Bluetooth and Wi-Fi based Indoor positioning system

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Abstract: All these years we have found new ways to reach a certain place. Initially we used to ask the people around for directions to our destination and we had these landmarks which made it easier to reach any place. Then with the technological advancements we came up with GPS (Global positioning systems) which acts like a boon for the recent times. We can get directions to places where ever we wish to go along with the information of traffic on the road and many such features. But what if we want to find a particular location inside a building or complex? We cannot do that with GPS as it does not locate us inside a closed premise. This is where Indoor positioning system comes into picture. Suppose we are in a mall and want to locate where a particular shop is within the mall. We have maps at different locations in the mall, but wouldn't it be convenient if we have the map handy and can locate us along the map. This is where the marauders maps can be used. We can simply scan the QR code of the map on our android device and can get our location through Bluetooth or Wi-Fi which will help us in finding the stores we want. As the malls are getting bigger and more complex, this app will be soon a must within the malls.

IndexTerms **- Indoor Positioning System (IPS), Magnetic fields, Received signal strength, Finger print database.**

I. INTRODUCTION

If you want to locate someone or some object indoors then IPS comes into picture. IPS is like GPS which is used to locate someone in indoor environments. The information that is generated is then fed into software to make the information equal. Proximity, Trilateration, Fingerprinting and Motion are categories of indoor positioning technologies. These technologies can be used alone or can be grouped for better results.

The basic idea is to provide a map on the phone which will locate us and find the appropriate way to a shop in the mall using Bluetooth or Wi-Fi. In particular when we see Wi-Fi has better characteristics than Bluetooth as it requires less sensors than Bluetooth. Wi-Fi based IPS is most promising as because of its existing infrastructure and wide usage of Wi-Fi enabled mobile devices.

II. EXISTING WORK

Following are the categories of Indoor positioning technology:

2.1 Proximity Positioning

It is either supported direct contact or on proximity between a receiver and a tool. It is mostly used on client-side except for Wi-Fi which has server-side detection capability-ties.

In Proximity positioning BLE (Bluetooth Low Energy) based beacons or NFC (Near Field Communication) based beacons are used. This technique is popular is it serves well with low cost budget. In this technique the proximity be-tween the sender and receiver i.e. the beacons. This method tracks the user based on the distance be-tween the user and the beacon. One needs to be aware that this method might not be suitable for indoor places which might not have beacons or organizations which mainly has Wi-Fi based technology as their focal use [1].

2.2Trilateration Positioning

In the Trilateration Positioning technique one needs to be aware of the pros as well as cons this method has. In this method usually the distance between the sender and the receiver is calculated with the help of Wifi RSSI signals or by using BLE (Bluetooth Low Energy) beacons. Having already known this method above, one needs to be aware that this method is not preferable because of the fact that it performance reduces when there are high obstacles. Hence this method is suggested only when there are less obstacles to have the best results.[1][2].

2.3Motion Positioning

Motion positioning within and outdoors buildings works on identical principles how-ever with totally different technologies [10]. Since it is not possible to use traditional IMUs, smartphone sensors are used to detect and quantify movements [10]. Here may be a list of sensors you'll notice in most smartphones: compass, accelerometers, ba-rometers, pedometers [10]. Algorithms such as Kalam filters process data that come from hose sensors to compute relative movement. The issue with those techniques is poor accuracy resulting from small size sensors and cumulative errors [10]. It goes without saying that the level of accuracy is far lower

this way than it would be with IMUs [10]. As for process, motion positioning is best accustomed increase trilateration positioning instead of as a complete technology [10].

III. PROPOSED SYSTEM

The proposed system for IPS includes the hybrid database. It has two types of elements Wi-Fi RSS and Magnetic field values at each referenced places in the experimental areas.

Phases of IPS

3.1 Calibration Phase

The calibration phase is basically when we store the data in the database. It is the phase on which the IPS is based on because without stored locations we cannot identify a new location. We gather some fixed amount of points which will have the RSS value associated with the Access point near it.

3.2Positioning Phase

After we have calibrated the points we have a database ready for identifying the current location of our phone. We can use any location based algorithm to find the location which will compare and calculate locations based on the stored location. We have various methods for this purpose.

- **. Trilateration**

This method is widely used in conventional surveying and GPS positioning. It uses the distances of an object from three or more known fixed points, to determine the position of an object. As shown in the below figure there are three APs to send signals which is received by the mobile device. Now the received signals (RSS values) are converted into spatial distances, which are used as the radii of circles i.e. d1, d2, d3 etc.

- **K-Nearest Neighbor (KNN) Algorithm**

The KNN algorithm is an extension of the NN algorithm of the minimum Euclidean distance values. To elaborate, in the NN algorithm we considered only one nearest neighbor and here we take into account K number of nearest neighbors. If k=1 then KNN turns into NN. After getting K number of nearest neighbors we take mean of their location coordinates and the outcome is the estimated location of the device.

- **Weighted K-Nearest Neighbour's Algorithm**

This is again extension of KNN algorithm. The difference here is instead of taking mean of location co-ordinates we perform weighted mean.

- **Dataset**

The received signal strength from all set of Wireless Access Points will create dataset for map Fingerprint. Since dynamic objects may create inaccuracy and frequency might change with moment of objects. So we will use static objects at know position inside the laboratory. To make its mapping discrete we will put some points as train-ing and testing respectively. For this we will take samples for each reference 6 times from every other reference points to create discretization in the dataset. In mapping of dataset we will scan the whole surrounding and store the each reference point in-formation in Wi-Fi network to create fingerprint along with time stamps. [4]

IV. IMPLEMENTATION

We have 2 phases in which the IPS system works:

a. Calibration Phase
b. Positioning Phase

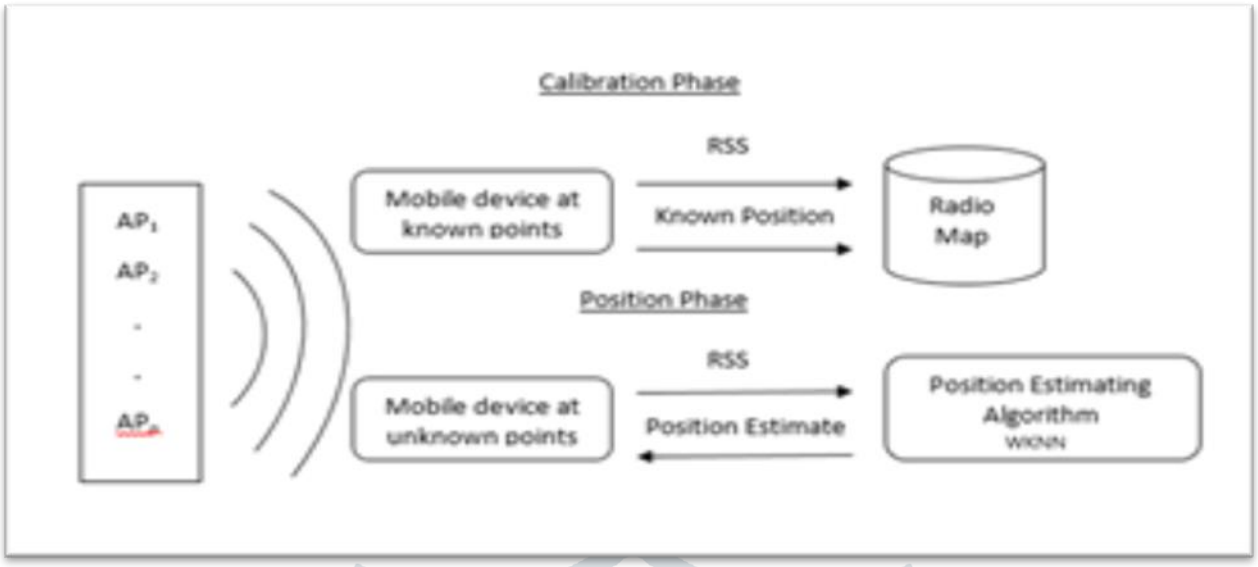

Fig. 1. Working of IPS based on WKNN algorithm

So the Calibration phase basically deals with the database storage. We have to collect various points' values which will include the RSSI value, BSSID, Mac Address, X, Y coordinates and the mean RSS value. Let us consider one floor which has an access point i.e. the router installed, we will calibrate some reasonable amount of data that will be the RSSI values from different locations on that floor, let us consider that floor to have 10 classrooms so we will calibrate data from each of the rooms and store it the database. So the classrooms are our Reference Points (RP) and every reference point will be linked to a access point and each RP will have a RSSI value which will determine how far is the access point, minimum the value closer the access point it.

Now after we have calibrated enough amount of data to locate a particular smart phones current location we can check if the location can be identified or not. So we are using the Weighted K Nearest Neighbor (WKNN) algorithm for identifying the current location of a smart phone when connected to an Access point. If the phones location data matches to one of the data that has been stored in the database then it will return the same, if it not stored then it will calculate the mean RSS values of the stored values that are closest to the phones location data and locate the phone

V. ADVANTAGES

- IPS works without GPS
- Existing Wi-Fi structure can used
- Enabled Wi-Fi is enough
- Large range
- Detects floor level

VI. TOOLS AND TECHNIQUES

- JDK 1.7 and above for source code
- Android Studio
- Wi-Fi enabled Android phone
- Selenium and J-unit for Testing
- Excel – storing data

VII. CONCLUSION

As per the proposed indoor positioning system is used to enhance the accuracy. We will be using basic Wi-Fi RSS and Magnetic field strengths integrated to form the fingerprint database at the initial stage. Then the selected base classifiers are used to along with the majority voting to improve the accuracy. We can improve the performance by adding additional sensors in future.

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