Received Signal Strength Indicator and Its Analysis in a Typical WLAN System (Short Paper)

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***Abstract*—Received signal strength based fingerprinting approaches have been widely exploited for localization. The received signal strength (RSS) plays a very crucial role in determining the nature and characteristics of location fingerprints stored in a radio-map. The received signal strength is a function of distance between the transmitter and receiving device, which varies due to various in-path interferences. A detailed analysis of factors affecting the received signal for indoor localization is presented in this paper. The paper discusses the effect of factors such as spatial, temporal, environmental, hardware and human presence on the received signal strength through extensive measurements in a typical IEEE 802.11b/g/n network. It also presents the statistical analysis of the measured data that defines the reliability of RSS-based location fingerprints for indoor localization.**

***Index Terms*—component, formatting, style, styling, insert**

I. Introduction

Historically, received signal strength indicator (RSSI) based fingerprinting has been playing a key role in numerous indoor positioning systems. Typical location fingerprinting algorithms consist of two phases: an off-line/training phase and an online/positioning phase. The training phase consists of collection of RSSI at known distinct locations called as Reference Points (RPs). These RPs are stored as a fingerprint in a radiomap. In the positioning phase, real-time data is collected at an unknown location called as a Test Point (TP). The localization algorithm uses the radio-map to derive the location of a TP by calculating the Euclidean distance between a TP and each RP fingerprint. The fingerprint consists of N RSS values for each cited Beacon/Access Point (AP) in a wireless network. Furthermore, localization algorithm uses either probabilistic or deterministic methods for positioning [1] [2]. RSS as a fingerprint forms a basis in creating a radiomap for fingerprinting algorithms. RSS at a given location is average of the signal received through different paths (multipath effects). Therefore, it becomes crucial to determine the factors that affect RSS. In this paper, we attempt to answer the question, whether RSSI can be used for creating the reliable location fingerprints? The main objective of our experiment is to study the characteristics of the RSS, to figure out the parameters and its effect on the RSS at a particular location and instant of time. We investigate the effects of hardware orientation, location, time and duration of measurement, interference and user's presence on the RSS

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II. Related Work

The data analysis of localization algorithm has been presented in [1]- [3]. Bahl et al. presents the effect of user's orientation on the mean value of RSS [1]. The study shows that RSS at a location can deviate by 5 dBm maximum depending on user's orientation. Based on the observations, researchers have suggested to exploit the orientational database for fingerprinting to improve the accuracy of localization. In [3] authors have pointed out that the factors such as hardware quality and number of received samples from APs affects the localization. But the study have not presented any investigations regarding the effect of these factors on localization. Ahmad et al. presented the analysis of the temporal variations on RSS samples [4]. The study indicates that the absence of samples from APs due to degradation of radio channels may adversely affect the indoor localization. This can degrade the performance and scalability of the localization algorithm with more computations. In [5] author has presented the detailed analysis of RSSI measurement and investigated the effect of wireless local area network (WLAN) card, time and duration of measurement, interference and building environment (corridor, small office or large hall). Make of WLAN card affects RSS significantly due to different quantization bins. However, the effect of user's presence and device orientation on RSSI is not considered. Further the study considers the antenna of WLAN card to be omni-directional. The analysis in carried out in 3 different building environment using limited (maximum 6) APs. All these studies raised some serious concerns on reliability of the RSSI in fingerprinting. In our studies, we show empirically that the RSSI is significantly affected by hardware orientation and several other factors. Therefore, RSSI when used to create

location signatures are unreliable when multiple devices from different vendors and physical constraints are being used. However it may be possible to use RSSI for fingerprinting using a single device with fixed hardware configuration to provide the reliable location fingerprints.

III. Data Analysis

In this section, we present the details regarding our measurements, figure out the various contributing factors responsible for RSS variation and discuss the statistical properties of the measured data.

A. Measurement Data Summary

The summary of logged data is shown in Table I

TABLE I
TABLE TYPE STYLES

Location Head	Factors		
	Duration in days	*total samples*	*observerd*
Location 1	2	66306	84[a]
Location 2	4	67306	67[a]

[a]Sample of a Table footnote.

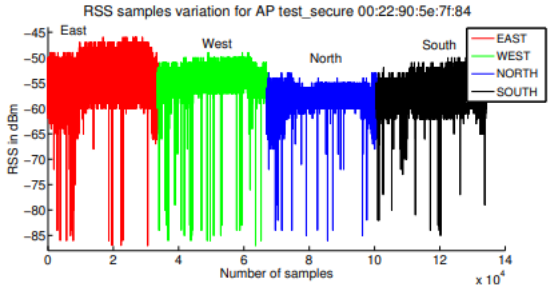

Fig. 1. RSSI for different orientations

IV. Conclusion

In this paper, we have investigated the factors affecting RSS including orientation of the receiver, distance between transmitter and receiver, time and duration of measurement, interference due to other radio devices, presence of human and building environment on the RSSI. We had shown empirically that the RSSI fluctuations are quite significant even for a single hardware. In the case of multiple devices from different vendors are used, this variations will be amplified even further due to different sampling rates and quantization bins. Our experiment shows that diferent orientation of a single device results in at least 2 dBm mean deviation whereas location granularity of 1 meter leads to upto 6 dBm mean fluctuation. Further, time and duration of the measurement for determining the required number of samples to form a location fingerprint varies due to irregularity of samples, its distribution and skewness. From our analysis, it is evident that multiple orientations at a fixed location with user's presence can provide various radio signatures that can be incorporated in the radio-map for location fingeprinting. We intend to explore the possibility of exploiting aggregated information from different types of devices, to determine the correlation between different devices that results in RSSI variation. This will help in normalizing the hardware dependency to provide more robust location fingerprinting using RSS signatures. References

References

[1] P. Bahl and V. Padmanabhan, "RADAR: an in-building RF-based user location and tracking systems," in Proceedings INFOCOM00': Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies. IEEE, vol. 2, 2000, pp. 775–784.

[2] M. Youssef and A. Agrawala, "The Horus WLAN location determination system," in MobiSys'05: Proceedings of the 3rd international conference on Mobile systems, applications and services, USA, 2005, pp. 205–218.

[3] H. Lemelson, T. King, and W. Effelsberg, "Pre-processing of fingerprints to improve the positioning accuracy of 802.11-based positioning systems," in MELT '08: Proceedings of the first ACM international workshop on Mobile entity localization and tracking in GPS-less environments, San Francisco, California, USA, 2008, pp. 73–78.