Optik 165 (2018) 54–73

Contents lists available at ScienceDirect

Optik

journal homepage: www.elsevier.de/ijleo

Original research article

A three-dimensional indoor positioning technique based on visible light communication using chaotic particle swarm optimization algorithm

Meiqi Zhang [a], Fangjie Li [a], Weipeng Guan [b,*], Yuxiang Wu [b], Canyu Xie [a], Qi Peng [a], Xiaowei Liu [b]

[a] School of Materials Science and Engineering, South China University of Technology, Guangzhou, Guangdong 510640, China
[b] School of Automation Science and Engineering, South China University of Technology, Guangzhou, Guangdong 510640, China

ARTICLE INFO

Article history:
Received 5 December 2017
Received in revised form 5 February 2018
Accepted 26 March 2018

Keywords:
Visible light positioning (VLP)
3-D indoor positioning
Chaos optimization algorithm (COA)
Chaotic particle swarm optimization (CPSO) algorithm
Positioning accuracy

ABSTRACT

In this paper, an indoor visible light localization system based on improved chaotic particle swarm optimization (CPSO) is proposed to achieve indoor 3-D positioning. In the field of visible light positioning, most of the localization is two-dimensional positioning under the condition of height determined. In addition, some three-dimensional visible light localization systems use a hybrid algorithm that greatly improves the computational complexity of the system, or requires the user to first provide a better initial point for three-dimensional positioning, which can't be applied to life well. In order to solve the problems in the field of VLP, this paper proposes an indoor visible light positioning system based on improved chaotic particle swarm optimization. In this paper, the chaos algorithm is firstly used in the visible light positioning area. Meanwhile, the proposed algorithm combines chaos algorithm and particle swarm optimization algorithm, and obtains a high positioning accuracy in the simulation space of 3 m × 3 m × 4m. Chaos optimization algorithm can make use of visible light indoor positioning system to achieve the positioning accuracy greatly, and join the particle swarm algorithm can offset the slow convergence of the chaos algorithm. The simulation results show that the visible light positioning system based on CPSO algorithm can achieve the average error of less than 1.4 cm, and the positioning accuracy of 96.6% sampling points can reach within 3.55 cm.

1. Introduction

In recent years, indoor positioning technology has shown great value in commercial development and public services, and has received widespread attention from the society. As a mature positioning system, the GPS (Global Positioning System) is widely used in outdoor positioning and has high positioning accuracy. However, due to the strength attenuation of satellite navigation signal passing through the wall and the serious indoor multipath effect, GPS has a large error in indoor positioning [1]. Therefore, many research institutes have put forward many indoor technologies based on wireless electromagnetic wave, such as infrared positioning, WLAN, RFID, Bluetooth, ZigBee, UWB, ultrasonic positioning and so

* Corresponding author.
E-mail address: gwpscut@163.com (W. Guan).

https://doi.org/10.1016/j.ijleo.2018.03.120
0030-4026/

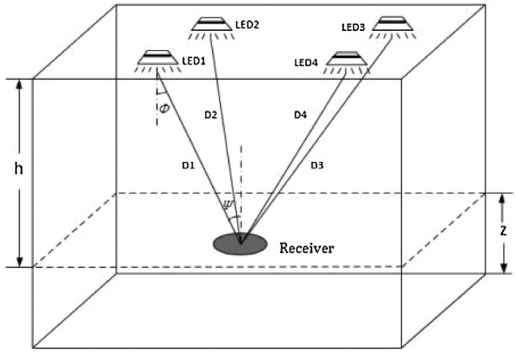

Fig. 1. The scene graphic of indoor positioning based on VLC.

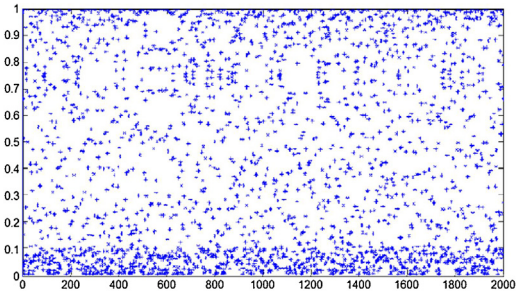

Fig. 2. A chaotic sequence which is obtained by iterating 2000 times with x(0) = 0.45 as the initial point.

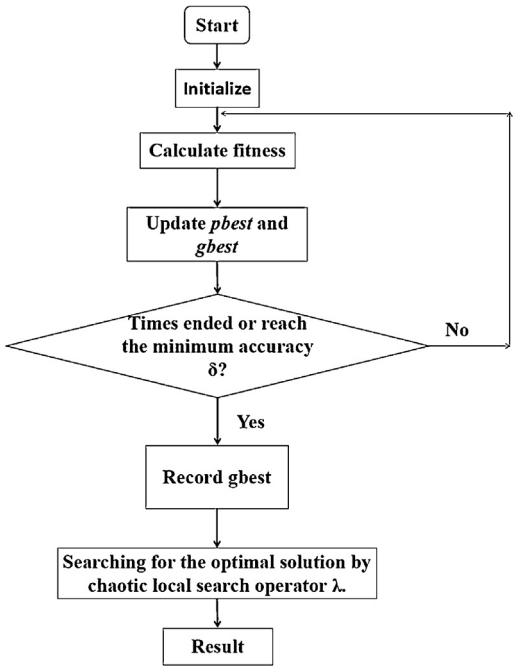

Fig. 3. Improved CPSO algorithm flow diagram.

on, which can achieve a positioning accuracy ranging from several meters to tens of centimeters. However, most systems based on wireless communication are subject to electromagnetic interference, and the positioning quality will be affected when shared by multiple users. Also, the systems based on RF (Radio frequency) are limited in electromagnetic sensitive environments such as hospitals and airplanes [2].