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Wi-Fi Indoor Positioning System to Implement Faculty Tracking

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Abstract: ***The swift development of Internet and an enormous increase in Smartphone usage has offered the open door for Wi-Fi indoor positioning to go under the spotlight because of its ease. In any case, the precision of Wi-Fi indoor positioning has never been able to meet the needs and hence was far from being practically implemented. This project demonstrates the use of Indoor Positioning System. We are all familiar with the term GPS (Global Positioning System). GPS helps us with tracking an object outdoors. It returns the latitude and longitude values of the object to be tracked. GPS fails to track an object indoors. We cannot determine the position of an object to its exact position when it is inside a multi-storied building. Indoor Positioning System helps us in tracking an object when it is indoors, and we are going to implement the same to track faculty with precision up to the floor and room number.***

Keywords: location, network, android, positioning, indoor positioning, Wi-Fi positioning

1. Introduction

Locating the faculty in our university campus has become a bit difficult after the faculty selection was implemented. The IT department was limited to the 3rd, 4th and th floors of the Technology Park but after the faculty selection classes have been happening all over the building. To locate a faculty, we must search for them in their respective staff rooms and if you can't find, then search for them everywhere. Indoor positioning system helps us to locate the faculty easily with the help of an android application.

It takes a lot of time to locate the faculty often delaying the work. Also, the faculty keeps moving and it becomes even more difficult to find them. The students don't have access to faculty schedules to know which class they'll be in at any specific time. It can also be disturbing to the faculty if everyone contacts him/her to know his whereabouts.

To tackle the problem mentioned above we are going to develop an application which makes it easy to locate the faculty. The Application returns the location of any faculty in almost no time, making the whole process very smooth and fast. It returns very accurate details of the faculty's location with timestamps thereby making the application very reliable. The Application can be used to find out if the specified faculty is present in the building.

Faculty location tracking has become tough after the classes have been happening all over the building due to the newly implemented Subject Selection. It consumes a lot of time and energy for the students to search for the faculty. Contacting the faculty to know his whereabouts might be very disturbing to the faculty as they are always busy with their classes and shuttling across them. So, this problem of locating the faculty opens an opportunity for us to rectify the same issue.

2. Related Works

The term Wi-Fi indoor positioning is not something new and hence there have been quite a few methodologies developed for its implementations. There are three major positioning algorithms, namely: Proximity algorithm, triangulation algorithm and scene analysis algorithm.

A. Proximity Algorithm

This positioning algorithm relies on the proximity relationship between the workplace and Wi-Fi access points to estimate the location of the workspace. When there is a mobile device in the simulated environment which is surrounded with many different access points, the connection details of the access point with the greatest signal strength are picked to determine the location of the mobile. How accurately this algorithm works is determined by the distribution density and signal range of Wi-Fi access points.

B. Triangulation Algorithm

The positioning algorithm uses the geometric properties of triangles to estimate the location of an object. There are three parameters that we will be needing to use for this method; Time of arrival (TOA), Angle of arrival (AOA) and Received Signal Strength (RSS). When the smartphone at the target place scans more than onethree networks, the three parameters mentioned above are extracted from the Wi-Fi signals to calculate the distances between the target place and Wi-Fi access points. With the connection information of three or more Wi-Fi access points, the target place can be estimated by the principle of triangulation.

C. Scene Analysis Algorithm

This algorithm, in the beginning collects some data called as fingerprints and it then tries to locate an object by matching the data recorded by the object online with the pre-recorded fingerprints. The most common type of scene analysis is in the form of signal strengths of the access points or beacons used. There have also been cases where GPS, magnetic field strength and radio frequency were used as fingerprints.

This approach to positioning can also be called as traditional fingerprinting algorithm and is of two types; online and offline. Moving on with the offline process,

there is a thorough check done on the site and details are jotted down. Signal strengths are taken along with the position parameters of access points to help in position retrieval. Next is the online stage wherein the pre-recorded data is matched with the live data recording from the target device. Since it happens really quick and in real-time, hence the name online. The real issue to the procedures in light of location fingerprints is that the got flag quality could be influenced by diffraction, reflection, disseminating and assimilation amid the proliferation in indoor conditions.

D. Related Researches

There have been many researches conducted on Wi-Fi positioning based on the above algorithms and we can safely say that though proximity algorithm is easier to execute, it is not precise enough. It can only act as a secondary support to our location positioning, adding that additional details. In the second algorithm of triangulation, since it is based on geometry of locations of the access points, we can say that its scope is limited. The last algorithm of scene analysis answers pretty much all the questions of stability, accuracy and being independent of location of access points, thereby playing a vital role in Wi-Fi indoor positioning.

The past inquires about on offline stage are for the most part centred around enhancing the nature of the database of fingerprints. For instance, Husen recommended that individual course ought to be contemplated when gathering Wi-Fi flag qualities. Galvn-Tejada displayed an augmentation and change of current indoor restriction demonstrate in view of the component extraction of 46 attractive field flag highlights. By adding more helper elements to Wi-Fi flag fingerprints in the offline arrange, it will help the online positioning to be more exact as in. The administration and use on the database of fingerprints were contemplated in. Atia and Yoon give their approach to refresh the database of fingerprints consequently. Koweerawong and Jung proposed two strategies about how to arrange the database of fingerprints. In spite of the fact that they didn't enhance the positioning exactness, they figured out how to enhance the proficiency of calculations.

Moreover, Aomumpai contemplated how to streamline the arrangement of gathering focuses, which could enhance the area execution. With respect to the online stage, the past investigates on online stage for the most part centred around how to enhance the precision of positioning. Snchez-Rodrguez and Chen specified the sensor combination, however additional sensors are vital, which would expand the cost of positioning. Tune proposed a weighted fingerprinting approach in view of the connection between the normal esteem and the standard deviation of Wi-Fi flag quality. The information combination technique is connected to the Wi-Fi positioning. Yang and Li both proposed new calculations coordinating conventional calculations. In the meantime, more explores received machine figuring out how to propose new calculations. The looks into on online stage are inexhaustible, however some of them may take excessively time and estimation. While particular to positioning applications, Laoudias displayed indoor positioning frameworks created for Android cell phones. However, their precision is not satisfactory. That shows that picking between the exactness and the viable application merits considering.

In spite of the fact that the above researches have made a few leaps forward, there are still a few drawbacks:

1) There are not many works related to the wireless signalling properties.
2) For the offline technique, we need more comprehensive approaches to lower the error rate.
3) For the online technique, there is usually a lot of time and processing power lost.

3. Proposed Wi-Fi Indoor Positioning Algorithm

To implement the Indoor Positioning System, we are going to create two apps. The first app (Locator App) needs to be installed on the faculty's phone. The Locator app uploads the faculty details, his credentials and location, to the server. The second app, Last Seen, shall be given to the students. In this app, we can search for a faculty using his name, and the app shall return his location with precision to the room number that he is present in.

The first app (Locator) needs to be opened by a faculty as soon as he arrives at the college. The faculty needs to login to the app to get the service started. The app then runs in the background. It switches on the Wi-Fi network and connects to the specified network. The app uploads the Faculty name, MAC address of the router to which it is connected and the signal strength of the network to the server. At the server side a PHP script resides which drops the received data to MySQL table. The second app, Last Seen, requests the student to enter a faculty name to be searched for. This App sends the data to the server and the server returns the location by matching the data with the data present in its tables.

4. Preliminaries

There are some prefatory things that every person trying to implement Wi-Fi positioning must be aware of. These shall clear the air on how to start the development and how to proceed further with Wi-Fi indoor positioning to suit in any environment.

A. Type of positioning

In this division, we concentrate on two sorts of positioning. The main sort is positioning items when there is an introduced positioning framework inside the building and clients are carrying apparatuses, for example, RFID or some other hardware in view of the remote sensor organize utilized as a part of the framework. For our situation, we will make utilization of Wi-Fi Access points i.e. Routers. We recognize this sort as a Fixed Indoor Positioning System. The second sort is positioning clients who have the hardware, for example, RFID when the building does not have the framework introduced inside that giving condition. It is referenced as people on foot positioning.

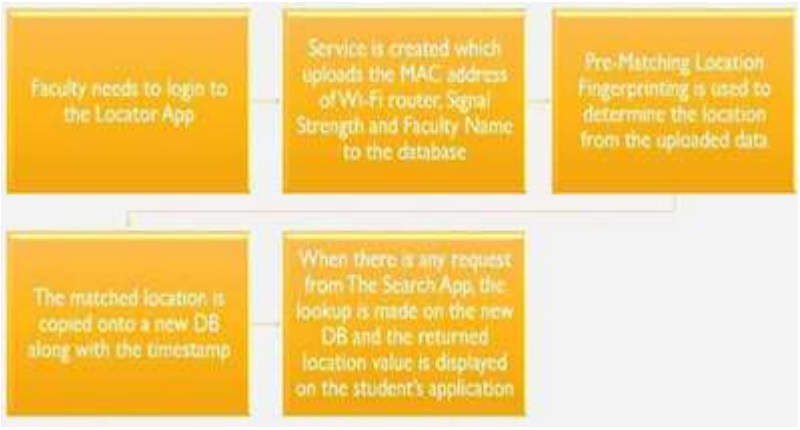

Figure 1: Proposed Algorithm

B. Positioning Principle

Positioning principles can be divided into four modules. These modules help us in achieving the positioning and they are Trilateration, Triangulation, Scene Analysis and Proximity. The module used determines how fast an object can be tracked or how accurately. It can also provide a better accuracy depending on the system architecture too.

In Trilateration, we discover the ”x” and ”y” directions of a point utilizing the separation between this point and three other focuses with known directions. To begin with, the three sweeps are registered. At that point, utilizing Equation (1) we subtract the sweeps to get the separation between each point and we disentangle the condition in 2 to get the estimations of ”x” and ”y” of the required point. ( ) 2 ( ) 2 a b r r ( ) 2 ( ) 2 a c r (1)

The Triangulation guideline is like Trilateration, be that as it may, we utilize points keeping in mind the end goal to get the separation d. Scene Analysis is another guideline of positioning in which fingerprinting is utilized. A unique mark is the mark that separates the scene from different ones. As such, a finger impression is the extraordinary trademark or accumulation of attributes of the scene. It works by gathering some data from the scene and contrast the gathered data and the current database coordinate for every scene.

The vicinity standard is mostly utilized as a part of Radio Frequency based frameworks. In this rule, we utilize a matrix of radio wires with settled areas inside the building. At the point when a man conveying the versatile station is identified, the nearest receiving wire is the one considered while com-putting the protest’s area. On the off chance that the portable is recognized by more than one receiving wire, the reception apparatus that gets the most grounded flag is then considered while ascertaining the protest’s area.

There are distinctive credits used to gauge the area of a question. These qualities are either sent by the sensor or measured by the Base Station when the flag arrives. The characteristics utilized are Received Signal Strength (RSS), Angle of Arrival (AOA) and Time of Arrival (TOA). The majority of the specified qualities are utilized by the Base Station to compute the directions of the objective question’s position.

In addition, choosing the trait utilized inside an indoor positioning framework brings about an alternate computation of the position. These qualities affect the subsequent position count alongside the sort of remote innovation and the calculation utilized inside the framework. TOA is the time taken by the flag to go from the source sensor hub to the Base Station. It is ascertained by subtracting the time the flag left the source sensor hub from the time the flag landed at the Base Station. TDOA is Time Difference of Arrival. It is figured by sending two sorts of signs. The contrast between the Time of Arrival of the two signs is the TDOA.

We have taken the architecture of our environment in mind and decided to go about with Radio frequency based systems. Our technology park has several classes and laboratories in each floor and is a multi-storied structure. We have Wi-Fi access points stationed in every classroom, laboratory and corridor. Hence, we can extract the attributes of the closest access point and keep periodically updating the database at the server. In our case, when a faculty carrying the mobile pre-installed with our locator application is recognized, the nearest get to point is the one considered while figuring the client’s area. In the event that the device is identified by more than one get to point, the get to point that gets the most grounded flag is then considered while ascertaining the client’s area.

C. Extractable location types

There are four types of locations that can be extracted by a positioning system. These types are as follows,

1) Physical location
2) Symbolic location
3) Absolute location and
4) Relative location.

5. Test Cases

A. Simulation Environment

The Indoor Positioning System contains of three parts:

The server, the faculty app and the student app. The faculty application is named as Locator and the student application is named as Last seen. The server is in charge of positioning estimation, the faculty application is in charge of gathering information and passing the information to the server and

the student application is in charge of showing the outcome by the portable customer.

The test case collects data in a typical indoor scenario. The testing is done in the 4th floor of the IT park building. The locator app connects to the closest router and hence gives the most accurate location. It takes 10 seconds for location refresh keeping the accuracy high. The test was also conducted with the faculty moving and it always produced accurate locations due to the high accuracy algorithm that we have used

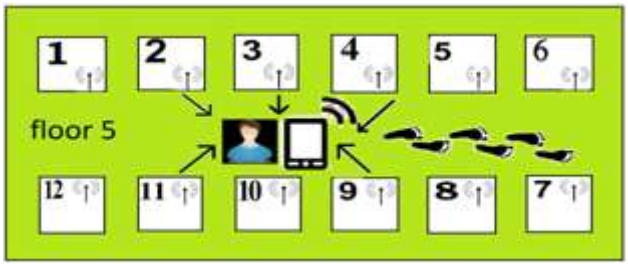

Figure 2: Test Case

Android Application

Figure 3: Locator Application Wrong Credentials given

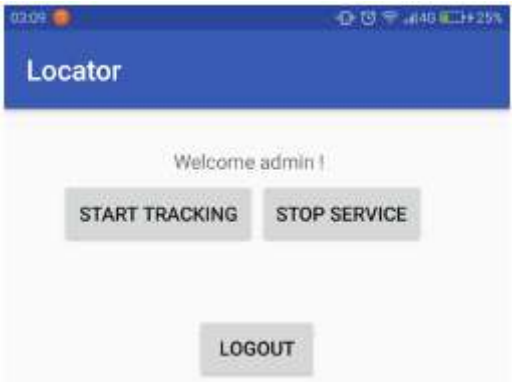

Figure 4: Locator Application Home Page with track option

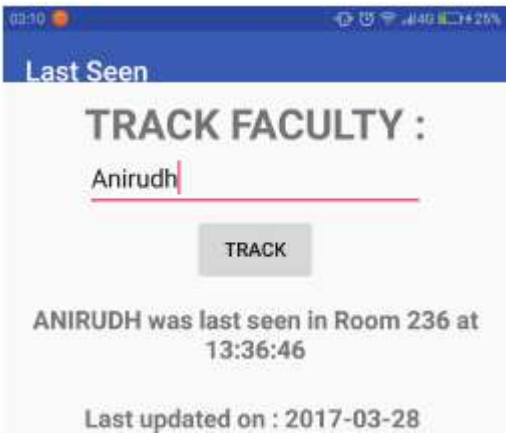

Figure 5: Last Seen Application Tracking faculty

6. Conclusion

Wi-Fi indoor positioning relies upon the Wi-Fi remote innovation to get indoor area data, which is of extraordinary centrality to the improvement of indoor positioning applications. Our work for the most part concentrates on the change of cur-rent customary positioning calculations and further proposes a Wi-Fi indoor positioning calculation. The proposed calculation depends on the customary area positioning calculation. By utilizing the Wi-Fi flag mistake dealing with, better positions amid the disconnected securing process could be gained. In the wake of enhancing the customary Euclidean separation positioning and the joint likelihood positioning, a more exact area result is accomplished.

This project sets out to serve the goals of Indoor Positioning and is used to locate people or objects with the help of applications in android platform and other hardware requirements. The Indoor Positioning System helps in overcoming the problems faced in locating objects or people indoors. It has a great accuracy, as close as the current room number, and works in cases where GPS fails to deliver. Therefore, the Indoor Positioning System is of great importance and is used for the easy positioning in indoors and helps in serving our need of Faculty Tracking.

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