Indoor Localization based on CSI and Mobile Sensors

Chaojun Xu[1], Fei Gao[1], Jiexing Gao[1], Gang Shen[1], Erwu Liu[2], Xinyu Qu[3], Ying Yang[4]
[1]Nokia Shanghai Bell Co., Ltd. P.R.China
[2]Tongji University, P.R.China
[3]Naviguy & Tongji University, P.R.China
[4]Ruijie Networks Co., Ltd. P.R.China
zhaojun.xu@nokia-sbell.com

ABSTRACT

We present a system that combines AoA at WiFi access points and sensor data in mobile phones like accelerometer, digital compass, gyroscope to localize the clients in indoor scenario. Such a system can bring indoor localization to homes and ware houses where infrastructure moves frequently.

The key enabler underlying our solution is a solution that can compute the angle of arrival (AoA) of signal and distinguish the direct path from the reflection paths at WIFI access points. By exploiting the sensor information reported by the mobile phone and AoA measured at WiFI access points, our solution can achieve a high accuracy.

Keywords

Indoor localization, CSI, WIFI, AoA, RSSI

1. INTRODUCTION

Advances in localization techniques have enabled a multitude of services including navigation, targeted advertisements, and locationaware applications. WiFi technology has gained a wide prevalence for not only wireless communication but also pervasive sensing. A wide variety of emerging applications leverage accurate measurements of the Channel State Information (CSI) information obtained from commodity WiFi devices. Due to hardware imperfection of commodity WiFi devices, the frequency response of internal signal processing circuit is mixed with the real channel frequency response in passband, which makes deriving accurate channel frequency response from CSI measurements a challenging task. In addition, with the growing prevalence of powerful mobile computing devices and the embedded sensors in it, localization with a number of observation from various sensors is practical. However, interference and measurement errors impact much the final estimation. Therefore, combining all the sensors in mobile phones with WiFi to achieve a self-calibrated indoor localization system is desirable. Measurement error can be identified and mitigated through multiple sensor data fusion.

GPS signal is usually too weak to provide an accurate localization service in indoor scenario. Traditional WiFi localization uses RSSI to construct an energy map. Two phases are needed to complete the localization. First, the positioning server divides the whole network into multiple equal area grids and derives the radio signal transmission model according to onsite environment. It is always exhausted to collect the fingerprint data, especially in a very large house. If a target needs to be located, APs report RSSIs to the positioning server after receiving location information of the target to be located. The positioning server compares the RSSI information received by the AP with the information in the database to obtain the target location. This RSSI map varies along the time, as well as the indoor layout. Thus leads to a poor accuracy, no mention to calibrate the mobile sensors. RSSI map calibration is proposed to dynamically update RSSI map according the on-site environment measurements. The influence on RSSI from environment variance can be mitigated. Furthermore, WiFi is exploited to provide accurate AoA information where we have the ability to conduct the super-resolution AoA estimation in real-time, to detect the direct path robustly, and dynamically optimize the parameters assigned to each sensor. Joint considering AoA and sensor information reported by the mobile phone with iterative algorithms achieves a high accuracy.

2. DEPLOYMENT

Localization accuracy is dependent on the multipath environment, the infrastructure, furniture deployment, the presence of metallic objects, the density of AP deployment. Here, we just illustrate the idea of the deployment of our solution. The APs are deployed on the ceiling for having the direct path as possible. First, all APs are set in monitor mode on a channel with 40 MHz bandwidth in the 5GHz band. The UE with various sensors is set on the same channel as the APs. The UE transmits packets with 50 ms interval and the APs surrounding it can hear the UE and log the packets as well as the CSI information and corresponding MAC addresses. At the same time UE reports accelerometer, digital compass, gyroscope, RSSI, etc. to the server. The localization server then applies the iterative algorithm to the all information collected. Combining the sensor data in the mobile phones, weightings are assigned to various observer to achieve a very high accuracy.

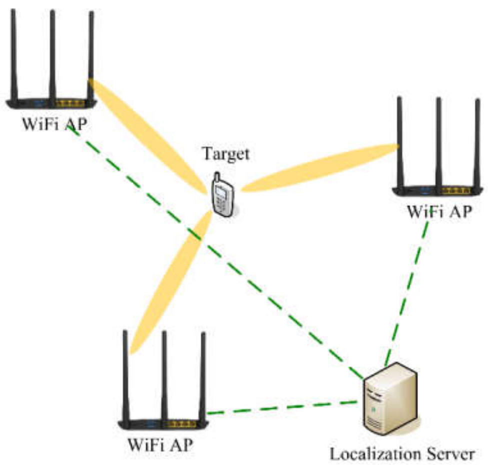

Figure 1: Deployment architecture