

Robust WiFi Time-of-Flight Positioning System

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I. INTRODUCTION

Reusing commercial off-the-shelf (COTS) WiFi access points (AP) for location-based services is an attractive and cost-effective approach to provide the much-needed positioning information in those scenarios where GPS fails. Classical solutions for WiFi-based positioning are based on signal-strength measurements [1]. Relying on signal-strength measurements has well-known limitations, such as the high dependency of the signal propagation with respect to the material of the obstacles between radio devices like walls, doors, etc.

Systems based on Time-of-Flight (ToF) ranging are gaining momentum as alternative to the above traditional approaches. Yet, they come with the inherent difficulties to obtain accurate time measurements with COTS hardware [2]–[4].

II. TOF-BASED MOBILE TRACKING SYSTEM

In this demo, we extend our previous ToF-based localization system that already participated in the Microsoft Indoor Localization Competition at IEEE/ACM IPSN 2014 [5]. As in the previous competition, our system uses an adaptive ToF-based ranging [4].

Our system uses COTS APs with customized firmware operating in the core of the 802.11 MAC state machine of a low-cost WiFi chipset (cost per unit of less than three dollars). The system can estimate the position of 802.11 standard-compatible devices, such as smartphones, with distance from each AP to mobile targets estimated with ToF ranging measurements and based on an environmental training algorithm.

The system presented at IEEE/ACM IPSN 2014 has been improved thanks to:

- filters to handle different WiFi chipsets (and their inherent offset delay) as mobile devices.
- backend infrastructure to store the system configuration and data of multiple mobile devices.
- automation of the environmental training process.
- several bugs fixed.

No offline calibration is required by our ToF system, that automatically adapts to environmental changes, such as more or less people presented in the area, chairs and furnished moved to a different location, variation of the radio interference level in the same channel. These features are considered essential for any positioning system [5].

A. Implementation details

The APs are equipped with Broadcom WiFi chipsets that run our customized version of the 802.11 openFWWF firmware [4]. Using only MAC-layer features of the 802.11 standard, we measure the ToF from received acknowledgments after the transmission of data frames and pass the results to the open-source b43 driver. Measurements are analyzed in the AP driver, and remotely sent to a MySQL database. The CLU connects to the database and computes the mobile position. The estimated position will be displayed on the mobile device using the indoor map provided by the organizers.

III. CONTEST SETUP

The APs and the mobile device to be tracked run exclusively on commodity hardware. For the contest, we will deploy five of our own 802.11 APs which are net5501 embedded machines from Soekris. We will demonstrate the tracking of a smartphone. Experiments are conducted using the 802.11b/g standard in the 2.4 GHz ISM band. Targets can move freely along the exhibition space and remain tracked as long as at least four APs are able to perform ToF measurements to the targets. The installation of the system at the exhibition requires only the placement of the APs at fixed location.

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