Exploiting LED Rolling-Shutter Effect in Indoor Positioning System
Modern Mobile Communications

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Abstract

It has been very mature to locate one's position in the outdoors using GPS like satellite positioning systems in a relatively acceptable deviation. However, Indoor Positioning System(IPS), still cannot be available in modern indoor environment such as airport or grand shopping plazas due to several constrains. But IPS has been proved to be very useful in the perspective future by the industry. Although this topic has been researched in recent 10 years in many related methods, there are two key issues of hardware cost against accuracy that cannot make a good balance between one another. In this article, we first give some research on related works of indoor positioning system, mainly on five systems of RADAR[00], Centaur[12], Cricket[04], Ubicarse[14], and Luxapose[14], then we fuifill the detail implementation of Luxapose, one method exploits visible light communication to realize IPS and evaluate its performance on some key factors of accuracy and available limit distance.

Keywords: IPS , AoA , Rolling Shutter, VLC

1. Introduction

Smart devices with cameras and LEDs are abundant in today's environment. This abundance creates an untapped opportunity for using these devices for wireless communication. Meanwhile, even if localization technology based on GPS developed maturely, we find the inconvenience with indoor localizations in malls or airports, which in fact in great need of the technology support of indoor localization since the environment is complex.

Indoor localization serves these situations, and it can detect a wireless user's gesture, movement, or can do location-based authentication. In this article we draws a novel way by exploiting the LED lights to realize this indoor localization problem.

This report does some survey on existing indoor localization methods and introduces some representative works in section 2. In section 3 we explicit the major task of Luxapose, involving the working scenario and techniques we planned to utilize, then we give a detailed definition of the indoor localization with LED AoA algorithm. In section 4 we introduced how the system been built on different modules. In section 5 we make an evaluation on several key metrics of location distance and accuracy and look forward to some future work that are needed to be worked on.

2. Related Works

Indoor localization has been worked on for years since its demand in industry is badly. We review four major representative work based on RF, acoustic, and MIMO techniques, the four main methods today in research of indoor localization. We analysis their defects to show the advancement in our work of Indoor Localization with LEDs.

2.1 RF-based Localization [Radar (2000)] [Centaur (2012)]

WiFi-based indoor localization approaches have been the center of attention in the field of indoor localization, due to their low deployment cost, potential for reasonable accuracy and readiness to be applied to mobile devices. Existing WiFi-based solutions usually fall into one of two categories: fingerprint-based and model-based approaches. We introduce fingerprint-based method by the Radar system, and model-based by the Centaur system.

While these methods have been shown to achieve promising localization accuracy (below 10 meters at 90% tile) under lab conditions, large-scale accurate indoor localization systems have yet to be developed. For example, given realworld fingerprint sampling conditions, the localization accuracy of existing approaches in large venues like shopping malls and airports can still be up to 25m at 90% tile; similar results are reported by Google[1]

2.1.1 RF-based Localization [Radar (2000)]

The fingeprint-based solution fingerprints locations in the area pf interest and then searches for the best matching location.

The model-based solution trains a signal propagation model using training/calibration data then applies trilateration for localization.

Radar first collects fingerprints from various known locations to build up a fingerprint database. It then determines the position of an incoming fingerprint by comparing it against all fingerprints in the database, an averages the locations of a few fingerprints nearest in signal space.

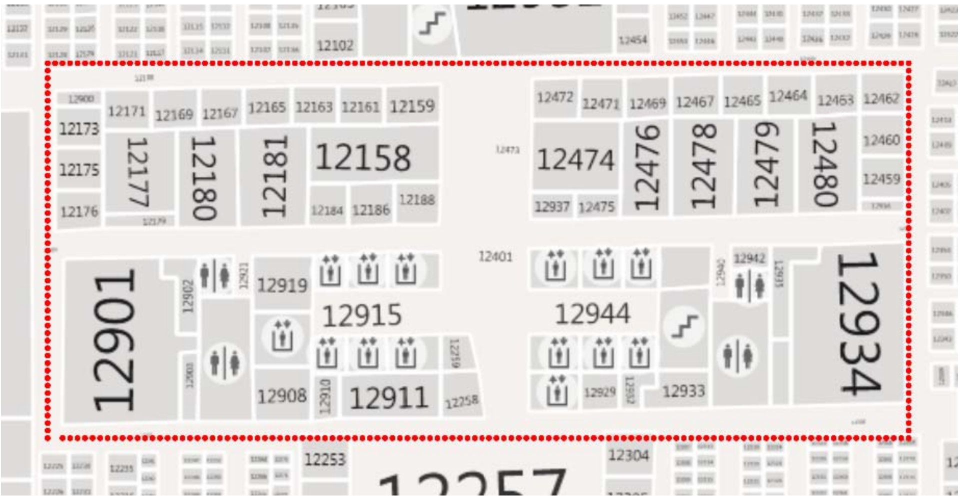

Figure 1: Fish

2.1.2 RF-based Localization [Centaur (2012)]

Centaur adopts the log-distance path loss (LDPL) model and trains model parameters from fingerprints with known locations. Model parameters instead of fingerprints are stored in the location database. Trilateration or multilateration is applied to estimate the location for an incoming fingerprint.

2.2 Acoustic-based Localization [Cricket (2004)]

2.3 MIMO-based Localization [Ubicarse (2014)]

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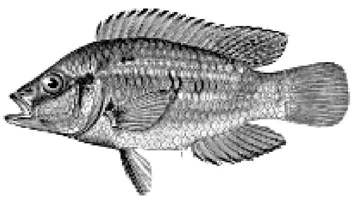

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3. Problem Definition and Algorithm of Luxapose

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4. System Modules Implementation

5. Evaluation and Conclusion

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