

# Indoor Positioning with FDM Coded RGBLEDs and Smart Phones

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**Abstract**—With the rapid proliferation of camera-equipped smart devices (*e.g.* smart phones, pads, gearings), visible light method as a novel way to suffice indoor positioning at mega malls or airports is appearing to be a reliable one since it provides high precision and with hardly additional peripherals excepts existing indoor LED luminaries compared with existing indoor positioning systems exploiting radio-frequencies that may defective at precision or RFID and other hardware-based approaches which needs rich deployment costs.

To achieve this goal, existing methods exploits the frequency domain to convey distinct landmarks. However, this relies on conditioned controlling of several rolling shutter camera parameters such as exposure time and is strictly limited to the highest exposure frequency since a camera can only identify different blink frequencies with sufficient small intervals parting them apart.

We describe our solutions that to address challenges mentioned above by exploiting a FDM coding mechanism to indicate multiple landmarks. After we determine the landmark, we can find a coarse positioning result collected from a digital map. We can introduce Angle of Arrival positioning algorithm to get a precise location as the result. Our prototype implementation demonstrate that our solution can offer an obviously promotion in the number of location landmarks compared to existing VLC based indoor positioning system under similar circumstances.

## I. INTRODUCTION

Indoor localization have increasingly significance in modern indoors scenarios since the building cover prevents the availability of GPS satellite positioning signals. We believe that for most mega malls or large airports, a precise and user-friendly positioning system would be mightly valuable since customers or passengers can be lost in a complicated indoors environment. Besides, a mall equipped with a positioning system can deliver guided recommendation of merchandise for customers who walks near it. As navigation and recommendation applications must rely on an indoor positioning system, We can figure out that a well designed indoor positioning system must satisfy at least four characteristics: 1)enough precise; 2)user friendly, which means user can attain the positioning results without extra active operations; 3)highly scalable, which means the system can be deployed in multi-layer skyscraper like buildings. 4)least extra hardware deployment, for you cannot prospect users to actively equip with an extra gearing that is essential for your system, and the ideal scene is the only needed equipment is barely the smart phone.

However, despite the strong demand, there are no existing systems that can cover the four characteristics listed above.

RF-based indoor localization systems such as RADAR delivers restricted accuracy. Indoors positioning system that rely on hardware such as RFID tags are restricted by the inconvenience and extra cost of hardware deployment. Existing visible light positioning systems as Luxapose have good performance in accuracy and with the only aid of smart phones, but it fails in the situation that it requires user to actively taking a photo and this is obviously inconvenient for user to follow, and besides, it's supported landmarks are strictly related to the performance of camera parameters, and for its experiment platform of Lumia 1020, no more than a hundred landmarks can be identified distinctly since its encoding algorithm is heavily dependent on the exposure time of smart phone camera. In section 2, we will identify these existing indoor positioning systems and try to list their flaws at the environment of actual deployment.

## II. BACKGROUND AND MOTIVATION

## III. SYSTEM ARCHITECTURE

## IV. BASIC DESIGN

### A. Encoding

### B. Decoding

### C. Positioning Algorithm

## V. IMPLEMENTATION

### A. Encoded RGBLED Board

### B. Decoding and Positioning Server

### C. Smart Phone Tracker

## VI. PERFORMANCE AND EVALUATION

## REFERENCES

- [1] H. Kopka and P. W. Daly, *A Guide to L<sup>A</sup>T<sub>E</sub>X*, 3rd ed. Harlow, England: Addison-Wesley, 1999.