International Journal of Scientific Engineering and Technology ISSN:2277-1581
Volume No.6 Issue No.1, pp: 18-22 01 Jan. 2017

Design and Implementation of an Android System for Indoor Positioning Using WLAN Finger Print Scheme

Dr. Ammar Dawood Jasim , Hiba Hussein Marza
Department of Information and Communication Engineering ,Al-Nahrain University, Baghdad, Iraq
Ammar@coie.nahrainuniv.ed.iq ,hiba_hussain89@yahoo.com

Abstract: A great development has been appeared in wireless technologies and location based servicesand especially with appearance of open android operating system. In outdoor environments, Global Positioning System (GPS) can be used to get the position of smartphone usersbut GPS receiver is mostly inefficient in indoor environments.In this paper, indoor positioning system is designed based on WLAN fingerprinting method. The proposed system collects the Received Signal Strength (RSS) from the wireless devices in the calibration phase and stored in MYSQL database. Then it is compared with the collected data in the positioning phase using matching algorithm to determine user's location with good accuracy.

Keywords: Android, Fingerprint, Indoor Positioning, Received Signal Strength, Wi-Fi, Access Points.

I. Introduction

In the recent years, the development in mobile telecommunications and information technology allowed for appearance of several services based on user's location in indoor environment. As well, various communication systems which based on the user's position are developed. For example, security services, location based services, access control, etc. [1].

Recently, smartphones are evolved and its functionalities are increased through integrating different kinds of sensors like Global Positioning System (GPS) receivers, Wi-Fi, Bluetooth and cameras etc. These sensors are used for various purposes such as communication, location-based services (LBS) and also entertainment. As for GPS is utilized to locate objects in outdoor environments but GPS's receivers is often inactive in indoor environment because of the satellite signal cannot penetrate obstacles. Thus, Indoor Positioning System (IPS) has been designed by using other sensors; particularly Wi-Fi where the 802.11 Wi-Fi networks is widely available at the most buildings [2].

The important alternative to GPS is Indoor or Local positioning systems (LPS). Unlike GPS, LPS does not offer global coverage but it is more efficient system to local environments [3]. In the past few years, the deployment of WLANs has been increased and any person can easily connect to a Wi-Fi network using smartphone. Recently, indoor positioning system using WLAN and smartphones is developed for locating mobile devices in indoor environments using wireless signal strength [2]. Location based services (LBS) are one of the important services that take advantage of the user's location. In the last years, these services are utilized in various fields, such as health, social networks, work, etc. [3]. There are several positioning techniques which have been developed. One of the most known techniques is the "fingerprinting". Fingerprinting is an important technique for LPS in indoor environment where WLAN is widely available. It is important to take into account that indoor locations depend on several factors that cannot apply in outdoor locations such as refraction, reflection and multipath [1]. Positioning systems can offer various services, which are classified into the following groups [4]:

- Positioning: Determine the location of an object.
- Tracking: Observe the movement of an object.
- Navigation: guide user inside specific building such as museum, Mall.

There are many studies in thefield of indoor positioning. As many researchers benefited from open android operating systems for designing positioning application and installing it on any android smartphone for determining its location. In [5]the researchproposed Indoor Positioning System (IPS) using WLAN fingerprinting with post processing scheme. This study consisted of three phases which are mapping phase, operational phase and post-processing phase. In mapping phase, RSS radio map is constructed at unknown points whileRSS values are measured and recorded at the database in operational phase. The data from operational phase are processed in the server to calculate users' positions at the post-processing phase. In addition, other researchers [6] built an application which uses the Wi-Fi trilateration method for indoor positioning. The distance between the user and each of the three transmitters (Access points) is computed based on RSS values. The position coordinates are calculated by using server and then sent to mobile client.

II. Methodology

A. Wi-Fi-Based Indoor Positioning System

Wi-Fi-based positioning system (WPS) is used in indoor environment where GPS is ineffective becausemultipath and the satellite signal cannot penetrate walls. There are various methods to obtain users' position from WLAN information. The best method in WLAN positioning is the use of RSS. In this method, the signal strengths from different Wi-Fi transmitters such as wireless access points (APs) are measured [7]. Positioning object in WLAN depend on a set of beaconsexchanged between the access points and the mobile devices. The beacon signals are periodically transmitted using access points, each beacon signal contains different communication information such as a time stamp, path loss information, and supported data rates. The signal strength of these beacons can be measured and used for positioning an object [7]. Different positioning algorithms and techniques can be used for locating an object and the best technique is fingerprint method.

B. Fingerprint Method

Fingerprinting is the widely used method in indoor positioning. Fingerprinting is based on the received power level by the mobile phone from each access points in the wireless network [4, 8]. This technique uses the outputs of a standard Wi-Fi card, which is the RSS from each access point. A list of RSS coming from all the APs covering the area can be obtained where the laptop/mobile is moving. Using this available information, a Wi-Fi device in a WLAN environment is located by approximating its position by the position of the APs received at that location with the strongest signal strength [3]. Fingerprinting method consists of two phases: offline phase and online phase as shown in Figure-1-

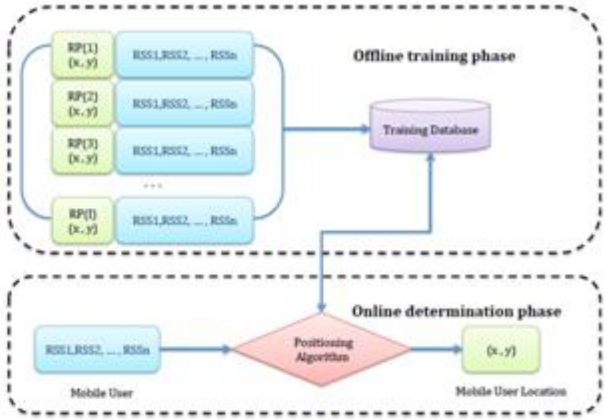


Figure-1- The diagram of Fingerprint method

Offline phase or data collection phase is the training period which is used by the positioning system to collect RSSs at the tested area and process it to enable the system for determining the mobile device's position in the online phase [9]. The goal of the training phase is to establish a fingerprint database. To build the database, collection of Reference Points (RP) is selected at the interested area [10]. Then the RSSs values from the existing access points are measured for locating a mobile device at all RPs and these values are stored in the database. In the online phase or positioning phase, the mobile device measures RSS at unknown location. The measurements (which include RSSs and SSIDs of the APs) are compared with the stored data in the database using matching algorithm. The best matching determines the location of mobile user [8].

C. Positioning Algorithm

RSS Mean Value Algorithm is applied in two stages: offline stage and online stage. In the first stage, RSS samples are measured in many locations as reference points. Then the mean value of RSSs is calculated and stored in fingerprint database with its reference point coordinates. While in the second stage, the live RSSs values are measured in location where positioning is required and these values are compared with database values, thereby the best matching is calculated between the mean valuesand the instant values. So, the coordinates of the estimated location can be obtained [10].

III. Experiment Setup

The experiment has been conducted on first floor of building C in the college of information engineering at AL-Nahrain University. The area has been divided into 16 zones and these zones represent a reference point to estimate the location information of user as shown in Figure-2-:

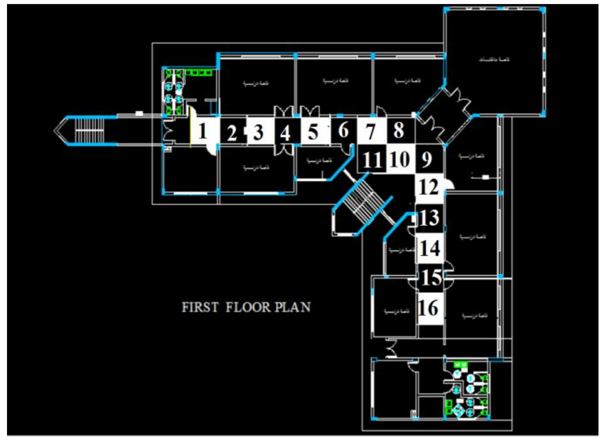


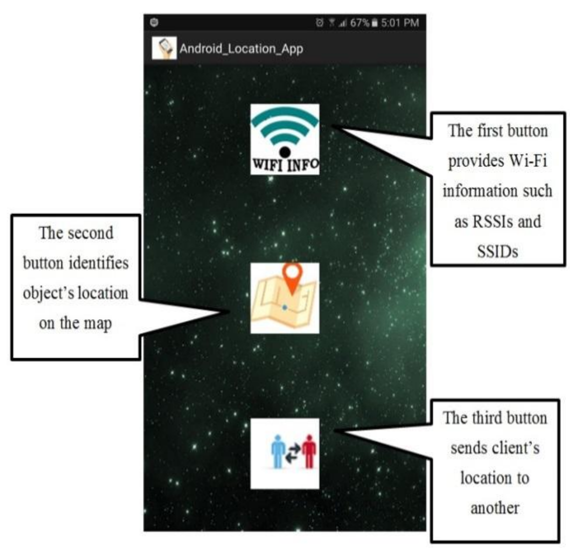
Figure-2- The 16 reference positions in the building C

The area of each zone is 3 x 3 square meter. The measurements of the received signal strength have been taken at the first floor of the building C at each zone. The experiment implemented indoor positioning system to identify the mobile user's location and tracking the paths of mobile user.Three access points have been placed in the building, which are named AP1, AP2 and AP3.

IV. System Design

The software consists of two main parts: the client side and the server side.

The client: The client side represents the application that has been written in Java and installed on the smartphone. This application is used to measure the received signal strength of the existing access points in the offline phase and also positioning service in the online phase as shown in Figure-3-.



3

Figure-3- Main page of application

ISSN:2277-1581
01 Jan. 2017

The server: The server siderepresents the fingerprint database. MYSQL WAMP server software has been utilized for building fingerprint database. This database consistsof two tables: the first table is used to record the Wi-Fi information while the second table represents the paths of clients' tracking. The client connects with the server to determine the location of mobile user or to keep track his paths.

V. The Results

a) Clients' Positioning

Two mobile devices have been used in this experiment and the results have been presented on both devices. At first the fingerprint database has been run by using WAMPSERVER software as shown in Table-1-) and then the application is run on the two mobile phones to send the Wi-Fi information to the database server and these information is processed to identify the location information as shown in Figure-4-:

Table-1- Fingerprint Database

Id	Zone_Number	RSSI_of_AP1	RSSI_of_AP2	RSSI_of_AP3
1	Zone 1 near C100	-42	-53	-61
2	Zone 2 near C102	-39	-48	-58
3	Zone 3 near C103	-38	-46	-57
4	Zone 4 near AP1	-33	-43	-64
5	Zone 5 near C104	-39	-42	-59
6	Zone 6 near C105	-39	-43	-55
7	Zone 7 near C106	-44	-42	-53
8	Zone 8 near C107	-45	-36	-49
9	Zone 9 near AP2	-46	-28	-49
10	Zone 10 near the staircase	-45	-39	-57
11	Zone 11 beside the outer door	-44	-45	-57
12	Zone 12 near C108	-51	-39	-52
13	Zone 13 near C109	-53	-45	-48
14	Zone 14 near C110	-58	-48	-39
15	Zone 15 near C111,C112	-63	-49	-38
16	Zone 16 near AP3	-60	-51	-34

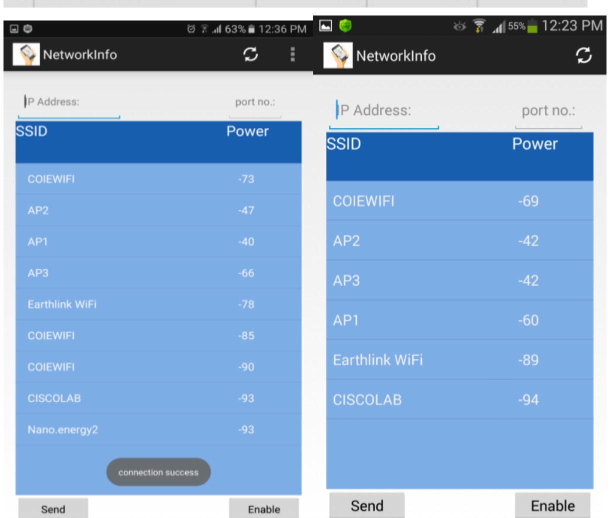


Figure-4- The received Wi-Fi Information by the two mobile phones

The send button has been clicked for connecting with database server and sending the Wi-Fi information. The reply has been arrived from the server to the smart phone represented by zone number and its location on the location map as shown in Figure-5-

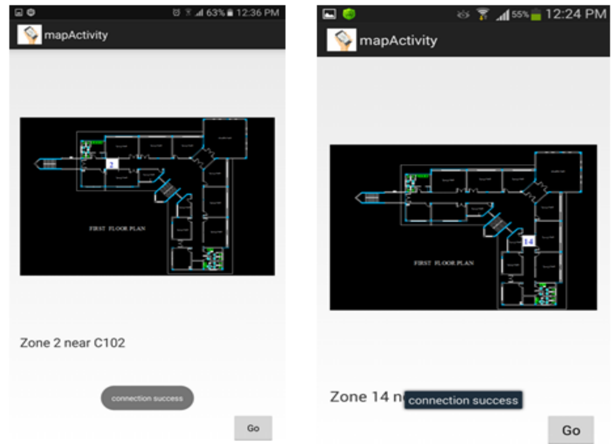


Figure-5- The current position of the two mobile users on the map

By clicking Go button, the conversation page is shownfor exchanging the location information between the users as shown in Figure-6-:

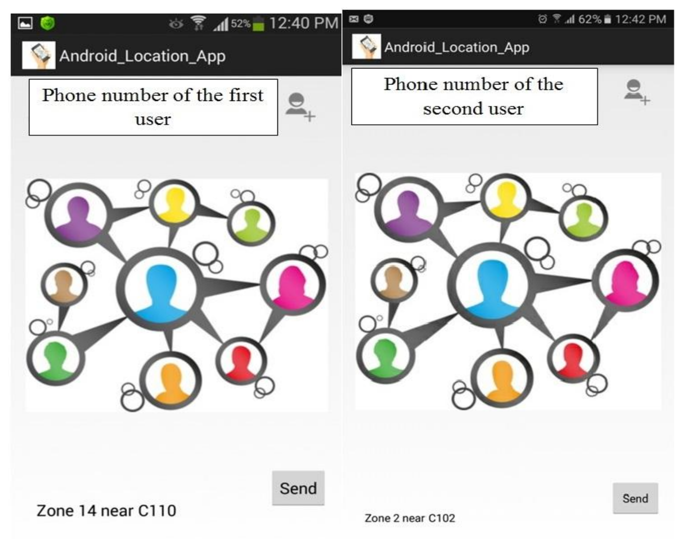


Figure-6-The conversation page

The phone number of the receiver has been entered by the sender for informing about his place. Then, the send button has been clicked for exchanging the location information between the users as shown in Figure-7-:

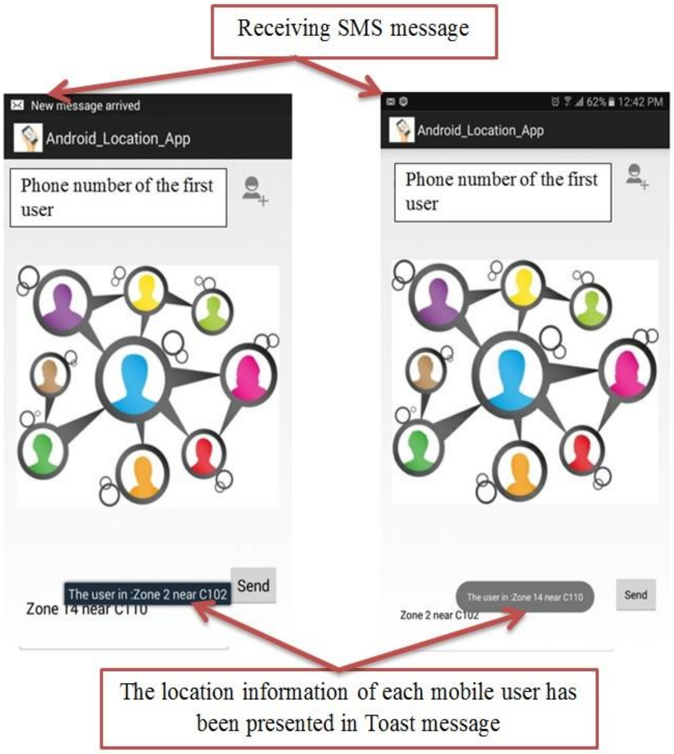
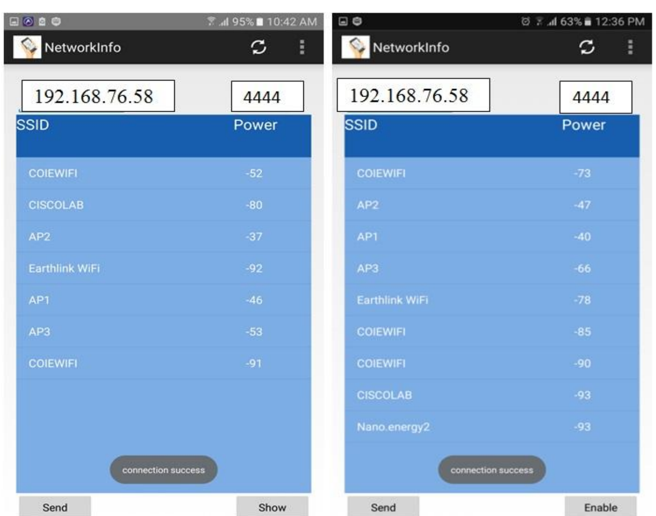


Figure-7- Exchanging of location information between mobile users

b) Tracking System Implementation

HP Laptop has been utilized as a server for establishing fingerprint database, computing the position and transmitting the estimated position to the smartphone. The mobile client connects with MYSQL database server by using IP address of the server and port number. Multiple measurements of signal strength have been taken at different locations to keep track the existing users inside the building. These measurements are sent by the client to the server as shown in Figure-8-.



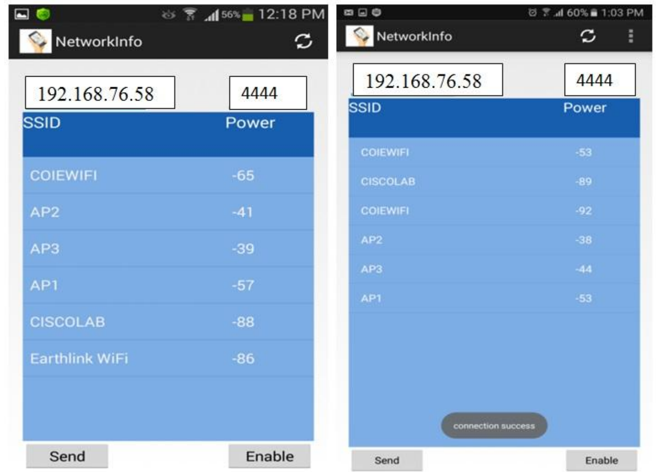


Figure-8- multiple measurements of RSSI at different locations for one client

Then the server processes these measurements and computes the position of the mobile user as shown in Figure-9-.

Figure-9-Tracking of Two Mobile Users

Finally, the location information of the mobile client have been stored in the clients' database which was built to record the user's paths inside the building as shown in Table-2-.

Table-2- The clients' tracking table

IP_Address_of_Client	Location
192.168.76.58	Zone 12 near C108
192.168.76.58	Zone 14 near C110
192.168.76.58	Zone 2 near C102
192.168.76.58	Zone 8 near C107

VI. Conclusion

This paper presented a method to calculate the location of a user in indoor area using Wi-Fi signal strength with IEEE 802.11b networking standard based on fingerprint technique and

RSS mean value algorithm. The client application is developed and run on Android smartphones to estimate the positioning of mobile user. Fingerprint database is created from the mean value of RSSs in the offline phase and finally the location of user is displayed on the screen of mobile device. Also the tracking of mobile client is done by using laptop server.The results show that the accuracy of the proposed system is about 2-2.5 meters which is the difference between the actual location and the estimated location.

VII. References

i. *Velasco and S. Delgado, "Indoor Positioning using the Android Platform", Blekinge Institute of Technology, Faculty of Computing, Department of Computer Science and Engineering, 2014.*

ii. *B. Hu, "Wi-Fi Based Indoor Positioning System Using Smartphones", School of Mathematical and Geospatial Sciences College of Science, Engineering and Health Royal Melbourne Institute of Technology (RMIT) University, November 2013.*

iii. *J. Li, "Characterization of WLAN Location Fingerprinting Systems", Institute of Computing Systems Architecture School of Informatics, University of Edinburgh, 2012.*

iv. *S. Sand, A. Dammann and C. Mensing, "Positioning in Wireless Communications System", German Aerospace Center (DLR), Germany, ISBN: 978-0-4707-7064-1, Feb 2014.*

v. *A. Puussaar, "Indoor Positioning Using WLAN Fingerprinting with Post-Processing Scheme", University of TARTU, Faculty of Science and Technology Physics Department, Computer Engineering, 2014.*

vi. *B. Bobescu, M. Alexandru, "Mobile Indoor Positioning Using Wi-Fi Localization", Transilvania University, Romania, Review of the Air Force Academy, 2015.*

vii. *N. R. Mrindoko and L. M. Minga, "A Comparison Review of Indoor Positioning Techniques", International Journal of Computer (IJC) ISSN 2307-4523 Volume 21, No 1, pp 42-49, 2016.*

viii. *L. Chen, B. Li, K. Zhao, C. Rizos and Z. Zheng, "An Improved Algorithm to Generate Wi-Fi Fingerprint Database for Indoor Positioning", ISSN 1424-8220 , August 2013.*

ix. *A. W. S. Au, "RSS-based WLAN Indoor Positioning and Tracking System Using Compressive Sensing and Its Implementation on Mobile Devices", University of Toronto, 2010.*

x. *S. Thummalapalli and T. Larsson, "Wi-Fi Indoor Positioning", School of Information Science, Computer and Electrical Engineering, Halmstad University, Information Technology PO Box 823, SE-301 18 HALMSTAD, Sweden, September 2012.*