Moth Flame Optimization Algorithm Range-Based for Node Localization Challenge in Decentralized Wireless Sensor Network

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ABSTRACT

Recently developments in wireless sensor networks (WSNs) have raised numerous challenges, node localization is one of these issues. The main goal in of node localization is to find accurate position of sensors with low cost. Moreover, very few works in the literature addressed this issue. Recent approaches for localization issues rely on swarm intelligence techniques for optimization in a multi-dimensional space. In this article, we propose an algorithm for node localization, namely Moth Flame Optimization Algorithm (MFOA). Nodes are located using Euclidean distance, thus set as a fitness function in the optimization algorithm. Deploying this algorithm on a large WSN with hundreds of sensors shows pretty good performance in terms of node localization. Computer simulations show that MFOA converge rapidly to an optimal node position. Moreover, compared to other swarm intelligence techniques such as Bat algorithm (BAT), particle swarm optimization (PSO), Differential Evolution (DE) and Flower Pollination Algorithm (FPA), MFOA is shown to perform much better in node localization task.

KEYWORDS


INTRODUCTION

WSN (Wireless Sensor Network) is an ad hoc network with a large number of nodes that are micro-sensors capable of collecting and transmitting environmental data in an autonomous way. The nodes position is not necessarily predetermined, they can be randomly scattered in a large geographical area, called “sensing area” corresponding to the area of interest for the phenomenon being captured. In WSN, a large number of nodes are distributed in network field, the information detected by the sensor node will be gathered and transmitted by multi-hop techniques to sink (see Figure 1).

A detailed survey of the relevant literature is available (Akyidiz et al., 2002; Yick et al., 2008), recently, WSN has become a very active domain. WSN has widened areas of application: in monitoring

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(Sung et al., 2016), a smart environment (Xia & Song, 2018), urban warfare (Rashid & Rehmani, 2016), medical domain (Sharma & Bhatt, 2018) and military application (Mahamuni, 2016). In addition, several kinds of WSN architecture of layers and optimization paradigm are described in the literature (Iqbal et al., 2015).

Furthermore, technical issues are also addressed in WSN such as fault tolerance, scalability, power consumption, deployment, topology maintenance (Sharma et al., 2013).

Node localization is widely considered to be the most important challenges in WSN (Boukerche et al., 2007). Much work on the potential of node localization has been carried out and it plays an important role such as Industry (Derr & Manic, 2015), habitat monitoring (Nguyen et al., 2017), health applications (Livinsa & Jayashri, 2016; Ammari & Chen, 2017) sniper localization (Figure 2).

Node localization is mainly estimating the location of the sensors with initially unknown location information. Localization uses knowledge of the absolute positions of a few sensors and inter-sensor measurements such as distance and bearing measurements. Sensors with unknown location information are called non-anchor nodes, whereas sensors with known location information are called anchor or beacons nodes. The self-localization capability is highly desirable in environmental monitoring applications as example: the monitoring and supervision of patients which has been carried out are often executed manually, each patient is equipped with a sensor. Note that, a hardware setup must be carried out for monitoring moving target and tracking. The gathered information by the sensors will be transmitted at each period to the base station and compared with the standard value of the patient, and intervene if it needs.

A simple way to locate sensors is to embed node with Global Positioning System (GPS) devices. This solution is not appropriate for many reasons:

- The high cost of the device in a term: value, energy, computation power and space;
- The poor precision of the service in special environments (indoors, underground, etc.).

A good way to avoid using GPS is to call optimization approaches. In (Doherty et al., 2001), a convex optimization approach is proposed to locate nodes in a WSN.
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