IJCAT - International Journal of Computing and Technology, Volume 3, Issue 1, January 2016
ISSN : 2348 - 6090
www.IJCAT.org

Indoor Position System using Wi-Fi Router's Through Smartphone

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Abstract - With the rapid development of Smartphone industry, various positioning enabled sensors such as GPS receivers, accelerometers, gyroscopes, digital compasses, cameras, Wi-Fi and Bluetooth have been built in smart phones for communication, entertainment and location-based services. Smartphone users can get their locations fixed according to the function of GPS receiver. This is the primary reason why the huge demand for real-time location information of mobile users has been unprecedented in recent years. However, the GPS receiver is often not effective in indoor environments due to the signal attenuation and multipath effects, although it as the major positioning devices have a powerful accuracy for outdoor positioning. This research investigates other built-in sensors and develops methods for improving the accuracy of indoor positioning. Combination with the wireless network, it can be a viable alternative solution for the indoor positioning purposes of the smart phone users. The main advantage of this solution is that it can be deployed with a minimal cost, as no specialized hardware is necessary for setting up the system. However, challenges remain for this solution due to complex indoor environment involved and extensive calibration data overhead.

Keywords **- Android operating system, LBS, GPS, Google Maps, and Reputation based security.**

1. Introduction

Driven by increasing demand for high-end smart phones from developed countries and unprecedented popularity for low-cost products from emerging economies, smart phones are expected to account for the majority (up to 52%) of global cell phone sales in 2013—two years earlier than previously predicted (LAM, 2012). With the rapid development of smart phone technologies, deeper personalized engagement and frequent important. Most people are dependent on their phones as the sole source of telecommunication and a key element of entertainment, as Well as an important way to connect each other via social media and emails. This means that application and operating system developers need to fulfill a hefty order, which makes smart phones an integral part of our daily life. This huge market potential triggers strong interest from developers, innovators and researchers. Figure 1.1 below shows the world market share of mobile handsets.

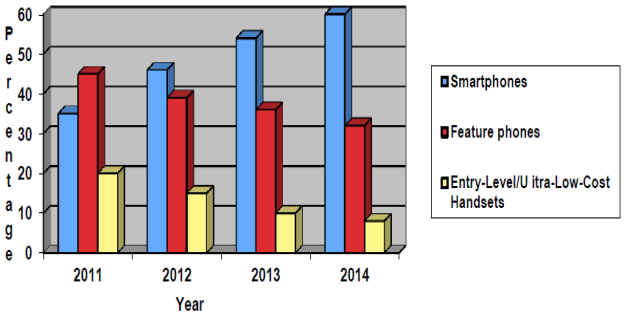

Figure 1.1 Worldwide market shares of mobile handsets

Wi-Fi has been a default feature for several years at the very high end of the smart phone market, whether it is the Apple iphone, Samsung Galaxy or the Nokia Lumia. Indeed, such a feature is an important characteristics of Wi-Fi to the overall experience of a smart phone that there is now strong evidence that handset manufacturers are seeking to differentiate through the Wi-Fi capabilities of their devices. In the past few years, WLANs have been widely deployed and people can easily connect to a Wi-Fi network using his/her smart phone. This opens a new avenue for indoor positioning using WLAN and smart phones. Recently, locating mobile devices in indoor environments using wireless signal strength has gained a strong interest in the international community. The main reasons driving WLAN as an alternative indoor positioning tool are due to the fact that GPS cannot be

used in indoor environments for positioning purposes and the availability of 802.11 Wi-Fi networks.

2. Problem Statement and Challenges

In the past few years, GPS has been widely used in outdoor positioning and tracking in our daily life (e.g. GPS in–car navigation systems). However, for indoor environments, it is well known that GPS does not work well since walls, floors and other construction objects can greatly attenuate or even block satellite signals. Several alternative techniques such as Assisted-GPS (A-GPS), Bluetooth, WLAN, ZIGBEE and Radio Frequency Identifier (RFID) etc. have been proposed for indoor positioning and tracking.

In this research, an efficient indoor positioning system based on the IEEE 802.11 wireless technique will be investigated (802.11TM). The Received Signal Strength (RSS) in WIFI range method in particular will be studied and smart phones, which have low-quality WLAN antenna requirements and limited power, memory and computation capabilities, will be used as a mobile device. There are four main reasons that lead to the high level of RSS variations. The first reason is the structure of the indoor environment and the presence of different obstacles, such as walls, doors and metal furniture etc.

The WLAN signals experience severe multipath and fading effects and the RSS varies over time even at the same location. Secondly, the IEEE802.11 WLAN frequency range is in the 2.4 GHz public bands, which is shared with many other devices such as microwave ovens, smart phones, laptops and other 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.

It is, therefore, not suitable for collecting stable signal strength and setting up a RSS database. Furthermore, normal human body can also affect the WLAN signal strength since the 2.4 GHz Wi-Fi signal strength could be greatly attenuated through human bodies.

3. Typical Positioning Techniques

Many positioning techniques are used to estimate the position or location of a mobile device in both outdoor and indoor environments.

3.1 GPS

GPS is a US satellite-based radio navigation system with a nominal constellation of 24 satellites. It was originally intended for military navigation applications, but in the early 1980s, the system was made available for civilian use. Since then GPS has been widely used for navigation and positioning, and various types of GPS receivers for different positioning accuracies have been available.

3.2 A-GPS System

A-GPS or AGPS can enhance the performance of standard GPS positioning using a cellular network as a complementary information source. It improves the location accuracy of cell phones.

3.3 Inertial Navigation System (INS)

INS usually can only provide an accurate solution for a short period of time because the sensors' measurement errors (e.g. bias and drifting) rapidly change over time and thus it is difficult to separate or mitigate them from navigation signals

3.4 Other Systems

A number of other systems, such as Bluetooth, Radio Frequency Identification (RFID), infrared and ultrasonic have been also investigated for their potential use and capability of positioning. Bluetooth is a technology commonly used for short-range wireless communications with low power consumption RFID is a generic term to describe a system that uses radio waves to transmit the identity of an object or person wirelessly.

3.5 Wi-Fi based Systems

Wi-Fi is now a widely acknowledged and used technology for positioning. Positions can be determined with a good accuracy in an indoor environment when Wi-Fi infrastructure is available.

Most positioning approaches using a Wi-Fi system are similar to the Cell ID approach. Signal strength fingerprinting methods are used for most advanced Wi-Fi positioning systems, in which Wi-Fi signal strengths are observed from various APs in the area of interest. Then the observations are stored in a database

4. Main Challenges for Indoor Positioning

For indoor positioning, Wi-Fi based positioning has been recently regarded as a favorable choice due to its widely availability. However, this technology still poses significant challenges and limitations due to the complexity and dynamics of indoor environments. It is adversely affected by many unpredictable factors including the movement of people, changes of environmental settings, radio interference and signal propagation loss caused by different building materials. In addition, wireless cards from different vendors can be also another factor affecting the RSS measurements. These pose a big challenge for developing a reliable and effective indoor positioning system.

5. Comparison of Different Techniques

Table1. Comparison of Different Techniques

Technique	**Accuracy Level**	**Advantage**	**Disadvantage**
GPS	High (10m)	Good accuracy	does not work in indoor
A-GPS	High (10m)	Assisted GPS	Network interaction is required
INS	Medium (accumula tive error)	Cheap	Bias and drifting are a concern
Wi-Fi positioning	High (10m)	Good accuracy for indoor environment	

6. Cell of Origin (COO)

COO is a mobile positioning method for locating a mobile device. This method relies on the fact that cellular networks can identify the approximate position of a mobile handset, e.g. in which cell the device is at a given time (Liu et al., 2007). The accuracy of this method depends on the size of the cells of the network. In a large urban network, the size of the cells can be from 100 to 1000 meters, which indicates the approximate accuracy of the COO positioning.

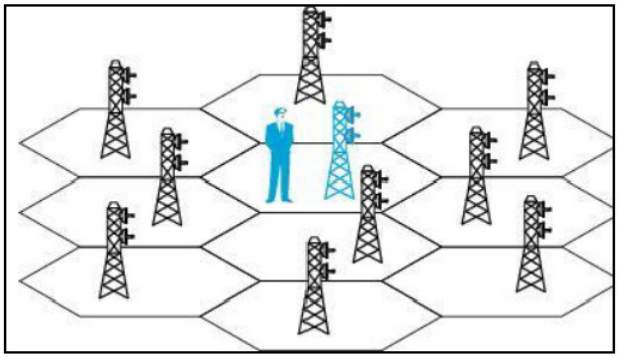

Figure 6.1. COO method for positioning

The concept of COO can be useful for indoor positioning. When applied in the Wi-Fi 802.11 systems, this technique tracks the cell (or "associated access point" in the Wi-Fi 802.11 systems) to which a mobile device is associated.

7. Measurement for Indoor Positioning

Various types of measurements can be used to determine the position of a mobile device and the following three types of measurements or models are commonly used

7.1 Time of Arrival (TOA)

An electromagnetic signal has a constant propagation speed. If the time of the signal propagation between a base station and a mobile station can be measured, the distance from the base station to the mobile station can be estimated using the trilateration method. The 2D position of the mobile station can be estimated using more than two such distances. In indoor wireless environments, this method can be used to locate smart phones using Wi-Fi routers.

7.2 Time Difference of Arrival (TDOA)

The aforementioned TOA uses the absolute time of signal transmission to calculate the distance the signal travels. TDOA uses difference between the propagation times arrived from different base stations. When a mobile station sends a signal, its strength will be received by at

least three base stations, the position of the mobile station can be estimated using the trilateration algorithm.

7.3 Angle of Arrival (AOA)

An AOA is defined as the angle between the propagation direction and its reference direction. The reference direction is known as orientation which is the fixed direction against which the AOAs are measured.

8. Algorithm

Dijkstra's algorithm works by solving the sub problem K, which computes the shortest path from the source to vertices among the k closest vertices to the source. For the Dijkstra's algorithm to work it should be directed-weighted graph and the edges should be non-negative. If the edges are negative then the actual shortest path cannot be obtained. At the k round, there will be a set called Frontier of k vertices that will consist of the vertices closest to the source and the vertices that lie outside frontier are computed and put into New Frontier. The shortest distance obtained is maintained in sDist[w]. It holds the estimate of the distance from s to w. Dijkstra's algorithm finds the next closest vertex by maintaining the New Frontier vertices in a priority-min queue. The algorithm works by keeping the shortest

8.1 Advantage

Finds shortest path in O (E+ V Log (V)) if you use a minimum priority queue. This is true only if you implement priority queue with Fibonacci heap, then amortized operation over it will take O(1).

9. Mathematical Model

The system uses the values from the wife routers and and uses these values for finding the location of the user. The levels are used to calculate for the distance.

Input:

1. Frequency of the router
2. Level of the router

Processing:

$$FSBL\ (dB) = 10\log_1 0\ ((\frac{4\pi}{}) \ 2df)$$

$$_c \quad = 20\log_1 0^{\frac{4\pi}{}} df$$

$$_c \quad = 20\log_1 0\ (d) + 20\log_1 0\ (f) + \frac{4\pi}{}$$

$$_c \quad = 20\log_1 0\ (d) + 20\log_1 0(f) - 147.55$$

For typical radio applications it is common to findf measured in units of MHz and d in Km/s in which t

$$FSBL(dB) = 20\log_1 0(d) +$$

$$20\log_1 0(f) + 32.45$$

f=MHz and d =Ks

$$FSBL(dB) = 20\log_1 0(d) +$$

$$20\log_1 0(f) - 87.55$$

f=MHz and d =MtrFSBL(dB)=20log 0(d) +20log$_1$0(f)−27.55

f=KHz and d=Mtr

10. Summary

In this chapter, an overview of mainstream positioning technologies including GPS, A-GPS, Wi-Fi and INS etc. are given. According to comparisons with other positioning systems, Wi-Fi based positioning systems are more favored for indoor environments. The main challenges using Wi-Fi positioning systems for indoor environments are also discussed and an overview of smart phone technologies is presented.

11. Review Table

Table2. Review Table

Existing System	**Proposed System**
The existing system only work for the outdoor using the Global Positioning System (GPS) Means the GPS is not work for the indoor.	That's why we developed these project using the WI-FI range and its work for the indoor like shopping mall, marriage hall ,ware houses , college campus etc.

12. Conclusion

Since IEEE wireless protocol was released about ten years ago, Wi-Fi technical standards have been well developed and widely used due to the high speed, wireless connectivity and large coverage of the Wi-Fi technology. Nowadays the demand for real-time location information

of mobile users is unprecedented. For outdoor environments, using GPS can achieve high accuracy positioning results. However, in indoor environments, due to the attenuation or obstruction of GPS signals, GPS technology cannot be used effectively. Therefore, Wi-Fi based positioning technology has been researched and developed for indoor environments.

13. Future Work

This research is our first attempt during the process of the establishment of the RMIT indoor positioning laboratory. Several aspects can be further explored to enhance the performance of the proposed Wi-Fi based positioning system for future work. Three main aspects are listed as follows:

1. Setup RSS database for different brand Wi-Fi adapters:

The proposed indoor positioning system is device-dependent, thus different brand Wi-Fi adapters with various receiving capabilities need to be tested. The fingerprinting process must be done for each type of Wi-Fi adapter. Further research needs to be carried out to investigate new methods to reduce the impact of the device-dependent errors. High stability is expected for other mobile devices rather than Samsung smart phone.

2. Multi Sensor Fusion:

Most current smart phone are equipped with other types of sensors such as accelerometer, gyroscope and digital compass, in addition to the built-in Wi-Fi adapter. Data obtained from accelerometers, gyroscope and digital compass could be very useful sources of information for indoor positioning since it can provide auxiliary data such as speed and orientation of movement. The improved positioning system can therefore make best use of the observations from these sensors to improve the accuracy of the position estimates.

3. Smartphone-based server or cloud server:

The positioning server of the proposed system is configured at a remote laptop. With the development of the CPU computation power and memory space of smart phone to decrease the data transmission time. This is important for the case of multiple clients. Moreover, we could also use cloud service, which has been popularly used in IT industry, as our positioning server.

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