Indoor Positioning System

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***Abstract*—This paper describes a method for indoor localization using Android-based mobile or any communication device. Approach is based on signal propagation and received signal strength measurement which indirectly can be used to detect the location of the user. In this method we take RSSI and grid location of the tracking space and generate a fingerprinting database. Generated database is then run though machine learning algorithm to predict user location. The users Wi-Fi signal strength and MAC address is tracked using beacon and RSSI value will be calculated and it'll be used to point location of user.**

Keywords—WIFI, Indoor Positioning System

I. INTRODUCTION

The easy access and availability of wireless technologies and mobile computing and internet have led to new opportunities in developing mobile applications which purpose is to make people's life easier. Nowadays, an individual will possess over one mobile device intend for various usage like communication, entertainment, office works. This paper proposes a mobile application ready to be able to estimate the position of a user inside a building by mistreatment local area network technology. The existence of mobile devices as a location pointing device using Global Positioning System (GPS) is a very common thing nowadays. The use of GPS as a tool to see the placement in fact incorporates a shortage once used inside. Therefore, the employment of indoor location-based services in an exceedingly space that leverages the use of Access point (AP) is incredibly vital.[5]

Indoor positioning techniques mistreatment radio wave primarily based approaches for localization will use completely different wireless technologies like Bluetooth, Wi-Fi, signals of cellular towers and ZigBee. The ways mistreatment Wi-Fi are a lot of most popular as a result of Wi-Fi networks are current in most public buildings and its use don't needs an extra infrastructure and permits confirm a location of each user of mobile device.

There are loads of algorithms supported Wi-Fi trilateration approach. Trilateration is that the determination of absolute or relative locations by mensuration of distances, mistreatment pure mathematics. By the mistreatment of this technique there are 3 fastened points is required to see an inside position. The main plan is that the calculate distances between access points (AP) and mobile device to produce a vicinity of localization. This distance is often provided by such signal mensuration techniques sort of a received signal strength (RSS), time of arrival of radio signals from transmitters (ToA) or time difference of arrival of several radio signals (TDoA). Similar approaches are supported triangulation technique and mistreatment mensuration of incoming signal angle. We are designing an easy approach to maintain indoor positioning system and implement this system at very low cost. And android application to easily generate fingerprinting database. We are using Machine Learning to make location tracking easy and accurate.

II. RELATED WORK

Our initial research to the problem statement is a problem. The problem is inaccurate location provided by GPS.GPS location is influenced by various factors, as some are mentioned belowSatellite position, takes significant time to track moving objects, to locate us we need a new form of location technology. Our Workable Solution are:

A. Fingerprinting

This solution is based on RSSI Pattern. The RSSI pattern will be recoded with available APs. Then when new device is entered the RSSI pattern will be matched with existing pattern. This method is called as Fingerprinting.

B. Angle of Arrival(AoA)

This solution uses Angle of Arrival (AoA). AoA determines the direction by measuring the Time Difference of Arrival at individual elements of the array. By deriving the Angle and determining radius by RSSI. The location can be tracked. [1]

C. Time of Arrival (ToA)

In this method location can be directly calculated from the time of arrival as signals travel with known velocity. From multiple APs, deriving To helps the position accuracy to increase. This solution uses Time of Arrival (ToA). The distance

III. THEPROPOSEDSYSTEM

The Proposed System will be based on Fingerprinting.

A. Wi-Fi fingerprinting

The fingerprinting method uses the existing Wi-Fi access points available in the surrounding and use those

access point as reference and uses parameters of known Wi-Fi networks like its signal strength, the network MAC-addressee and real coordinates of Wi-Fi access points in the location. The aggregator is used to collect the beacon frames of the user. Aggregator is an ESP8266 Wi-Fi integrated SoC which has custom firmware flashed in it to capture the beacon frame and extract probe request messages from the management beacon frame and will calculate the RSSI signal strength of the mobile and relay it to the central server for processing. The fingerprinting database is generated using custom designed Android application, which generates a CSV database file with all the Wi-Fi signal record at different position of the racking area

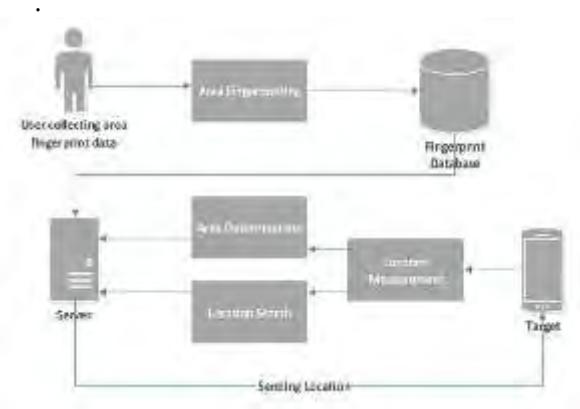

Figure 1. Flow chart showing parts of IPS[7]

The app will generate the database for us by scanning all the available access points in the surrounding and will only record have assigned access points received signal strength of the targeted access points at different location at different instant. Multiple recording will make the training database file size more but the accuracy of the predicted result will be higher. The recorded access point's data at different location is mapped to the floor plan.

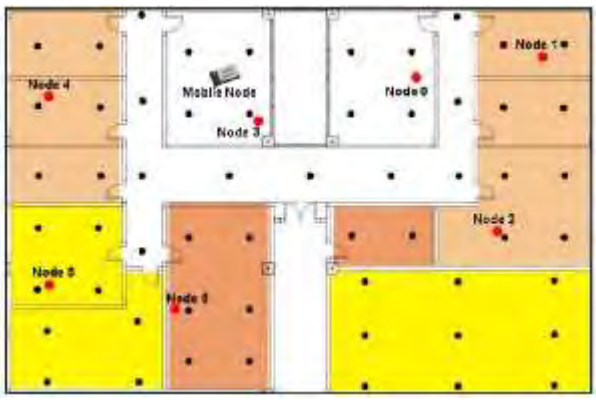

Figure 2. Fingerprint to Floor plan map[6]

Once the mapping is done then the dataset generated by the app is transferred to the ML algorithm to train the classifier on the generated dataset.

B. K-Nearest Neighbor

The principle of this algorithmic rule is to assign membership as to perform the Euclidian distance vector from the essential K-NN algorithmic rule and memberships within the probable label. The basic matching algorithmic rule wide accustomed find the most effective classifier, really perform and non-parametric classification technique is that the K-NN algorithmic rule. In the process of online positioning step, the K-NN algorithm was used to search for K-neighbours closest between classes of training database and measure RSSI point based on Euclidean distance. Before we get into details of the K-NN we need to define the minimum distance using Euclidean distance based on Bayesian classifier [2]

The KNN algorithm selects and combine the nearest K neighbours around a device to determine its position. Using a fastened variety (K) of fingerprints could decrease positioning accuracy: if K isn't modified throughout the positioning method, sometimes, access points far from the device might be included in the KNN algorithm. Therefore, eliminating some access points before applying the algorithm. Therefore, eliminating some access points before applying the positioning algorithmic rule seems necessary. [1]

KNN seems to be a good candidate for classification of this sort. It is due to the fact that KNN tries to make the classification by calculating the distance between features, while the intensity of various RSSI signals depends on the physical distance between Wi-Fi source and mobile phones. In this case, closeness in feature area could be a smart indication of closeness in physical area.

C. Wi-Fi RSSI measurement collection

In presented paper signal strength levels was measured by distance of three access points allocated in the three rooms within the floor. This data is collected to points estimation for fingerprint method described above. These measurements are made in 15 points at the 1-meter interval for each access point using developed Android application. This application found three different access points by MAC addresses and measured the RSS levels 10 times for each of 15 distances for every access point. The RSS level changes at time therefore it is necessary to use its average value. The AP RSS levels are displayed in the Table I.

Distance, m	AP1 RSS, dBm	AP2 RSS, dBm	AP3 RSS, dBm
1	33.3	38.8	55.3
2	45.7	43.1	50.3
3	50.9	48.9	65.7
4	51.7	55.2	61.2
5	51.8	75.1	62,5
6	53.4	75.5	66.4
7	57.8	76.4	70.5
8	62.4	80.8	72.3
9	65.7	80.8	74.7
10	62.9	76.0	78.0
11	72.9	88.6	76.07
12	72.7	88.2	86.02
13	63.9	91.0	79.03
14	74.0	91.9	85.08
15	76.7	92.1	82.05

TABLE I. THE RSSIMEASURE RESULTS FOR THREE ACCESS POINTS

Proceeded measurement points may be selected for location estimation as reference points. The reference points are the points with RSS level difference more than observational error calculated for each of 15 measurement points.

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V. RESULTS

The resulting android app created by android studio is completed. It is able to perform all the functions required for the purpose of efficient calibration/tracking of an entire room showing good results.

The app is reading the RSSI values received by a mobile phone from the APs even when not connected to them.

We asked to enter the location coordinates inside the room and to add it. The system saves the coordinates and reads RSSI values from all nearby APs and shows them for respective APs on a single-click.

Further by clicking on create database, it creates one and keep on adding more data to it. The app also has some more functions like auto increment, so that each time we do not enter the location coordinates manually. Result is shown in Figure 3 & 4.

Figure 5 shows the output of the Aggregator which is the collector device which is collecting the RSSI and MAC address of the device in the field.

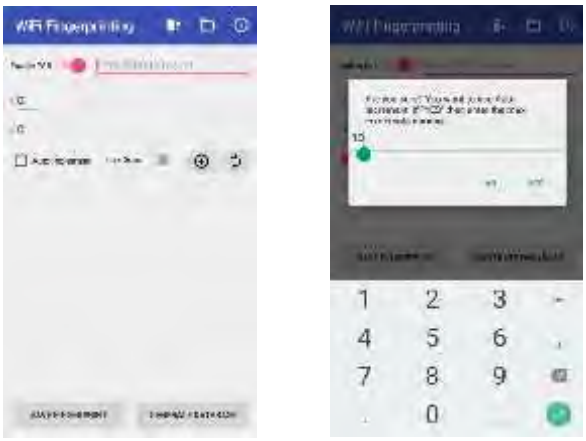

Figure 3a. Screenshots form Android Application

Figure 3b. Screenshots form Android Application

Figure 4. Software of System

Figure 5. Serial output form Aggregator

VI. CONCLUSION

The fingerprinting app is working as required. There are some factors which may cause a decrease in accuracy of the results. We need to consider all such factors, we need to improve the system more in order to increase the accuracy of tracking in order to achieve desired result.

The instability of RSS in indoor environments is the major challenge for RSS-based WLAN positioning systems.[3]The first reason is the structure of the indoor environment and the presence of different obstacles, such as walls, doors and metal furniture etc. Also the RSS value varies over time, even taken at the same location.

Many devices such as microwave ovens, smartphones, laptops another wireless signal transmitters. In the calibration phase, which is used for Collecting the RSS data and storing the corresponding location information in a database, these devices will likely lead to radio interference and make the wireless signal strength fluctuate.[5]

Furthermore, normal human body can also affect the WLAN signal strength. The RSS values on the straight line between the smartphone and an access point (AP) will be influenced by the body of theperson. We have overcome this by taking multiple RSSI reading to decrease the error.

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