system so that we can find out the exact location of the mobile device under the indoor environment and can navigate to the destination using the navigation function and also can enable the low consumption of the smart mobile battery for the tracking purpose.***

Keywords: Indoor Localization Algorithm; GPS; WIFI Access Point; Smart Phones, Android.

1. Introduction

The communications is currently the major driving force of the development of several indoor location services for wide range of applications such as those in commercial, agriculture, medical, and the military uses. Various wireless technologies can be employed for indoor positioning applications. Some systems make use of an existing wireless network infrastructure such as Wi-Fi. More flexible and efficient systems employ IEEE 802.15.4 Wireless Sensor Networks (WSNs) due to the advantages in term of low power consumption, light weight and low cost.

Existing indoor localization systems[4] can be classified into three types based on the structure of service areas. These include the indoor localization systems for two-dimensional service areas, three-dimensional service areas, and multi-story building. Most of existing systems are designed for usages in two-dimensional areas where the position of target object is specified by a coordinate (x, y). The second type of the indoor positioning system considers a three-dimensional space in a small service area, such as in a room. The state of the object location is derived in the form of coordinate (x, y, z). Lastly, the positioning systems designed for the indoor multi-story building need to specify not only coordinate (x, y) in two-dimensional plane but also the floor where the object Located.

Compared with outdoor localization, the difficulty of indoor localization lies in that indoor maps pay more attention to small areas, large-scale, high precision and subtly display of the internal elements. Along with the rapid development of wireless net- works and smart phones, the number of WIFI access points[7] increase dramatically and most WIFI access points' locations are fixed. This phenomenon suggests a new direction for indoor localization research in wireless sensor network.

Existing wireless localization algorithms require either special hardware support or complex computing, which consuming valuable battery resources greatly, especially comes to smart phones or sensors. The contribution of this paper is that it proposed a new algorithm which increases the indoor localization[6] accuracy without any additional hardware support or increasing the computational complexity.

2. Literature Survey

2.1 GPS(Global Positioning System)

GPS is used for the location tracking in the outdoor environment. Global Positioning System (GPS)[9] is a worldwide radio-navigation system formed from the constellation of 24 satellites and their ground stations. The Global Positioning System is mainly funded and controlled by the U.S Department of Defense (DOD). The system was initially designed for the operation of U. S. military. But today, there are also many civil users of GPS across the whole world. The civil users are allowed to use the Standard Positioning Service without any kind of charge or restrictions.
Global Positioning System tracking is a method of working out exactly where something is. A GPS tracking system, for example, may be placed in a vehicle, on a cell phone, or on special GPS devices, which can either be a fixed or portable

unit. GPS works by providing information on exact location. It can also track the movement of a vehicle or person. So, for example, a GPS tracking system can be used by a company to monitor the route and progress of a delivery truck, and by parents to check on the location of their child, or even to monitor high-valued assets in transit.

A GPS tracking system uses the Global Navigation Satellite System (GNSS) network. This network incorporates a range of satellites that use microwave signals that are transmitted to GPS devices to give information on location, vehicle speed, time and direction. So, a GPS tracking system can potentially give both real-time and historic navigation data on any kind of journey.

GPS provides special satellite signals, which are processed by a receiver. These GPS receivers not only track the exact location but can also compute velocity and time. The positions can even be computed in three-dimensional views with the help of four GPS satellite signals. The Space Segment of the Global Positioning System consists of 27 Earth-orbiting GPS satellites. There are 24 operational and 3 extra (in case one fails) satellites that move round the Earth each 12 hours and send radio signals from space that are received by the GPS receiver.

The control of the Positioning System consists of different tracking stations that are located across the globe. These monitoring stations help in tracking signals from the GPS satellites that are continuously orbiting the earth. Space vehicles transmit microwave carrier signals. The users of Global Positioning Systems have GPS receivers that convert these satellite signals so that one can estimate the actual position, velocity and time.

A passive GPS tracking system will monitor location and will store its data on journeys based on certain types of events. So, for example, this kind of GPS system may log data such as where the device has traveled in the past 12 hours. The data stored on this kind of GPS tracking system is usually stored in internal memory or on a memory card, which can then be downloaded to a computer at a later date for analysis. In some cases the data can be sent automatically for wireless download at predetermined points/times or can be requested at specific points during the journey.

An active GPS tracking system[9] is also known as a real-time system as this method automatically sends the information on the GPS system to a central tracking portal or system in real-time as it happens. This kind of system is usually a better option for commercial purposes such as fleet tracking or monitoring of people, such as children or elderly, as it allows a caregiver to know exactly where loved ones are, whether they are on time and whether they are where they are supposed to be during a journey. This is also a useful way of monitoring the behavior of employees as they carry out their work and of streamlining internal processes and procedures for delivery fleets.

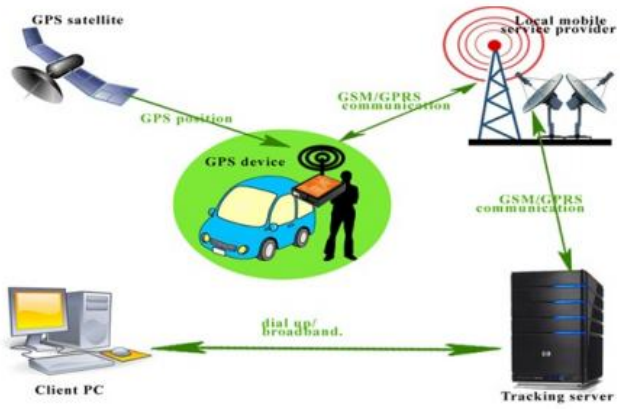

Figure: Working of GPS

The GPS satellite gives the exact position of the device which is situated in the Car. This device is in turn which is connected to the local GSM service provider via a GSM network as it has SIM card present in it thus the GPS parameters which the device has are send to the tracking server which has a Static IP address via a GPRS network.

The tracking server consists of a Socket listener application running in the background which listens at a particular port. The GPS parameters received by the port listener[9] are given to the Parser and converter for proper conversions and this data is stored in the database. These values from the database are fetched and are manipulated to get the reports in proper format.

But the basic drawback of the system is that the GPS signal does not work in the indoor environment. These signals cannot be used for the tracking purpose in the GPS isolated area because of the poor signal strength in the indoor environment

2.2 Fingerprinting

Indoor pedestrian tracking[9] extends location-based services to indoor environments. Typical indoor positioning systems employ a training/positioning model using WI-Fi fingerprints[9].While these approaches have practical results in terms of accuracy and coverage, they require an indoor map, which is typically not available to the average user and involves significant training costs. A practical indoor pedestrian tracking approach should consider the indoor environment without a retrained database or floor plan. Using the fingerprinting technique[9] the indoor plan of the floor can be constructed using the smartphones it uses inertial[2] sensors, an observation model using Wi-Fi signals, and a Bayesian estimation for floor-plan construction.

Fingerprinting is a two-phase approach to localize a device based on radio frequency signals. . In the first phase, also called “pre-deployment” or “offline”, data is collected which is then used in the second phase, called “real-time”, to localize a device. Wi-Fi Compass requires an algorithm, which is able to localize a user without a “pre-deployment” phase. As a result, Fingerprinting is not a feasible approach for indoor localization

3. Indoor tracking

3.1 Technologies for Indoor Localization

There are many wireless localization technologies and solutions. The commonly used localization techniques include infrared, ultrasonic, radio frequency signal, Blue-tooth, and Ultra-Wideband, WIFI but they are not suitable for indoor localization.[6] Infrared is only suit-able for short-distance transmission, and could easily be influenced by fluorescent lamp or the light in the room, there are limitations on the localization accuracy; ultra-sonic, Bluetooth and Ultra-Wideband require special equipment, the cost is too high, hence they are not widely used; RF signal does not have communication capability, and is not easy to be integrated into other systems.

But currently there are number of indoor WIFI access points[7] which are offering the services for free. So WIFI is the most used technology.

3.2 Algorithms for Indoor Localization

Conventional methods for indoor positioning[8] are based on time of arrival,[5] time difference of arrival and angle of arrival of radio signals transmitted by mobile stations. For these methods to accurately estimate the location of a receiver, line-of-sight (LOS) between the transmitter and the receiver has to be ensured. Furthermore, specialized time synchronization hardware is required to be integrated into the existing equipment. These requirements increase the cost of implementation considerably.

But because this algorithm does not require any additional hardware support and has the higher accuracy for the indoor localization[4][6] this is widely accepted and used technique for the indoor localization.

4. GPS isolated area tracking with WIFI routers and Mobile sensors(Proposed work)

In the indoor environment[4][6] with each WIF routers there are some attributes. In our system we will be using the strength that is the level and the frequency for the calculation of the distance of the mobile from the WIFI routers. But as we are dealing with the accurate location finding and also less consumption of the battery we take the assistance from the mobile sensors. The smart mobile[1] has the number of the sensors embedded within it. But for our system we use the accelerometer and the orientation sensors. We calculate the distance value to plot the mobile device location and to check whether the user is moving to check speed and the path change we take the sensor values.
The system has one web application and one application running on the smart mobile. The smart mobile user first download the map of the indoor environment for which he wants to enable the navigation with login in to the system. The user gets the map on the smart mobile. With the search function user can search for the desired position and can enable the navigation to reach to the destination.

We are taking the assistance from the mobile sensors[2][3] also for the low battery consumption and for the more accurate location of the smart mobile in indoor location and to find out the movement of the user

The system offers the technique for the localization of the indoor and the GPS isolated areas. This technique uses the Wi-Fi routers[1] and also the sensor information for the accurate calculation of the position and to save the battery life of the smart mobile user

5. Conclusion

This paper provides technique for indoor tracking using the WIFI routers. The Smartphone sensors accelerometer and the orientation sensors are also used to find out the accurate location of the smart mobile. These techniques don't require any additional hardware and as the sensors require very less battery consumption than the GPS it can be used to save the battery life.

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