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Indoor Tracking Using Wi-Fi Access Points

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ABSTRACT: Locating the person using wireless network is very unique and key technology. We are familiar with GPS technology but it can be used only for outdoor locations, when we deal with the indoor locations GPS does not work. Indoor locations include buildings like airports, huge malls, big parking, universities and locations under the same roof. Along with this, also when the GPS is used in the mobile device it uses a lot of the mobile battery to run the application which causes the drainage of the mobile battery within few hours. So to find out the accurate location for indoor environment we use the various algorithms like RSSI and Fingerprinting**.** The above algorithm has the low cost and the algorithm does not require any additional hardware support and along with this the algorithm is easy to understand and implement. The algorithm uses very less battery as compared to the battery consumption of the GPS. Due to these good features the RSSI algorithm has become important algorithm in the wireless sensor networks. The mobile smart devices detect three or more known WIFI access points, and using the values from the WIFI routers it calculates the current location of the mobile device. In this paper we have served various techniques which can find out the exact location of the mobile device under the indoor environment and also can enable the low consumption of the smart mobile battery for the tracking purpose.

KEYWORDS: GPS, RSSI, Fingerprinting.

I. INTRODUCTION

GPS is most efficient technique used for tracking, but it can be used only for outdoor locations. When we need the indoor localization or tracking, GPS is not at all use full. GPS can be used only for outdoor locations and not for indoors. Indoor locations include buildings like supermarkets, big malls, parking, universities, and various other infrastructures with wide area. In these areas the accuracy of the GPS location is greatly reduced. When GPS is used for indoor localization, the map shown by GPS is not much correct. But for the indoor localization it requires the

Higher accuracy so GPS is not compatible for indoor tracking. And also when the GPS is used in the mobile device the amount of battery consumption is quite more as compared to other applications.

Indoor tracking can be very useful in large buildings such as airports, shopping malls and enterprises during emergencies. Indoor localization provides vital services for mobile and general applications such as advertisement of a product or promotion of new shops in shopping mall. It can also be very helpful for navigation during emergency rescue. Now a day, mobile phones have become the most important information interface between users and environments, motivating extensive research on localization based on smart phones.

In recent few years, localization of indoor things such as pedestrian or rooms or exit doors in a building has become a true requirement for which a variety of technologies have been introduced in order to obtain the good accuracy. The challenge is in developing map based floor plans of interiors, selecting the effective indoor positioning technology and various efficient algorithms and deploying the proper indoor positioning devices for the buildings. The existing systems that offer in door localization services mostly use different wireless technologies like Wi-Fi, RFID Tags, Bluetooth, signals of cellular towers and ZigBee. Existing indoor localization systems can be divided into three types based on the structure of service areas. The three types of indoor localization systems are, 2D (two dimensional) service areas, 3D (three dimensional) service areas, and multi-story building.

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II. GENERAL SYSTEM ARCHITECTURE

Given Below is the general architectural diagram of the system. 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.

The system takes the assistance from the mobile sensors also for the low battery consumption and for the more accurate location of the smart mobile in indoor location. In the environment we can't guess the user behaviour the user might be at one position or he can take the turns the speed variation all these behaviour can be pointed out using the accelerometer and the orientation sensors. These sensors send the location samples to the server and those are plotted on the map and the trajectory is made. The mobile sensors and the WiFi routers can be used for the indoor localization because of the accuracy and the consumption of the less mobile battery.

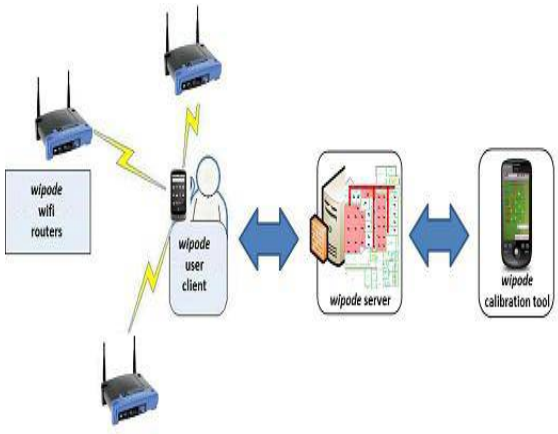

Fig 1: General System Architecture [2].

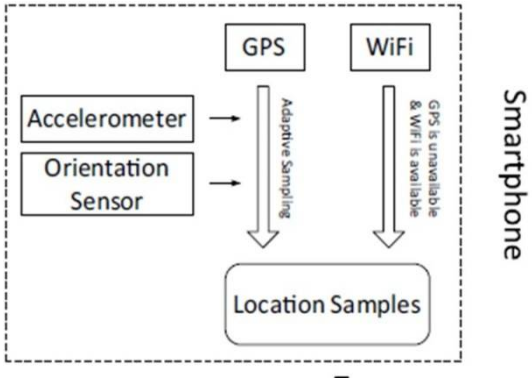

Fig 2: Architecture of Smartphone [2].

III. RELATED WORK

Various systems have been developed for indoor localization. Some of important systems that are developed are discussed below.

A. *GPS (GLOBAL POSITIONING SYSTEM)*

GPS i.e. Global Positioning System is the system that is used tracking the location for outdoor environment. It cannot be used for tracking of indoor things. GPS is formed from constellation of twenty four satellites [3] [4]. Initially the system was developed for U.S. defence purpose only [3] [4]. But later the use of GPS was permitted to all the civilians. GPS is open source i.e. it is available total free of cost. The special GPS are developed which are fixed or portable unit. Global Navigation Satellite System (GNSS) is used for GPS tracking. The microwave signals are transmitted from this to GPS device to give information of location of a particular thing. Hence GPS tracking system potentially gives both real-time and navigation data on any kind of journey.

B. *FINGERPRINTING*

Fingerprinting also known as mapping or scene analysis is the approach that is used for tracking which is based on geometrical measurements. Fig 4 shows the basic idea of fingerprinting is to build a database with features of the scenario at reference locations and then apply regression techniques to match the measurement and infer current position. It consists of access point's database to store results and fingerprints. Fingerprinting can be classified basically into types as follows [1] [6].

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1] Offline training phase:

The scenario is surveyed at known locations, and the features of the environment at each location are then recorded into a database. These features are referred to as fingerprints and could be RSS, magnetometer measurements, or any other type of data that is position-dependent. For instance, when RSS is considered for fingerprinting, the database is composed of the coordinates of the training location, and the RSS of the nearby AP's measured at that location.

2] Online phase:

Online phase is also known as operating phase, as in this stage actual tracking is carried out. This phase needs offline phase as pre requisite. This phase includes the process where the mobile node navigates from one point to other, while sensing the same type of fingerprints that were recorded in the database. The results that are obtained are then used to perform matching with the content of the database and provide a correct position of mobile device which is handled by user.

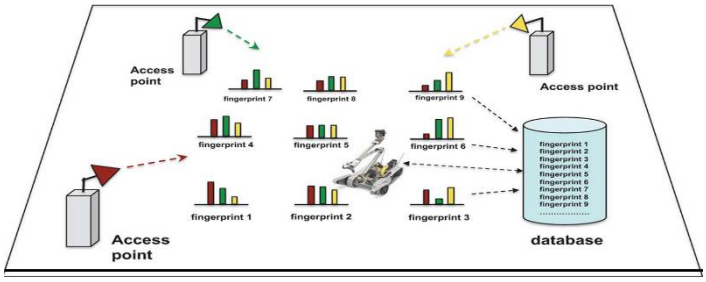

Fig 3 Example of fingerprinting using RSSmeasurements from Wi-Fi access points [6].

C. ***DEAD RECKONING (DR)***

Dead Reckoning is the tracking system which determines the current position of a thing by using the knowledge and information from previous known location. It can also be useful to predict the future locations, by analysing the current location.

Indoor tracking can be done by using DR technology along with the help of some other techniques. Working of DR can be classified into two methods [1].

1] First method uses the accelerometer and magnetometer which help in analysing reference direction towards the gravity. The accumulation of orientation error is avoided which is one of the advantage of this method. The limitation of this system is that, the extra errors will be produced due to imperfect separation of gravity signals from linear acceleration imposed on phones.

2] The second method is to use the sensors with gyroscope, which are less noisy and error free. They are also not affected by external interface. But they cannot measure the angular position, instead of that they can only measure angular velocity because of which only relative movement of phone can be known with help of gyroscope readings [6]. The heading direction can be efficiently found out by merging these two techniques. The raw values as received of accelerometer, magnetometer, and gyroscope are given as inputs to the filter and output is estimate of azimuth, pitch and roll of the phone in global home.

D. ***PARTICLE FILTER (PF)***

The important challenge in field of indoor localization is to reduce the accumulation of localization error over time. The localization error accumulation should be able to minimize by using particle filter. It uses a sampling method, which makes the analysing and updating the new information that is acquired after periodic interval. Partial Filter can

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be efficiently used to handle obstacles like walls or doors. The performance of PF varies as the number of particles is tackled [1] [6].
Particle Filter consists of three major models.

1] Motion Model: - Motion model is used to update the positions of particle after a fixed interval of time.

2] Observation Model: - It sets the particle weight.

3] Re-sampling Algorithm: - This algorithm modifies the distribution of particle which helps in reducing variance.
The information that is obtained from DR system is used as pre-requisite to derive the motion model.

E. *MAGICOL(A MAGNETIC FIELD BASED INDOOR LOCALIZATION)*

Magicol is the system which uses the magnetic field for indoor tracking and localization. It is beneficial for Smartphone users. This system uses the device called as magnetometer which is present in almost all Smartphone. It does not require additional setup of hardware. Magicol is very efficient as it uses the magnetic sensing that consumes very little amount of energy and also it can be used for all indoor environment. Recognizing that the indoor geomagnetic field anomalies are ubiquitous, location specific and temporally stable, Magicol leverages the locally disturbed magnetic signals as location-specific signatures [4].

During implementation of Magicol it comes across three main challenges which are discussed below:

1] Magnetic signal as not much distinguishable. A signal observation cannot be used or cannot be considered as a reliable which is used as unique location signature. In Magicol we collect the user motion to form a set of multiple observations and it is called as vector. This vector is then compared with pre-determined Magnetic Signal Map (M-Map). M-Map is the offline map that is already created and stored in database. User may walk randomly in any direction or can stop or start to walk at any point. To handle such complexity the vectorization is out on per-step basis.

2] Secondly Magicol is not dependent on WiFi or access points. It can work in infrastructure which is not supported with WiFi or any other access points.

3] Thirdly, as in Radio Frequency indoor localization system the database of indoor may need to construct in advance. This is major challenge and has been studied recently here they proposed a complaint walk (CW) based solution for site survey. In this system the person who is dining survey needs to walk along the pre-determined path. The mobile device analyses and collects sensor readings and magnetic signals which surveyor is walking. Then the actual walking traces are compared with survey path through dynamic programming and form the tracking path [4].

F. *HORUS SYSTEM*

Horus is a Radio Frequency based indoor location determination system. Current working of Horus is been done in the context of 802.11 wireless LAN's. Horus uses the Received Signal Strength (RSS) technology. In this technology the signal strength this measured to find the location. WLAN location determination system consist of two types: client based and infrastructure based. Horus works basically into two phases, offline phase, and online phases [5].

1] Offline phase: - In offline phase, initially the construction of radio map is done. Clustering of radio map locations and pre-processing of the Received Signal Strength model is performed.

2] Online phase: - In online phase, the actual tracking is carried out. Here the user location is found out by using the Received Signal Strength from each access point and radio map, which is constructed in offline phase [5].

Horus is the system that lies in the category in which multiple possible outcomes occurs. It is designed to satisfy the two major goals: first is high accuracy and second are low computational requirements. Horus system analyses the various causes of wireless channel and helps in solving them to achieve high accuracy.

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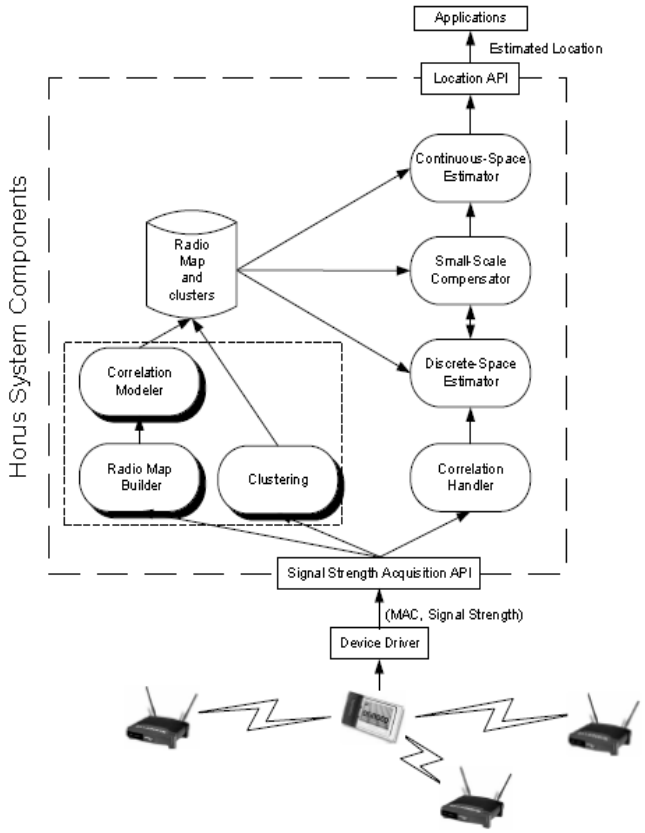

FIG 4: Components of HORUS [5]

G. ***MADT***

MADT i.e. Motion Assisted Device tracking, is a unique and efficient algorithm which is used for quick localization of target devices. It does not require any additional labour survey of site and also it does not require any access point. MADT uses the fundamental rules of RSSI and environmental factor such as direction and distance instead of signal entries from access points. This help to guide the user to move gradually towards the direction of target [7].

MADT can be combined with either Bluetooth or WiFi to form a complete system for indoor tracking. But the challenge is to find out, which of these two technologies are efficient for use along with MADT. After comparing both Bluetooth and WiFi in terms of various attributes, the obtained result shows that Bluetooth will be more efficient then WiFi for MADT [7] [10].

Basic idea of MADT is to set the target device as signal emitting source which send the signals and gradually draws the user in its own direction. The movement of user shows certain pattern which supports the rules derived in empirical study. It uses two basic rules: Rule 1 – It decides whether target in close range or not. Rule 2 – To find the direction of search i.e. target. The pseudo code for MADT is divided into four parts.

1] Selecting the start point: - Choose the starting point of the search area manually.

2] Calculate the RSSI reading: - Place the receiver facing towards all four directions and calculate the distances.

3] Choose the search Direction: - Identify the correct quadrant by considering the gained RSSI values from step 2.

4] Identify whether the target is closer or user or not.

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IV. CONCLUSION AND FUTURE WORK

We have studied 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. We mainly introduce a new tracking system that relies on Bluetooth and Wi-Fi simultaneously. The main aim is not only to make the best utilization of the existing infrastructure available in an organization but make the deployment of the system most commercially viable by using technologies that are already available with the consumers.

The In the future the system can be integrated with the outdoor tracking and positioning to form the complete system which will help the user to enable the tracking for both indoor and outdoor locations. Future scope of the system lies there in the efficient indoor navigation system which cans be useful in many places. Accuracy in positioning can be improved a lot with the combination various technologies like Bluetooth, GSM and RFID's. Indoor system for user and device tracking for security reasons can also be the future scope of the system.

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