بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

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MONA MAGHRABY

AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Electronics Engineering and Electrical Communications

Enhancing Indoor Localization System Based on Visible Light Communication

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

By

Marina Karmy Roufail Botros

Bachelor of Science in Electrical Engineering

(Electronics Engineering and Electrical Communications)

Faculty of Engineering, Modern Academy for Engineering and Technology, 2013

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Date: 19 October 2020

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

Rapidly growing in the demands of mobile users leads to an expansion in the need for alternative innovations. So, wireless communications based on Visible Light (VL) have lately become popular to support Radio Frequency (RF) technology. This is because of its advantages such as its availability everywhere, high Bandwidth (BW) and security, privacy, free license, and does not interfere to RF communication. Visible Light Communication (VLC) depends on the VL spectrum for communication, which has wavelengths of 380 to 780nm. It utilizes Light Emitting Diode (LED) or Laser Diode (LD) as a Transmitter (Tx) and Photodetector (PD) or image sensor as a Receiver (Rx). VLC is used in different applications, one of the most important applications is indoor localization. One of the localization methods is a two-step positioning method in which the localization process is performed in two steps: 1) Estimating distances between multiple reference points and a target. 2) Determining the target position from these estimated distances. The required distance can be obtained based on several methods like Received Signal Strength Indication (RSSI), Time of Arrival (TOA), Time Difference of Arrival (TDOA), and Angle of Arrival (AOA) method. Also, several techniques are used to get the target position, including proximity detection, geometric, and fingerprinting method.

In this thesis, an RSSI/TDOA hybrid VLC indoor localization system in a room with dimensions 5× 5× 3 m^3 is proposed. Although RSSI localization algorithm is simple, but its performance is poor at areas with low lighting intensity. Using this technique, the localization Root Mean Square Error (RMSE) value will be 15.66 cm at a noisy environment with total noise variance mean of $2.5109x10^{-12}$W. This error can be decreased by controlling some Tx and Rx parameters such as the Tx semi-radiation angle, Rx noise BW, and estimation approach used. Another localization algorithm, TDOA, which does not use the received light intensity information, can be used to estimate the target position. Some parameters that can also enhance this approach performance such as distribution of lights and the used estimation approach are also considered in this work. Based on TDOA algorithm the localization RMSE value will be decreased to 7.21cm but at the expense of cost and time. Therefore, the proposed system solved this problem by combining the two techniques and estimating the target position based on RSSI only at places with acceptable received electrical power (between $6.53x10^{-9}$:$9.91x10^{-9}$w or equal to $1.04x10^{-8}$W) while TDOA will be used at the other positions. Thus, the VLC indoor localization system RMSE will be decreased at the whole received area from 15.66cm (using RSSI technique only when the total noise variance mean is $2.5109x10^{-12}$W) to 6.68cm using this hybrid system.

Key words: AOA, BW, GPS, IR, LED, OWC, RFID, RMSE, RSSI, Rx, TDOA, TOA, Tx, VLC.

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