

Robust Indoor Wi-Fi Positioning System for Android-based Smartphone

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Abstract- positioning systems can be used for different purposes and for different services, so a lot of research tries to find low error techniques with good results, GPS Global Positioning System is widely used but unfortunately it is difficult to use for indoor applications, Wi-Fi positioning system (WPS) solve this problem, So in this paper we introduce some enhancement on Indoor WiFi Positioning System for Android-based Smartphone[3] to get more accurate results, this will help in many application for mobile users and network administrators..

General Terms- Andriod, Mobile, Positioning System.

Keywords- Android; Mobile; WIFI; GPS; WPS; Positioning System; Smartphone; network;

1. INTRODUCTION

There are a lot of studies about Wi-Fi positioning system (WPS)[1], since knowing indoor user geographical location can help users and network administrator, for example users can know the map of building like floors and rooms by connecting to database or application which use WPS, and an administrator can detect the location of users who cause copyright violation or information leakage in LAN system, There are several methods to measure a geographical location. GPS (Global Positioning System) is the most popular method [2]. GPS measure a user's geographical location using radio waves from satellites, However, GPS is not suitable for network administration .Because may be users' Mobiles or PC does not have GPS interface. Even if it has the interface, users are indoor. The PC or Mobile cannot catch radio waves from satellites, So GPS is widely used for outdoor positioning System. In this Paper We propose an Enhanced Indoor Wi-Fi Positioning System for Android-based Smartphone by make some enhancement to algorithm used in [3], we use RSS (Received Signal Strength) of signals from dense Wi-Fi access points dedicated for localization. Then we use Formula and calculation in [4] to measure the distance between AP and user So the location will be more accurate. Section 2 has some related work in paper topics. Section 3 illustrate Enhanced Positioning algorithm steps .Section 4 is our Experiment and Evaluation .in Section 5 we conclude the paper .Finally Section 6 is References.

2. RELATED WORK

There have been a lot of studies about Wireless Position System WPS for example RADAR [5] has the position

calculation using the WiFi signal strength and has an average of three meters error on the coordinate of two dimensions. WPS [6], KF (Kalman Filter) stabilizes Wi-Fi signals and is used to calculate the position. In [7], a method to calculate the position by combining Wi-Fi with the GPS is proposed, Place Engine [8] and Google Geolocation API [9] are provide service and API for the WPS estimation.

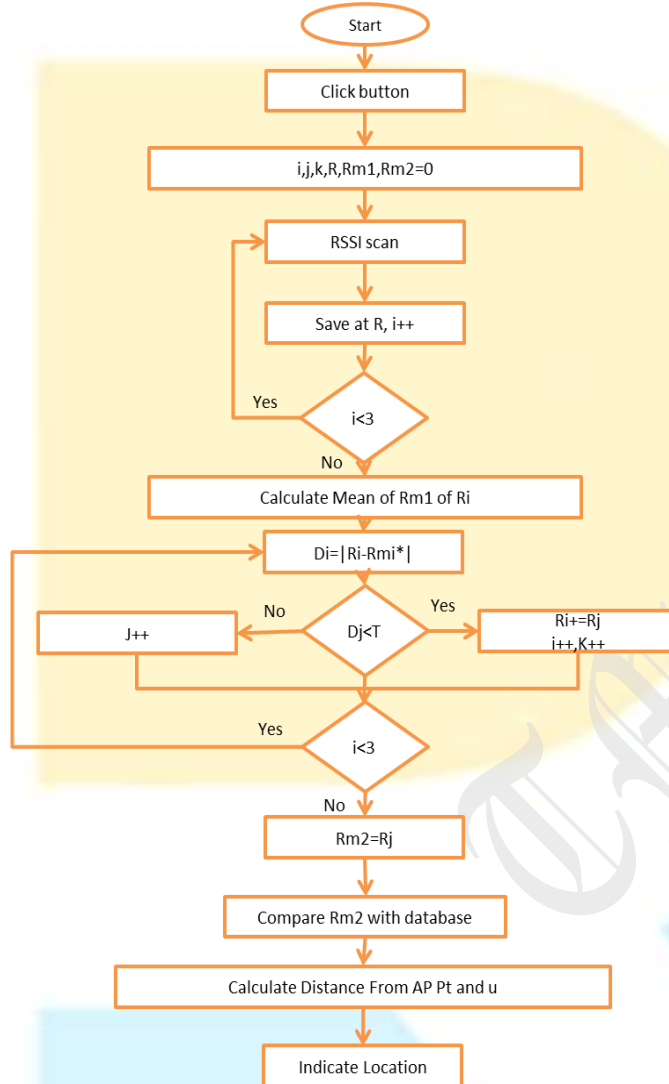
3. ENHANCED POSITIONING ALGORITHM

When Mobiles measured RSS from each AP three times and the mean value of three RSSs is calculated. The algorithm use the difference between the mean value and each training value. If the difference is below a threshold (T), the training value is withdrawn and then the mean of filtered training values is calculated again. the mean value is compared with the value of database and a proper. Then we get the RSS measured from AP chosen from database to find the distance between AP and Mobile. Finally, location on the map is found:

3.1 Distance Calculation

In this system, we used the Received Signal Strength Indicator (RSSI) method to estimate distance between an AP and a PC. In this method, we calculate free space propagation loss from a value of RSSI. The free space propagation loss is a value of radio wave signal loss from a transmitting station. The free space means is an ideal space model. The model assumes only distance between sender and receiver courses the signal loss. The model also

assumes a non-directional antenna is used in the space. We show a formula for free space propagation loss.



Rm1 : The mean of Ri Rs : Sum of available data Rj
Rm2 : The mean of available data Rj i, j : The number of iterations
D : Difference between Rj and Rm1 T : Threshold of difference
k : The number of available data Rj R : Training values of RSS

Fig 1: Flow chart of positioning algorithm

L [dBm] is a value of free space propagation loss. d [m] is a distance between sender and receiver. $C = (3 \times 10^8)$ [m] is the speed of light. $F = (2.4 \times 10^9)$ [Hz] is a frequency of Wifi radio wave. $\lambda = (C/f)$ [m] is an wavelength. L is expressed a formula below.

$$L = 10\log_{10}\left(\frac{4\pi d}{\lambda}\right)^2 = 10\log_{10}\left(\frac{4\pi df}{C}\right)^2 \quad (1)$$

Using formula 1, we express a formula for P_t [dBm] (the Sent Signal Strength) and P_r [dBm] (the Received Signal Strength) in the real environment. GTA [dBi] is an absolute gain of an antenna for sender. GRA [dBi] is an absolute gain of an antenna for receiver. In the model, a non-directional antenna is used. So that GTA and GRA are 0. Thus, the formula 2 equals to a In this system, we introduced and assumed P_t value is equal to formula below

$$P_r = P_t + (GTA + GRA) - L \quad (2)$$

$$P_r = P_t - L \quad (3)$$

In this system P_t is taken form AP. Using formula 3, we can calculate d , which is contained in L , from P_r value measured by AP. However, the formula 3 is a formula in the ideal model. We consider effects of the multipath and the fading. We add a new parameter μ in the formula. μ is a value of a transmit quality index. As shown below.

$$P_r = P_t - L_u \quad (4)$$

$$L_u = 20\log_{10}(4\pi/\lambda) + 20\log_{10}(d) \times \mu \quad (5)$$

Table 1. The μ values

μ	Descriptions
2	Outdoors with clear condition
2.5	Indoors with clear condition
3.0	Indoors with not clear condition
4.0	Indoors with bad condition

4. EXPERIMENT AND EVALUAION

We make our experiment in a building, which locates in Gaza building, Islamic University. Consists of three floors each floor contains one access point AP we make a small android application which contains data base of each AP calculated mean and AP floor information with distances, the application calculate RSSI of available AP then it apply our Enhanced algorithm to find the location of mobile then it retrieve information to user belong to distance found. Results shown below where $p_t=18$ dBm and $u=2.5$.

The smartphone is Galaxy-S2 made by Samsung and has Android 4.1.2 O/S. The threshold for the filtering is set to be 16 dBm.

TABLE 2. Results (a)

Floor	Ap1 RSSI dBm	Ap2 RSSI dBm	Ap3 RSSI dBm	Mobile Calc. Mean dBm	Actual Dist. m	Calc. Dist. m	Diff m
1	-87	-74	-50	-84	5	4	1
2	-90	-80	-65	-78	10	12	2
3	-53	-64	-88	-90	15	13.5	1.5

TABLE 3. Results (b)

Floor	Exists AP	Calc. AP	Actual Dist. Between Mobile & AP (m)	Calc. Dist. Between Mobile & AP (m)	Diff (m)
1	AP1	AP1	7	5	2
2	AP2	AP2	10	12	-2
3	AP3	AP3	15	13	2
1	AP1	AP1	4	4.5	-0.5
2	AP2	AP2	6	8	-2
3	AP3	AP3	7	6	1
1	AP1	AP1	20	17	3
2	AP2	AP2	16	15	1
3	AP3	AP3	18	19	-1

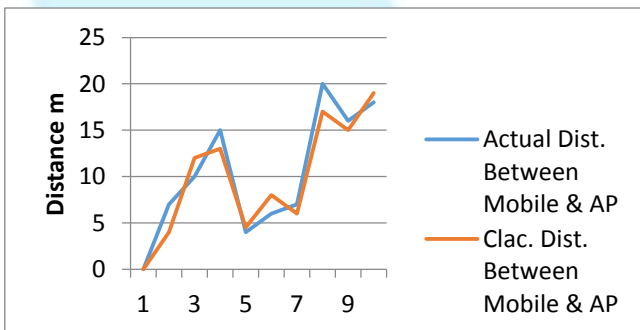


Fig 2: Calculated Distance Results

5. CONCLUSION

In this paper we have added some enhancement to Positioning Algorithm proposed in [3], to find the distance between AP and mobile user and we use algorithm in small android application which used to provide users with details about the position in building of three floors , this algorithm can be used also for network administrator to find the position of mobile users who connect to System network.

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