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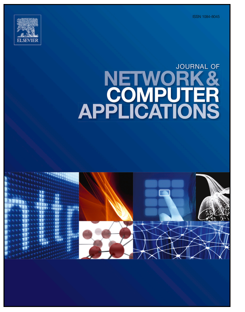

Differential evolution algorithm applied to wireless sensor distribution on different geometric shapes with area and energy optimization

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Differential evolution algorithm applied to wireless sensor distribution on different geometric shapes with area and energy optimization

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Abstract Sensor distribution is a significant issue in wireless sensor networks and has been frequently sub-optimally solved by several heuristic algorithms. This research applies multi-objective differential evolution algorithm to jointly optimize the sensors distribution over diverse area shapes, increase the coverage area and reduce the network energy at the same time. A case base and different scenarios with constraints are considered. The restrictions are based on the boundaries of the delimited areas to prevent their centers to be close to the given boundaries, and on the area of interest by reducing the overlap among the covered areas of the nodes. At the end, the shortest distance between the initial node positions and the final node positions is determined finding which node should go in which position using the Hungarian algorithm. Finally, a minimum spanning tree among the nodes is also obtained. The results for different sensor network sizes from 9 up to 56 sensors and different sizes of target areas are presented (fitness, coverage area, energy and needed generations). The computed results show that the right combination of the control parameters leads to an optimized energy and a total coverage area of at least 87% of the target area.

Keywords Wireless sensor networks, sensor distribution, coverage area, energy consumption, differential evolution.

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1 Introduction

Typically, wireless sensor networks (WSNs) use a large number of sensor nodes. These are densely positioned within the sense perception area or near to it. Commonly, a sensor has wireless communication, collaborative signal processing, low energy consumption, and querying abilities [1,2]. The WSNs help to determine the value of some parameters at a given location, detect the occurrence of an event, estimate the parameters of a detected event or events, classify a detected object, and track an object. Some significant issues in wireless sensor networks, among others, are sensor distribution, sensor coverage area, topology optimization, connectivity, and routing. Based on [3–6], sensor distribution with minimum energy connectivity in wireless networks is an NP-complete problem.

Nowadays, sensor distribution is one of the essential problems in WSNs, and normally is sub-optimally solved by heuristic algorithms, like genetic algorithms, among some others as shown by [7–11]. The sensor coverage problem is treated in the literature and it consists in analyzing how sensors fill a physical space. The coverage concept is a measure of the quality of service (QoS) of the sensing function and is subject to a wide range of interpretations due to the great variety of sensors and applications [12]. In [13], topology control is one of the problems in WSNs and a key factor to extend the network lifetime, to reduce radio interference, increase