InfraRad: A Radio-Optical Beaconing Approach for Accurate Indoor Localization

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ABSTRACT

Accurate indoor localization is a big driving force for many human-centric applications. Over the years, various approaches have been exercised, but still not converged to a common technique ready for commercial usage everywhere due to the energy, size or cost constraints. We present the *InfraRad* system that uses a hybrid radio-optical technique to achieve high localization accuracy with low energy consumption.

1. INTRODUCTION

The importance of indoor localization is well known. For example, since RADAR [2] was proposed as the first large-scale WiFi indoor localization system back in 2000, this area has attracted nearly 6000 follow-up projects of different forms in our community. Broadly speaking, most work fall into either probabilistic or deterministic approach. As a typical example of probabilistic approach, fingerprinting requires collecting signal statistics through a site survey, which is known to be tedious in both initial deployment and frequent recalibration later to maintain long-term accuracy. In the family of deterministic approaches, the task could be decomposed into estimating the target's relative location to the reference points, which is essentially an Angle-of-Arrival (AoA) and ranging estimation problem. However, in order to achieve accurate estimation, it usually requires PHY-layer information, which often makes product development and deployment challenging due to energy, cost and design complexity constraints, such as UWB, MIMO or VLC.

To reduce energy consumption and hardware complexity while maintain high accuracy, we introduce *InfraRad*, a hybrid radio-optical localization system. The localization is achieved through AoA and ranging estimation using the infrared beacons transmitted from the battery-powered tags placed at strategic points. The receiver uses the ratio of the received power over multiple angled photodiodes to determine the AoA of the signals and uses the sum of absolute received powers to estimate the range of the signals. Each point is differentiated uniquely through an ID communicated via radio, and the radio link is also used to synchronize transmissions with the receiver and reduces battery energy consumption.

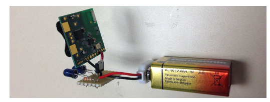

Figure 1: Our *InfraRad* tag.

2. INFRASTRUCTURE SETUP

We will demonstrate our system using a receiver apparatus where the radio-IR receiver with an array of photodiodes is mounted onto eyeglasses. With the premise of accurate angular and ranging estimation in our early work [1], we designed a localization algorithm to integrate multiple *InfraRad* beacons from different reference points to collaboratively determine not only the location but also fine-grained orientation. The radio module of the *InfraRad* receiver also periodically uploads the object position and orientation data to a local server. We will deploy several reference objects with our battery-powered *InfraRad* transmitter tags (each bearing a unique ID shown in Figure 1) in the target rooms and require line of sight to some of them. We will let the attendees wear the glass and find their locations through and android app installed on mobile phones. We will also demonstrate the details of the system functions using a calibrated setup.

3. REFERENCES

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