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Location Recognition Algorithm for Automatic Check-In Smartphone Applications Based On Enhanced Wi-Fi Fingerprint Technology

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Abstract— Human life becomes more complex without technology. It makes our life more comfortable, here we define a new step for the location recognition technology. The Location Based Service (LBS) is an information service, accessible through mobile devices, such as Smartphone's, which provides the identification of peoples and object locations. In recent years, many indoor and outdoor location recognition methods has been developed. GPS is the most popular and widely used positioning system. Here we go to show our a new Location Recognition Algorithm for Automatic Check-in Smartphone Applications (LRACIS), suited to be implemented within Smartphone's, integrated in the Cloud platform and representing a service for Cloud end users. This algorithm, uses both Global and Hybrid Positioning Systems and, in an opportunistic way, the presence of Wi-Fi Access Point's, through a new definition of Wi-Fi Fingerprint (FP). This FP definition considers the order relation among the Received Signal Strength (RSS) rather than the absolute values.LRACIS is designed to be employed where traditional approaches, usually based only on GPS/HPS, fail, and is aimed at finding user location, with a room-level resolution, in order to estimate the overall time spent in the location.
Key words—Check-in applications, cloud computing, GPS/HPS receivers, GSM Ack: Acknowledgement, Smartphone terminals, Wi-Fi fingerprint.

I. INTRODUCTION

Nowadays Smartphone act as the important thing for the human life. It makes our works simple. Normally a lot of applications available for Smartphone's for the multiple purposes these are plays major rolls to our day to day works. Smartphone applications are well emerged and also it provides the effective communication environment. Global Positioning System's (GPS) are the one of the major applications for today's Smartphone environment. It supports a lot like vehicle tracking, friend finder, position search, Map supportability, Navigation analysis etc. In this scenario, this projects focus on the Location recognition for the Check-in environment. It supports people who are Check-in in a particular region they will get the information's, offers, notifications, and feedbacks about the region, here we focus on indoor location recognition to take the next step for location recognition environment. Indoor Location and Positioning technology is the Next Big Thing. It is bringing the power of GPS and Maps in indoors. We spend most of our time in indoors, working, shopping, eating, at the mall, at the office, on campus, etc. Apple and Google are competing on street maps, but are also working on Indoor Location. A Location-Based Service (LBS) is an information service, accessible through mobile devices, such as Smartphone's, which provides the identification of people and objects location. LBS can be used in many applicative scenarios, such as health, object search, entertainment, work and personal life. LBS applications may include parcel and vehicle tracking services and mobile commerce when taking the form of advertising directed at customers and based on their current location. One of the most popular LBS applications concerns Check-In, whose aim is allowing people to Check-In at specific locations such as pubs, supermarkets, and post offices. Two well-known Check-in applications are Foursquare and Gowalla [6], which have spread rapidly. Location-based services (LBS) require on-the-fly localization of the user to provide its service and other information. Indoor localization applications, such as indoor navigation, require precise user location. Since positioning services such as GPS remain inefficient for indoor use, other sensor techniques should be considered. With the maturation in Wi-Fi technologies and the increasing capabilities of hardware in our smart devices, locating a person indoor became a good starting point for providing indoor LBS. Two well-known Check-In applications are foursquare [5] and Gowalla [6], which have spread rapidly. Using these applications, users can Check-In at a location, sharing information with other people, leaving comments and votes, retrieving suggestions and enjoying benefits dedicated to "regulars" that spend some time in the location. On the other hand, the increasing popularity of these applications has allowed revealing some of their weaknesses. For example, it is difficult to guarantee the admin of the system or owner of the location that a customer has actually stayed in the particular location for a given amount of time. Some users could be tempted to Check-In when they simply pass near the location without really staying, just to obtain possible commercial benefits dedicated to accustomed people. To avoid this possibility Check-Ins should be validated by considering not only the correct user location but also a minimum period of time spent by a user in a given location. This period is called Stay Length (SL) and it is usually set by a business owner. In practice, a Check-In request is considered valid only if the user permanence in the location (i.e., the overall time spent by that user in the location) is larger (or equal) than the SL and the exact location identification are also enhanced for the identification of peoples actually where they are exactly staying by the user reply messages through Global System for

Mobile (GSM/GPS) mapping. This enhanced GSM/GPS mapping suitable for the universities or the very big campus environments.

This allow peoples to various locations such as railway stations, airports, supermarkets, shopping malls then information sharing will starts, here the information may navigation details, advertisements or any local offers and its enhanced version supports blind peoples to navigate easily with any environment. The success of Cloud Computing (CC) offers further opportunities for LBSs, which can be exploited in the Cloud and give origin to cloud-based LBS's. CC paradigm is clearly defined in [7].The cloud model is composed of: five essential characteristics: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service: three service models: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS): four deployment models: private clouds, community cloud, public cloud, and hybrid cloud. The detail of service models is important to evidence the exploitation of LBS through the Cloud. From [7]: SaaS represents the capability provided to the consumer to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through client interfaces, such as web browsers and/or program interfaces. PaaS focuses on the capability provided to the consumer to deploy onto the cloud infrastructure consumer created or acquired applications developed by using programming tools supported by the provider. IaaS evidences the capability provided to the consumer concerning processing, storage, networks, and other computing resources where the consumer is able to deploy and run arbitrary software's, which can include operating systems and applications. Another model, detailed in [8], is important to mention: Data as a Service (Dash), which focuses on the capability provided to the consumer to access shared Data in the Cloud. The paper is structured as follows: Section II surveys the State of the Art in the field and highlights the main differences between the existing solutions and the proposed approach. Section III contains the main contribution of this work: it describes the analytical details of the opportunistic location recognition method. The computation of the Permanence in a location. Section IV contains Implementation of LRACIS and section V contains performance evaluation in terms of location recognition accuracy (through real measurements) and as a tool in a Crowdedness Monitoring Application operating over the Cloud (Preliminary real time implementation). Conclusions are drawn in section IV.

II. STATE OF THE ART

In recent years, many indoor and outdoor location recognition methods have been developed. For indoor environments, infrared, ultrasonic, GSM, Wi-Fi and RFID are commonly used technologies while, in case of outdoor scenarios, GPS and Cell Tower Localization are the most employed[11], although also Wi-Fi is used at metropolitan-scale. GPS is the most popular and widely used positioning system, it is maintained by the United States government and provides Location information obtained by signals sent from a group of satellites. GPS can provide users' locations very accurately but its signals are often blocked and absorbed by walls or other obstacles. Nowadays lot of organization takes their steps for supporting indoor based location recognition. Navizon, Inc. is a provider of location-based services and products. Navizon was an early developer of technology that makes it possible to determine the geographic position of a mobile device using as reference the location of cell phone towers and Wi-Fi-based wireless access points instead of GPS. Navizon also developed technology for locating mobile devices indoors with room and floor-level accuracy. Byte Light is a new approach to indoor location. With market leading accuracy and user experience, Byte Light helps retailers reach shoppers at the critical moment in-store. Skyhook Wireless is a global location network with more than a billion Wi-Fi access points and millions of venues. Founded in 2003, the company originally began by working on Wi-Fi location and evolved with the idea that hybrid positioning technology, which incorporates Wi-Fi, GPS, cell towers, IP address and device sensors, could improve their location services. Skyhook offers a software development kit (SDK), which allows developers to create location-enabled applications. This uses Skyhook's software-only Hybrid Positioning System on the platform of their choice. The software development kit is compatible with all GPS and provides excellent accuracy and confidence estimation. The SDK supports Android 2.2 (Froyo), 2.3.x (Gingerbread), 4.0.x (Ice Cream Sandwich), and 4.1.x (Jelly Bean) [19]. All the above mentioned localization systems are not suitable for smart phone's platforms integrated in the Cloud, which is the reference technological environment of this paper.

III. LOCATION RECOGNITION ALGORITHM FOR AUTOMATIC CHECK-IN SMARTPHONE APPLICATIONS (LRACI)

There are many technologies that can be used for indoor localization and positioning. Radio Frequency ID (RFID), Ultrasound, Infrared Beacons, Bluetooth, Global System for Mobile communication (GSM), Wireless Local Area Network (Wi-Fi), just to name a few. Depending on location and need, one option will be better than another. For instance, using Wi- Fi based methods in a hospital environment could prove dangerous as the Wi-Fi signals could interfere with hospital equipment radio frequency signals. On the other hand, densely placed Wi-Fi AP will provide a solid coverage in most urban settings. Additionally with the number of Wi-Fi capable devices in the market and an abundance of pre-existing Wi-Fi infrastructure at present time, Wi-Fi has become a logical choice to use for tracking and providing LBS to general public. Recent researches [4] demonstrate the feasibility of indoor localization and have even been applied into an indoor navigational context operating on an Android device. However, the precision of the user location is not very well explored as the focus of the research was on traversing from point A to B. As such, it is more of a symbolic representation of locations. It is, however, a useful first approximation of the user's location.

A. Positioning VS Localization

A clear distinction should be made between the terms positioning and localization. Positioning is the determination of global world coordinates (ie. 43.77568, 77.12243) while localization is the determination of relative coordinates [gps/hps paper]. Positioning is particularly important for trilateration method as coordinates must be known for access points prior to any distance determination. On the other hand, fingerprinting approach is much more reliant on symbolic representation and thus does not require absolute positioning to be known.

B. Fingerprinting

Wi-Fi fingerprinting requires a robust RSS database which will be used for generating signal strength maps as well as used for matching. Each reference point includes signal strength measured from all accessible Access Points (AP). Live RSS data can be compared to the find the closest match from the database which stores the location of each reference point [17]. Fingerprint matching algorithm generally consists of two components: 1) the radio map and the 2) estimation method. The radio map must be established as part of the training phase to building up the database.

C. Trilateration

Trilateration method uses distance from nearby AP with known Media Access Control (MAC) addresses, calculated from signal strength values, to approximate the distance to the user. It is important to note that different networks of AP, particular ones with different hardware configurations, may vary in calculating the distance. Unlike fingerprinting, this method does not require priori data collection [20].

D. Signal Multipath Propagation

In any study involving indoor Wi-Fi signals, one must consider the effect of multipath propagation (ie. reflection and absorption of signals). Due to the nature of multipath, it is important to consider a range of values when trying to match the signal strength with the pre-recorded database values.

IV. IMPLEMENTATION

This abstract uses two different Wi-Fi based approaches to locate a person in an indoor space. First step requires the use of fingerprint matching to compare signal strength data received from nearby access points (AP) by the user, to the reference data stored in the Wi-Fi signal strength database. The second method is by means of trilaterating the distances between three known AP coordinates thereby calculating the distance the user is relative to an AP.

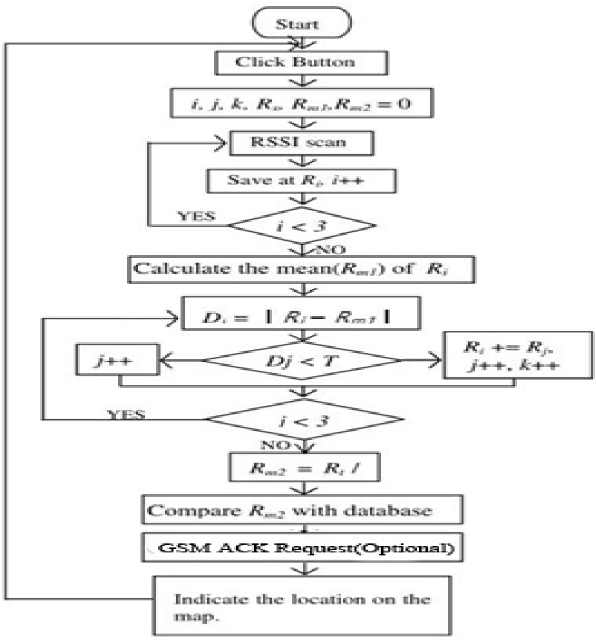

Fig. 1. Flow Chart for LRASCI

Rm1 : The mean of Ri
Rs : Sum of available data
Rj Rm2 : 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

A. *Data Collection*

The reference data to be used by the database for comparison in the fingerprint matching process consists of 84 locations distributed evenly on floor 1 to 3 of Brookfield's shopping mall in the Coimbatore city. The RSS are measured in units of dBm, using the open source software in SSIDer2.0, along with its corresponding MAC address, SSID, channel, etc. In SSID er2.0 is a freeware used to detect wireless signals in multiple channels and it has been used in previous researches providing accurate data. All AP in the shopping mall are the same Cisco AP1120B model that supports 802.11b band which operates at 2.4GHz range only. The AP are transmitting at full strength at 100mW

B. *System Requirements*

The preliminary system is aimed toward Android users due to its large user base and open source system development. Both Smartphone and tablets with an Android OS can install an application that allows RSS data from the device be sent to the database for analysis, thereby computing the user's indoor location.

C. *Radio Map*

The CAD floor plans of the PSE building was geo-referenced in Arc GIS as part of the AP mapping process which is required for generating the RSS map. See Figure 3 for a RSS map of the 3rd floor of the PSE building. Note that signal strength measurements were taken in corridors; therefore no empirical RSS data were plotted for the shops in different floors.

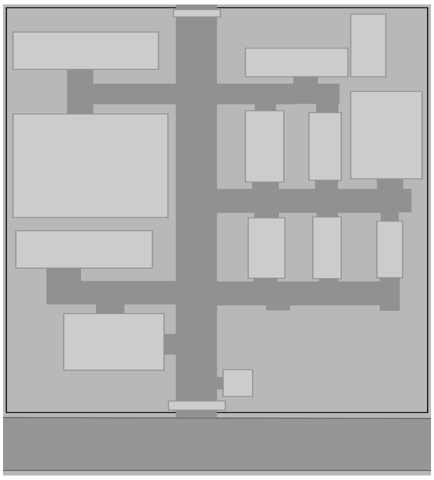

Fig. 2. Map View

RSS values in dBm

Fig. 3. Received Signal Strength (RSS) Range

D. *Mobile Application*

The initial preliminary tests are conducted with the android version 2.6 and above application. It is suitably developed for Shopping mall near at our city. It consists of three floors we implement our preliminary test over there.fig 5 below shows that.

E. *Distance Computation*

Computing the distance between the user and a nearby AP requires knowledge of the signal root path loss which can generally be represented using the Log-distance Path Loss equation [2]: $RL = RL_{1m} + 10\log(d^n) + S$

Fig. 4. Application View

RL = Root path loss between sender and receiver
RL_{1m} = Root path loss at a distance of 1 meter away
d = distance between sender and receiver
n = path loss exponent in environment
S = standard deviation of signal strength variability

Distance'd' from a specific AP can be computed using the above equation. The distance computed represents a radius'd' meters around the AP to the user. An overview of the system is demonstrated in the flow chart in Figure 4.

Fig. 5. Sequential Flow chart

II. PERFORMANCE INVESTIGATION

F. *Fingerprinting Approach*

An unknown user position was tested in this method as demonstrated below. The user received signals from a list of AP, each with their unique MAC addresses

MAC ADDRESSES	Avg RSS Value
01:40:96:A1:0F:3C	-35.15
00:40:96:A1:0C:B2	-55.62
00:40:96:A1:0C:BC	-57.69
00:02:8A:9E:4F:AF	-60.77
00:40:96:A1:0D:AF	-62.77
00:40:96:A1:0D:3B	-64
00:40:96:A1:0D:DE	-69
00:09:B7:7B:9F:5F	-85
00:40:96:A1:0C:AC	-91

Table 1. List of signal strengths (dBm) measured at one unknown location

This unknown position with the given list of unique MAC addresses is then compared to the master list in the database that stores all detectable MAC addresses within the building. In this particular case, it can be concluded that the user is at position P0301, as evident from Table 2, which can then be translated from a symbolic point to a real world reference point.

Position ID	# of Matches	Position ID	# of Matches	Position ID	# of Matches
P0101	2	P0201	0	P0301	8
P0102	1	P0202	0	P0302	1
P0103	0	P0203	0	P0303	1
P0104	0	P0204	0	P0304	0
P0105	2	P0205	0	P0305	0

Table 2. Matched each MAC address from the user's RSS with pre-recorded RSS from database to derive location

G. *Trilateration Approach*

Distance'd' has been computed using for the same unknown location as given above with the path loss exponent assumed to be 4 and standard deviation of 8.5 dBm for preliminary testing. Note that the assumed parameters are similar to many other empirically found values [3]. Three known distances away from three AP are then used to derive the intersecting point where the user is located. Table 3 shows the distance computed from three observed strongest RSS in an unknown position.

MAC Avg RSS Distance (m)	MAC Avg RSS Distance (m)	MAC Avg RSS Distance (m)
00:40:96:A1:0D:3A	-33.15	3.477
00:40:96:A1:0C:B1	-56.62	13.427
00:40:96:A1:0C:AD	-59.69	16.023

Table 3. Computed the distance away from each AP from the user measured RSS

MAC Avg RSS Distance (m)	MAC Avg RSS Distance (m)	MAC Avg RSS Distance (m)	GSM Replay Message from user
01:40:96:A1:0F:3C	-34.15	3.477	Not send
00:40:96:A1:0C:B2	-57.62	13.427	Send
00:40:96:A1:0C:BC	-58.69	16.023	Send

Table 4. Computed the distance away from each AP from the user measured RSS with optional GSM Ack measure finally a local coordinate (x, y, z) can then be deduced to locate the position.

II. CONCLUSION AND FUTURE ENHANCEMENT

Navigation it is the more important issue in the today's world.Smartphones are effectively supports for this opportunities. Location recognition for the Check-in environment algorithm works with the Smartphone's Wi-Fi to identify the check-In persons with in the indoor environment. Indoor based location identification technologies are more emerged nowadays it supports identify or track the persons, post advertisements to the users/shoppers mobiles or post the offers about the particular shop in the shopping mall while they cross that shop. Indoor based location reorganization it is another milestone for location recognition technology.This paper introduces a new Location Recognition algorithm for Automatic Check-In applications called LRACIS.It is implemented over Smartphone's and integrated in the modern Cloud Computing platform so representing a service for Cloud end-users. The proposed Location Recognition method is based on the joint exploitation of GPS/HPS positioning information, corrected by using a simple sliding window filtering (ECF), and of a novel Wi-Fi Fingerprint (FP) definition. The proposed FP definition is independent of the Received Signal Strengths (RSS's) measured absolute values because it considers only the order relation among them. From a more theoretical viewpoint, the idea of determining a fingerprint which is not based on absolute values but on the order relation among the measures has a more general meaning. In this view, location recognition is an application field, but the idea may be applied to other scenarios, where the measures are device-dependent. Their feature enhancement version supports blind peoples to navigate easily with any environment.

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