Toward sensor localization using WiFi-AP anchors: realtime AP-RSS monitoring using sensor nodes

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1. INTRODUCTION

Sensor networks play an important role to enhance indoor mobile applications. The sensor network for human detection in a house, for example, cooperates with a mobile application and automatically controls home appliances.

To realize such enhancement in a vast indoor environment such as in a building, we face a sensor localization problem. We need to get location of huge number of sensor nodes since location of sensor nodes is important itself. Although there are many studies on sensor localization [1], these works still require so many anchors, namely reference nodes, to improve accuracy.

We tackle the sensor localization problem by developing a sensor localization system that requires no newly deployed anchors. Our main idea is quite simple: we utilize WiFi APs as anchors for sensor localization. WiFi APs are already used as anchors in WiFi localization systems. We extend these WiFi-AP anchors to a sensor localization system.

Several challenges come up with this idea.

1) How to detect WiFi-AP signals on sensor node?: Sensor nodes cannot demodulate WiFi (IEEE 802.11) signals since sensor nodes are equipped with IEEE 802.15.4 (ZigBee) modules. We need to pick WiFi-AP signals out from WiFi signals sent from many WiFi devices using a ZigBee module. We then measure received signal strength (RSS) of the AP signals.

2) How to distinguish WiFi APs?: Using the RSS value, we can calculate distance between a sensor node and an AP. For sensor localization, we need to figure out the AP that sent signals.

To overcome these two challenges, we utilize a signal folding scheme presented in ZiFi [2] and configure each AP to have different beacon intervals. The folding scheme detects periodic WiFi-AP beacon frames. Using the different beacon intervals, we can separately detect WiFi APs. We then measure RSS of each AP and estimate sensor location.

2. SYSTEM OVERVIEW

Figure 1 shows an overview of our sensor localization system. Our sensor localization system consists of sensor nodes, a localization server, and WiFi APs installed in the environment. The WiFi APs periodically transmit beacon frames with different intervals.

To collect AP-RSS, sensor nodes continuously sample RSS in a specified channel. The sensor nodes then convert each RSS sample into a channel usage sample: `1` for busy and `0` for clear. The channel usage samples are processed by the folding scheme presented in ZiFi [2], which gives us WiFi-AP beacons. We finally average RSS of the beacons to get AP-RSS.

The sensor nodes send the AP-RSS to a localization server. The localization server calculates sensor location using a concurrent localization method such as triangulation and fingerprinting. We assume that the localization server knows location of all APs. This assumption is natural since the APs are managed by a network system manager in most cases.

3. DEMONSTRATION

In this demo, we show how a sensor node simultaneously detects signals from three different APs in a realtime manner. Figure 2a shows our demo overview. Our demo consists of three WiFi APs and a sensor node which is connected to a laptop. Figure 2b depicts detection results of three APs: high peaks mean that the sensor node successfully detects APs. Our demo also shows realtime RSS plot of each AP.

4. REFERENCES

[1] J. Wang et al., A survey on sensor localization. *J. Control Theory Applications*, 8(1):2–11, Feb. 2010.

[2] R. Zhou et al., ZiFi: wireless LAN discovery via ZigBee interference signatures. In *Proc. ACM MobiCom*, pages 49–60, Sept. 2010.

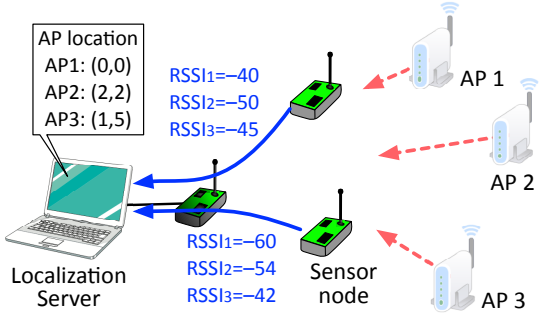
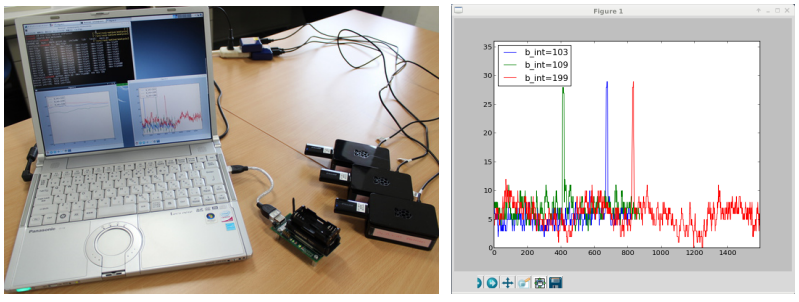


Figure 1: Overview of a sensor localization system using WiFi APs as anchors.



(a) (b)

Figure 2: Demo overview: (a) demo setup, (b) realtime AP detection results.