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Energy Efficient Sensor Deployment with TCOV and NCON in Wireless Sensor Networks:

Energy Efficient Sensor Deployment with TCOV

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ABSTRACT

In the past years, wireless sensor networks (WSNs) have increased successful real-world deployment in a wide range of civil and military applications. In order to ensure effective environmental sensing and robust communication, the two fundamental issues like TCOV and NCON are the very challenging tasks in WSN. As sensor nodes are battery-operated devices, the wide utilization of WSNs is obstructed by the severely limited energy constraints, this article tackles these kinds of issues by proposing an approach based on the energy model and aims at enhancing the network lifetime by improved balancing the movement and energy losses in the network. This article proposes a design which minimizes the power consumption and movement cost, thus enhancing the network lifetime. Finally, the authors compared the energy efficiency of the proposed approach with that of the existing approach. As such, the proposed AVABC improves the network lifetime by 14.29%, 26.09%, and 14.29% over VABC in response to the varying sensing radius of 5, 10, and 15, respectively.

KEYWORDS

AVABC Algorithm, NCON, Sensor Deployment, TCOV, TV-Greedy Algorithm, Wireless Sensor Networks (WSNs)

1. INTRODUCTION

Recent advancement in wireless sensor networks is affordable and efficient using micro-electro-mechanical systems (MEMS). With its advancement different kinds of microsensors in WSN are available. The high speed and low power electronic devices are valid because of micro sensors (Huang et al., 2012; Blumrosen et al., 2013; Liu et al., 2013a; Wang et al.,2014; Tan et al., 2010a; Fu & You, 2013; Luo & Chen, 2012). These sensors are useful for monitoring physical phenomena, health care, surveillance and national security (Jagtap & Kumar, 2017; Alsmirat et al., 2017; Kartalopoulos., 2015). Typically, sensor nodes are small and tiny devices composed of three basic components namely, a sensing subsystem for transceiving the data, processing subsystem for acquired data processing and st1orage resources, and also possible actuators subsystems for transmitting the data (Omkar et al., 2011; Yildiz, 2012b; Ozturk et al., 2011; Tan et al., 2010b). Also, the organization of Sensor nodes in networks is particularly dense (Huping Xu et al., 2015; Liao et al., 2012b). Due to the smaller size of sensor nodes, the source of energy required by the device to function is provided by a tiny battery with a minimum energy budget. Since the WSNs are made up of tiny energy-hungry sensor nodes, their

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limitation is in its usage of energy constraints posed by the sensor nodes (Liu et al., 2013c; Liao et al., 2014; Zahhad et al., 2015). A major issue in WSNs is power scarcity, driven during environmental monitoring, data processing, and wireless communications.

To overcome this issue, a WSN with proper sensor node deployment is considered to improve the sensing as well as communication capabilities of the physical environment (Korbi & Zeadally, 2014; Liao et al., 2012a; Dorigo & Birattari, 2010; Agarwal et al., 2014; Stergiou et al., 2018). In general, a successful sensor node deployment strategy should consider both connectivity and target coverage of the network (Agarwal et al., 2015; Luo et al., 2012; Mini et al., 2014; Temel et al., 2014; Liu, 2012). The main objective of WSN is the target coverage (Alkhazaali, et al., 2017; He et al., 2013; Liu et al., 2013b;) (He et al., 2012; Mahboubi et al., 2011; Mahboubi et al., 2014; Yang et al., 2010). Coverage means each node in the network should be involved in the quality of surveillance (Luo et al., 2014; Mathews & Mathew, 2012; Shi et al., 2015). The sensor node's prime function represents every location in the Region Of Interest (ROI), it is sensed for any incidence of the event of interest (Wang et al., 2013). The events detected by these mobile nodes in the heterogeneous network should be involved in communication with the sink called Connectivity and network is not separated while on sensor node communication. Therefore, the efficiency of WSN has significantly depended on Sensor Node Deployment.

Two different strategies of sensor node deployment are deterministic and random deployment strategy. In deterministic deployment strategy, the sensor nodes are deployed deterministically in order to meet the predetermined goals (Yen & Cheng, 2009) In such cases, the coverage of ROI has ensured through the predetermination of exact sensor locations. In the case of random deployment strategy (Sonmez, 2011; Yildiz, 2012a; Akay, 2013; Develi et al., 2015), an unrestrained degree of target coverage in the ROI can be improved either by detaching sensor nodes randomly with larger sensing area or by deploying larger sensor nodes with smaller sensing ranges. This helps to ensure its effective coverage in outdoor surveillance applications (Rebai et al. 2015).

TCOV and NCON together can be treated as a measure of the quality of service in a sensor network; it tells us how well each point in the region is covered and how accurate is the information gathered by the nodes. They are fundamental and crucial in designing a wireless sensor network. The TCOV is essential to find optimal scheduling for sensors lifetime to monitor every target can be as long as possible, which is concerned with the random deployment of sensor nodes for monitoring the specific targets for maximum duration. Moreover, for successful communication better NCON is necessary. Hence it is important to investigate TCOV and NCON issue. In this paper, we discuss an updated review of sensor node deployment techniques being used to solve different problems in heterogeneous environment and sort the subsequent contributions: (1) We propose a new analytical precision model for the target coverage and energy constraint network lifetime of the heterogeneous WSNs. (2) We propose the ECST-AVABC algorithm for maintaining the network connectivity between the sink and the coverage sensors, as per the geometry of the optimal path routing. (3) Moreover, we added specific attention for the design of energy-efficient sensor networks using the proposed TCOV and NCON methods that satisfy application requirement.

The rest of this paper is as follows, we first focus on the two mobile sensor deployment problem for heterogeneous WSNs and formulate the conventional solutions of sensing the coverage of sensor nodes and connectivity in Section II. The optimal deployment in the sensor networks with energy constraint is analysed in Section III. Section IV presents TCOV and NCON methods based on the improvement of sensing performance as well as maintain connectivity with the sink. Section V presented the experimental results, and finally Section VI provides the conclusion of this paper.