Construction and Visualization of 3D Wi-Fi Radio Map in Urban Environment

Tatsuya Amano, Shugo Kajita, Hirozumi Yamaguchi, Teruo Higashino
Graduate School of Information Science and Technology, Osaka University, Japan

Mineo Takai
University of California, Los Angeles, USA

1. INTRODUCTION

In order to maintain a certain quality even in crowded, unconditioned ISM bands in the city, Wi-Fi clients must intelligently select appropriate access points (APs). Since the location and channel occupancy of Wi-Fi APs are not changed frequently, it would be helpful to construct Wi-Fi radio map in urban areas and provide them to the clients to let them make proper AP selections (e.g, vertical handover) by themselves. Recently, the rapid spread of smartphones has made it easier to war-driving and war-walking like Wi-Fi beacon data sensing [2] [3]. In these approaches, radio information observed by smartphones is stored in a database for each observation point, and the information is used to understand Wi-Fi radio conditions in large area or Wi-Fi client localization. However, the existing crowdsensing approaches to construct radio map in large-scale areas have several drawbacks. Firstly, they do not model 3D environment where APs installed in different floors. Secondly, it is not discussed how efficiently collect a number of APs information and radio propagate in such urban environments. In this work, we propose a Wi-Fi radio map construction and visualization system. This system constructs a radio map by estimation of the virtual AP position and radio propagation simulation.

2. SYSTEM OVERVIEW

The architecture for Wi-Fi radio map constuction system is shown in Figure 1. Similarly with several existing approaches, this system relies on a crowdsourcing approach where smartphone users help to collect Wi-Fi beacon data. By a range-free localization method based on the Wi-Fi beacon received signal strength(RSS), the system estimates "tx-tile" for each AP. A tx-tile is a "virtual" transmission source assuming the AP is on the wall of the building in which the AP exists. Then using this virtual location, the system executes online Wi-Fi radio propagation simulations with 3D city models to complement RSS information in many other areas that are not covered by the users. The radio map information obtained by the simulation is distributed to the Wi-Fi clients via REST API server and the clients can select appropriate APs using the information. Further, as shown in Figure 2, the constructed radio map is 3D visualized on web application, and users can understand the density of Wi-Fi APs in urban environments from this map. We implemeted this system on Amazon Web Service and constuct a radio map of Osaka City [1].

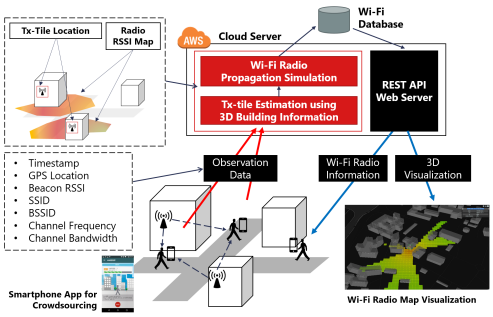

Figure 1: System Architecture

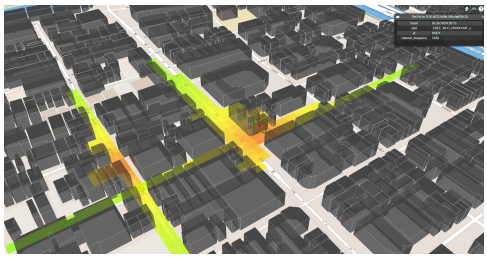

Figure 2: Visualiation of Wi-Fi Radio Map in Osaka City

3. ACKNOWLEDGEMENT

This research and development work was supported by MIC/SCOPE No. 165007009.

4. REFERENCES

[1] Wi-fi observation area map of osaka city. http://map.wifibigdata.org.

[2] A. W. T. Tsui, W.-C. Lin, W.-J. Chen, P. Huang, and H.-H. Chu. Accuracy performance analysis between war driving and war walking in metropolitan wi-fi localization. *IEEE Trans. Mobile Computing*, 9(11):1551–1562, 2010.

[3] D. Wu, Q. Liu, Y. Zhang, J. McCann, A. Regan, and N. Venkatasubramanian. Crowdwifi: efficient crowdsensing of roadside wifi networks. In *Proc. ACM 15th International Middleware Conference (Middleware 2014)*, pages 229–240. ACM, 2014.