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ORIGINAL ARTICLE

Process of 3D wireless decentralized sensor deployment using parsing crossover scheme

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Abstract A Wireless Sensor Networks (WSN) usually consists of numerous wireless devices deployed in a region of interest, each able to collect and process environmental information and communicate with neighboring devices. It can thus be regarded as a Multi-Agent System for territorial security, where individual agents cooperate with each other to avoid duplication of effort and to exploit other agent's capacities. The problem of sensor deployment becomes non-trivial when we consider environmental factors, such as terrain elevations. Due to the fact that all sensors are homogeneous, the chromosomes that encode sensor positions are actually interchangeable, and conventional crossover schemes such as uniform crossover would cause some redundancy as well as over-concentration in certain specific geographical area. We propose a Parsing Crossover Scheme that intends to reduce redundancy and ease geographical concentration pattern in an effort to facilitate the search. The proposed parsing crossover

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method demonstrates better performances than those of uniform crossover under different terrain irregularities.

1. Introduction

In recent years, territorial security have been studied intensively for various applications such as environmental monitoring and surveillance, such as airports, public transit, emergency services or nuclear facilities. When trying to monitor large geographically distributed area, in general Wireless Sensor Networks (WSN) are deployed. A WSN usually consists of numerous wireless devices deployed in a region of interest, each able to collect and process environmental information and communicate with neighboring devices (Wang and Tseng, 2008; Bai et al., 2006; Hefeeda and Ahmadi, 2009). Hence, A WSN can be regarded as a Multi-Agent System (Wooldridge, 2002; Hewitt and Inman, 1991; Ferber, 1999; Cai et al., 2011) for territorial security, where individual agents cooperate with each other to avoid duplication of effort and to exploit other agent's capacities (Wooldridge, 2002; Athanasiadis and Mitkas, 2004; Cai et al., 2011). Sensor deployment is an essential issue in WSN, as it affects how well a region is monitored by sensors. This is a critical issue as there are a number of high potential applications for sensor deployment, such as national defense (Nickerson and Olariu, 2007), home security (Zhang, 2008), industrial surveillance (Chen, 2008) and environmental monitoring, etc. the primary objective for sensor deployment is two-fold: WSN should cover a region of interest as complete as possible, while minimizing the number of sensors deployed, and thus minimizing costs associated with sensor deployment.

Considering a region of interest monitored by sensors, one of the most critical concerns is the region coverage (Wang and Tseng, 2008; Kar and Banerjee, 2003; Zhou et al., 2007; Kumar et al., 2006; Liu and Towsley, 2004; Hefeeda and Ahmadi, 2009; Romoozi and Ebrahimpour-Komleh, 2012). In general, one of basic requirements for a WSN is that each location in a region of interest should be within the sensing range of at least one of the sensors. An alternative approach is to have a region of interest covered simultaneously by at least K sensors (Wang and Tseng, 2008; Zhou et al., 2007). Some deterministic methods have been proposed to address the problem of coverage. It has been shown that covering an area with disks of equal radius can be done in an optimal manner (Bai et al., 2006; Hefeeda and Ahmadi, 2009; Kar and Banerjee, 2003). Similar results have been reported when multiple coverage of the target area is required (Bai et al., 2006; Zhou et al., 2007; Kumar et al., 2006; Wang and Tseng, 2008). Besides, the majority of optimization methods proposed are deterministic, and are generally functions of a fixed sensing range, as shown in Fig. 1.