WiFi indoor localization based on the fingerprint

Danyang Chen, 5130309354

***Abstract*—The utility and necessity of indoor location technique in some special occasions has increasedThis technique has a broad prospect and develops very fastThe significance of its study is very large. This paper is mainly about the WiFi indoor loacalization based on the WiFi fingerprint. We will establish a model to realize this alogrithm. Aiming at solve the problem that traditional indoor positioning methods based on WiFi cannot eliminate the impacts to RSSI caused by dynamic variation of the environment effectivelythis paper proposes a new indoor positioning system which is based on WIFI fingerprintThis new system adopts a new method based on the Usage of People(UOP)and deployment of Reference Point Tags(RPT)to update the database of WIFI fingerprints dynamically and the impacts to RSSI caused by different orientation of mobilesthe users bodyand dynamical changes of the environment in actual use process are declined effectivelyThe simulation results show thatcomparing with traditional indoor positioning methodsthe new indoor positioning methods proposed in this paper is more stableeasier to maintainand simultaneouslyhas better positioning accuracy and adaptation.**

***Index Terms*—indoor localization; WiFi fingerprint; wireless LANadaptation**

I. Introduction

RECENTLY, positioning systems such as GPS [1] have become very popular and have made possible a large range of applications. However, most actual techniques, especially those requiring satellite coverage, are not suitable for indoor positioning. And, as nearly all modern buildings are equipped with Wi-Fi access points, indoor positioning using IEEE 802.11 standard has now become a realistic alternative. Moreover, recent smartphones are commonly equipped with Wi-Fi sensors, which makes them adequate devices to implement such an indoor positioning system. The range of potential applications is very large. Indoor positioning systems could be used to give access to an interactive map of a building. For example, they could orientate a person through an airport to the boarding gate, help a student find his classroom or facilitate the way of finding items of a shopping list in a supermarket.

One successful approach for indoor positioning is based on Wi-Fi fingerprints [2]. It is applicable to scenarii with severe multipath unlike triangulation techniques where the distance to the base-stations need to be estimated based on time-of-arrival, roundtrip-time or signal strength attenuation [3]. Moreover, those techniques often require uninterfered propagation paths to work well. The fingerprint-based algorithms work differently and contain two phases: an offline and an online phase. The purpose of the offline phase is to collect information about the Wi-Fi access points signal strengths at different locations. During the online phase, the measured signal strengths are compared to the offline measurements in order to estimate the user position.

In an attempt to improve the accuracy of fingerprint-based indoor positioning systems, we propose a method that compares online and offline signal strength probability distributions in order to find the nearest offline locations.

II. Methodology

A. Estimation of signal strength probability distributions

In both offline and online phases, the signal strength probability distribution of each detected access point (AP) is estimated from a set of samples collected at the location of interest. A sample is a set of instantaneous signal strengths measured in dBm, where i is the identifier (MAC address) of the AP and O is the set of detected APs.

One way to proceed is to use histogram estimation. It approximates the probability of AP i to have signal strength s as the relative frequency of occurrences of s over the total number of samples L:

$$P_i(s) = \frac{N_i(s)}{L} \tag{1}$$

where Ni(s) counts the number of samples for which the signal strength of AP i is s. Pi(s) is a function of discrete values of s in the interval $[s_{min}, s_{max}]$ (determined by the sensor bounds) and constitutes an estimation of the probability distribution of AP i. It is important to notice that the minimum step between two discrete values of s is limited by the resolution of the measuring device. For instance, the smartphone we used could only measure integer values.

Figure 1 shows an example of such a distribution. We observe that the signal strength has strong variations even if the measurement was taken statically. They can be caused by fading or perturbations such as persons walking in the building.

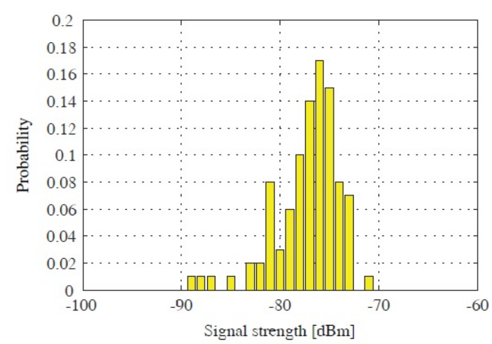

Fig. 1. Estimated signal strength probability distribution of one AP (L = 100)

B. Offline phase

During the offline phase, the signal strength probability distributions are estimated at N evenly located positions, with

L_{off} samples per location. They are stored to constitute the offline map, which serves as a reference database for the positioning system.

However, it is necessary to be cautious when taking the offline measurements. Indeed, the users body acts as a barrier for the signal and can therefore perturb the measurements. For each location, it is preferable to estimate the probability distributions in several orientations and then combine them together by averaging the probabilities

C. Online phase

The purpose of the online phase is to find the position of the user by measuring the signal strengths of the detected APs. Similarly to the offline phase, a set of L_{on} samples is collected at the user location and is used to estimate the signal strength probability distributions $Q_i(s)$ of the detected APs. These probability distributions are then compared to those of the offline map in order to find the most similar offline locations.

III. Experimental Results

This experiment is located in the classroom 103, the APP scan WiFi strength around the classroom. Because of the different APs in the same name, it is hard to find the accurate location. In fact, the APP can tell the user whether they are in the classroom or not. It only cost 3 seconds to scan WiFi and get the result.

IV. CONCLUSION AND FUTURE WORK

The system presented in this paper has proved to be suitable to accurately locate an user in a building. It is based on the existing WiFi infrastructure and can be implemented on portable devices like smartphones. We have investigated on the effects of different parameters on the accuracy.

These are performances that a user can expect from a localization service. Besides it outperforms the WiFi fingerprint-based techniques RADAR [4] and LOCATOR [6] and can be used as a realtime indoor tracking system. It is therefore adequate for many interactive uses and we can easily imagine it to be integrated to existing navigation systems or in commercial smartphone applications.

In a future work, we want to add a prediction system that would take into account a model of the user movement. We also consider dividing the search area into smaller clusters. It would reduce the computational complexity, especially when the system is used in large buildings.

References

[1] P. Enge and P. Misra, Special issue on global positioning system, Proceedings of the IEEE, vol. 87, no. 1, pp. 3C15, 1999.

[2] A. Taheri, A. Singh, and A. Emmanuel, Location fingerprinting on infrastructure 802.11 wireless local area networks (wlans) using locus, in Local Computer Networks, 2004. 29th Annual IEEE International Conference on. IEEE, 2004, pp. 676C683.

[3] H. Liu, H. Darabi, P. Banerjee, and J. Liu, Survey of wireless indoor positioning techniques and systems, Systems, Man, and Cybernetics, Part C: Applications and Reviews, IEEE Transactions on, vol. 37, no. 6, pp. 1067C1080, 2007.

[4] P. Bahl and V.N. Padmanabhan, Radar: An in-building rfbased user location and tracking system, in INFOCOM 2000. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE. Ieee, 2000, vol. 2, pp. 775C784.

[5] M.A. Youssef, A. Agrawala, U. Shankar, et al., Wlan location determination via clustering and probability distributions, in Pervasive Computing and Communications, 2003.(PerCom 2003). Proceedings of the First IEEE International Conference on. IEEE, 2003, pp. 143C150.

[6] A. Agiwal, P. Khandpur, and H. Saran, Locator: location estimation system for wireless lans, in Proceedings of the 2nd ACM international workshop on Wireless mobile applications and services on WLAN hotspots. ACM, 2004, pp. 102C109.

[7] S.H. Cha, Comprehensive survey on distance/similarity measures between probability density functions, in International Journal of mathematical models and methods in applied sciences. Citeseer, 2007.

[8] R TesorieroaRTebaraJA GalludM D LOzanoa VM R PenichetaIm p roving location aw areness in indoor space S using RFID technology[J]Expert Systems with Applications201037(1)894ł898

[9] Junghyo K im Dongho JungYeonsu Jung and YunjU BaekScalable RTLSDesign and Implementation of the Scalable Real Time LOCating System Using Active RFID[J] Lecture N otes in Com puter Science2008 Volume 5200503ł512