IJCAT - International Journal of Computing and Technology, Volume 7, Issue 3, March 2020
ISSN (Online) : 2348-6090
www.IJCAT.org
Impact Factor: 0.835

Indoor Location Identifier Using Wi-Fi

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Abstract - Indoor location identification of a person is used to track and locate the user inside the building. One of the emerging and significant technologies in wireless sensor networks is location tracking by using wireless technology. Global Positioning System (GPS) can mainly be used for outdoor areas. It cannot be used to track the user inside the building as there is no direct communication with the GPS satellites. The proposed system is helpful for all, particularly for wide land area organizations to locate a specific person's location within the workplace. This system intends to incorporate greater user-friendliness in different tasks such as location updates, maintenance, and searching. The exact indoor location can be determined through the Received Signal Strength Indication (RSSI). This paper presents a system that result in finding out the exact location and tracking of the mobile device in the indoor environment.

Keywords**:** *Indoor Localization, Mobile Application, Received Signal Strength, Wi-Fi Access point localization.*

1. Introduction

The locating system has always been in human's thought, following back to the past times when human beings used to follow the guiding-star for navigation. Since then, there has been a great technological development. Today, in an organization when one person wants to search for another person for some work then they can use their mobile phones. By talking on the mobile phone, we get to know where a particular person is, but if mobile phones are not reachable, then there is no easy way to reach out to a person. The second way is, in which a person can go in the entire organization to search for their colleagues physically. This way is helpful if the organization is small but if the organization is large then this way is not suitable. Because searching for a particular person in the entire organization is a tedious task. So to overcome this problem a system is designed which can easily track a person's location in a wide organization. There is a huge demand for offering applicable indoor positioning solutions, since people spend 90% of their time, and 70% of made phone calls occur when indoor. The wide use of the smartphone market and location-based services lead to the development of positioning systems with relatively high accuracy.

In the outdoors, the smartphone uses the Global Navigation Satellite Systems (GNSS), such as the Global Positioning System (GPS), which works by satellites positioned a thousand miles from the ground. Such efficiency, however, is diminished while approaching the indoor. This is attributed to the obstruction of the GPS signals by the roofs and walls of the buildings, as well as the indoor complex structure. GPS restriction contributes to difficulty in designing a modern indoor tracking system.

Traditionally, indoor location tracking or positioning systems are built based on different infrastructures, such as Wi-Fi, Bluetooth, and RFID. Recently, Wi-Fi has been the focus of attention for location identification techniques mainly due to the existing infrastructure to support Indoor Location Identification, as well as being readily deployable and cost-efficient. Mobile phones have now become the most significant medium for communication between users and environments, encouraging extensive research on smartphone-based localization. Modern smartphones typically include the following multi-sensors: Global Navigation Satellite System (GNSS), barometers, magnetometers, accelerometers, gyroscopes and Wi-Fi and Bluetooth transceiver modules. Wi-Fi coverage for indoor

environments is normally 5-15 meters. This is because access points are usually used whose position has been optimized for data communication. This accuracy relies on the walls, doors, artifacts or persons and even the number of access points. Using smartphone sensors will produce improved performance, and it is even possible to assess floor level. The precise indoor location can be found out by using the RSSI. RSSI doesn't need the additional hardware, and it's simple to understand. Using Wi-Fi access points and mobile devices, the RSS values are determined. This paper describes a method that aims to identify and track the precise location of the mobile device in the indoor environment.

The aim of this paper is to describe about the proposed Indoor location identifier using Wi-Fi. The rest of this paper is organized as follows. Section II describes about existing Indoor Positioning System techniques like angle of arrival, received signal strength, time of arrival. In Section III we introduce the proposed model of indoor location identifier using Wi-Fi. Section IV is about the result of the proposed system. In Section V we discuss the future scope of the system. Finally describe conclusion in Section VI.

2. Existing Indoor Positioning Techniques

For the indoor location tracking system the most frequently used technology is Wi-Fi. This is a standard and affordable technology that many people use that has the basic components and, at the same time, Wi-Fi does not need extra equipment to help to track indoor locations. This technology is compatible with an electronic device that uses radio waves to communicate information over the air. Wi-Fi tools such as smartphones typically communicate over 2.4 GHz but today 5GHz is commonly used for communication because 5GHz channels have less vibration, less interference, higher rates and more stable.

With Wi-Fi technology different forms of position estimation and location determination are done. However, the fingerprinting approach dependent on Wi-Fi signal strength is often used in the case of Wi-Fi-based indoor localization. Generally, the indoor tracking system requires two components: a base station with known location information, and a device (user) that needs to know the location. For Indoor location tracking, certain methods are used, such as time of arrival, angle of arrival and received signal strength and fingerprint.

2.1.Time of Arrival (ToA)

ToA is the transit time of a radio signal from a base station to a user. The interval between the base station and the user is determined from the absolute time and the known signal speed. A TOA specifies a circle of possible locations in the two-dimensional area. This circle has its middle point at the base station and its radius corresponds to the distance.

2.2.Angle of Arrival (AoA)

AoA of a signal is the direction from which the signal is obtained. This methodology appraises the user's location from the convergence of over two direction lines. However, signal reflections could lower accuracy.

2.3.Received Signal Strength

Received Signal Strength (RSS) and fingerprint approach needs to survey the site in advance. Signal strength and distance to the base station are estimated at each pre-defined point. Since the multipath effect provides a unique signal to each location, the user's location can be derived from the signal's fingerprint data. This pre-measured database gives the statistical probability of the user's possible location for given signal strength. The accuracy of this method depends on the distances between the points, the signal differences and the database for RSS and fingerprints.

3. Proposed Model

This paper proposes an indoor location tracking solution based on measurements of the Wi-Fi signal and the inertial sensor. The solution can be used as a localization application that uses smartphones to track people indoors. This solution precisely locates people indoors when they carry their smartphones. Figure 1 shows the block diagram of the proposed system. The location calculation is based on the following measurement.

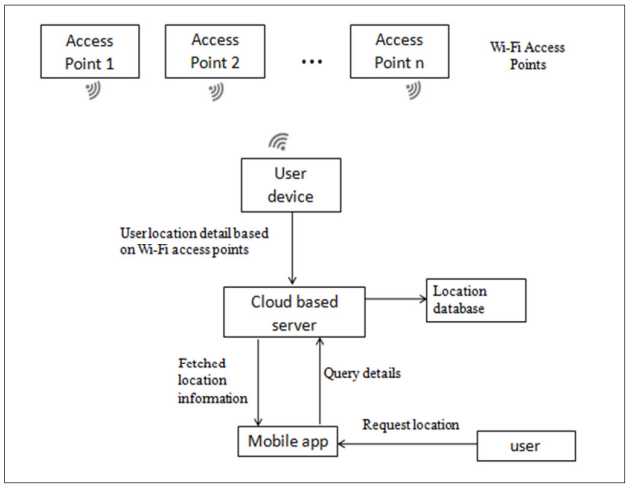


Fig. 1 Block diagram

By receiving the signals from the Wi-Fi access point, the method estimates the proximity between the Wi-Fi access point and the smartphone using RSS measurements. The strongest Wi-Fi access point signal is then selected from all available Wi-Fi access points. The positioning technique does not require the mobile device to establish a connection to a wireless access point (AP) but only has to acquire the signal transmitted by the access points. This feature is valuable because most APs are often encrypted with passwords, making the system that requires a connection to the AP's impossible. The system only needs to measure the strength of the radio signal to estimate the location of the users. Then, the proposed method defines the position of the smartphone by merging the measured RSS proximity level with the sensor measurements. In the model of the location fingerprinting based system usually works in two phases:

In the offline phase, reference points are selected at a major location and distances from AP to reference points are calculated offline and AP details are stored in the database.
The actual monitoring is done in the positioning phase. Here, the person's location is determined based on the signal strength received from each access point and the data available in the database, which are created in the offline phase.

Modules present in the proposed system are as follows:

3.1 Server module

In the server module the information about the access point's location, MAC address are stored in the access point details table. The user table is maintained to store user details. The tracking table is used to store the data about a person's last location at regular intervals. The user should register and after successful verification, mail id and password are sent to the user's registered mail id. The user could log in using those credentials to find the location. Once the registration is successful the tracking of the user is started. That is the Wi-Fi is enabled all the time and the app in the phone sends MAC address, access point connected and other details to the database at regular intervals. The server matches the MAC address of AP in the database and retrieves the location of AP. Then it finds the minimum RSS value among all AP's and stores in the tracking table.

3.2 Current location identification

After successful registration, the user gets access to the application. If the user is not aware of his current location he can just click the current location button. It displays the current location of that person. The current location is identified by searching for the nearest access point based on the strength of the received signal. Then its MAC address is sent and using the details stored in the access point table the location is displayed to the user.

3.3 User module

In this module, the registered users can find other registered person location by entering their unique identification number or roll number. This system provides information about any person with the help of data collected from the Wi-Fi device of every registered user and is stored in the database. In user's smartphones, Wi-Fi is enabled all the time and the application in the phone sends particular data to the server at regular intervals. The data is updated in the database. When a user requests the location of another user, the data is retrieved and the last location visited by him is shown to the user. This can also be used to find the history of places visited by a person.

4. Experiment & Result

The RSS is calculated in dBm (decibel-milliwatts). The RSS value is calculated between the mobile device and existing APs. Table 1 consists of the gained signal strength at a particular distance. The distance is calculated in meters whereas the RSSI is calculated in dBm. The results were obtained from the single Wi-Fi access point. Figure 2 shows the accuracy of the proposed system. The test was done with five persons and three rooms. Out of five, three persons location was got right.

Table 1 RSSI at Particular Distance

S. No	Distance(m)	RSS (dBm)
1	1.5	-53
2	5	-60
3	9	-70
4	14	-79
5	25	-86

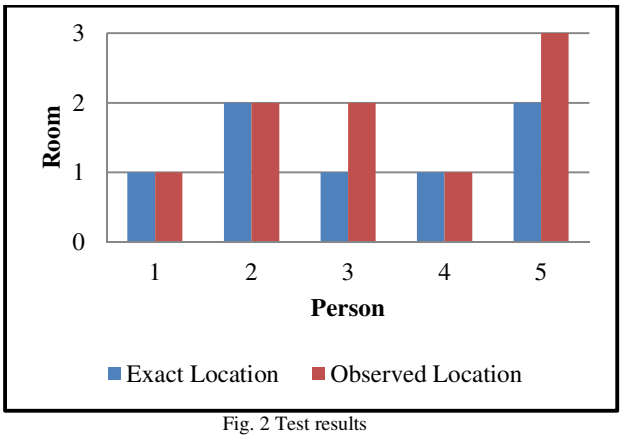


Fig. 2 Test results

The measurements have been carried out in working hours with humans walking around and the Wi-Fi internet being used. The system performance is demonstrated through the IEEE 802.11. The range of the RSSI will increase because the human behaviour impacts the propagation path of the real signal of APs, which causes the RSSI to increase/decrease instantly. The RSSI value is in negative form. If the value is close to zero, it means that the signal strength is high. It can be seen that the larger the number of Wi-Fi access points, the higher the positioning accuracy. Using this technique the person's last location is easily identified as in figure 6. Below are some of the screenshots of the proposed system.

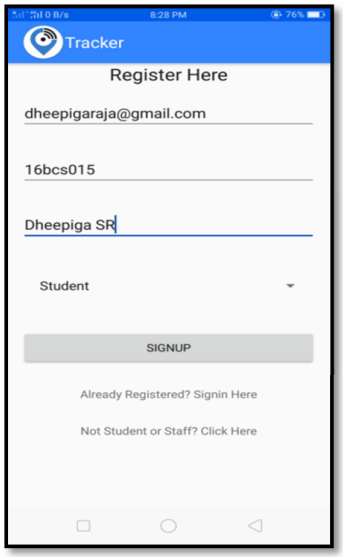
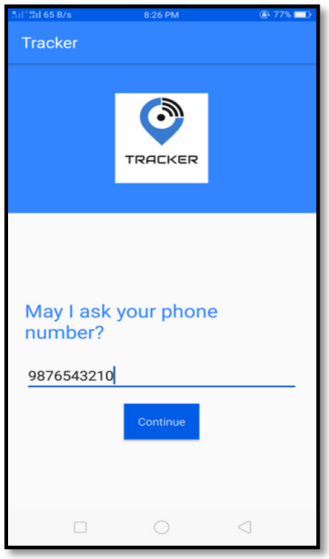


Fig. 3 Registration page



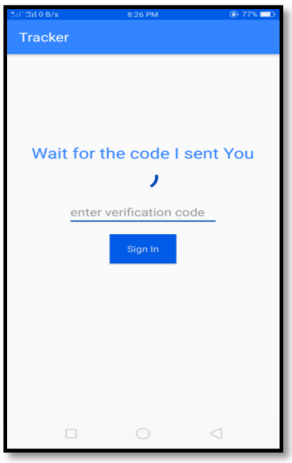


Fig. 4 Guest Registration

5. Future Scope

Future scope of the system lies there in the efficient indoor location tracking system which can be useful in many places. High accuracy is important to identify the location of the users. Accuracy in positioning can be improved a lot with the combination various technologies like Bluetooth, GSM and RFID's. Intuitively, adding more access points would increase the accuracy of the location. Servers are not just installed, they must be even maintained. This can be done by using platforms and tools that help us monitor our application, update parts when needed, and ensure it operates properly. It must be done automatically as much as possible in the future. Indoor system for user and device tracking for security reasons can also be the future scope of the system. Today, smartphones are equipped with built-in sensors to improve the user experience, provide applications with better information about the world around the phone and provide robust and increased battery life. Since the smartphone sensors are being developed it can improve the accuracy of tracking or localizing in the future.

Fig. 5 Menu page

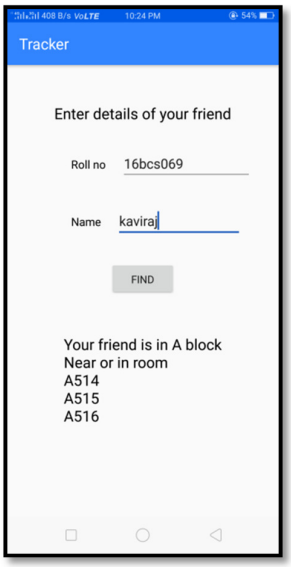


Fig. 6 Location of a friend

6. Conclusion

There are large organizations, where a number of people work together. Each person is related to every other people in terms of work. One need other's help or advice to complete a work. For this purpose, one needs to search them which is a tedious task. Our proposed system will solve this problem within a few seconds. Without any delay, the user can find the last visited location of a person inside his organization. Since this reduces time and stress and would be useful in large organizations where more number of people is present. The new person entering a new building and searching for a person is a very hectic task for them. Using our system, everyone can start a guided tour from their current location. They do not need to worry about being late for finding out a person.

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