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Research Article

Metaheuristic Load-Balancing-Based Clustering Technique in Wireless Sensor Networks

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The resource-constrained nature of wireless sensor networks engenders the development of energy-efficient network operations. To mitigate the prime concern of developing an energy-efficient network, clustering of the nodes has emerged as a very effective tool. If executed intelligently, clustering can not only help in obtaining even load distribution among the network nodes but also help in having the enhanced network lifetime and scalability. In this work, a Metaheuristic Load-Balancing-Based Clustering Technique (MLBCT) in wireless sensor networks has been proposed which formulates the energy-balanced clusters based on the differential evolution technique to improve the network lifetime. To ensure the formation of balanced clusters, several metrics like nodes' proximity, nodes' distribution, and energy distribution across the sensing field have been considered. Moreover, to facilitate the even load distribution among the cluster members, a randomized rotation of cluster head is implemented. The supremacy of the proposed scheme is confirmed through an extensive set of simulations against the state-of-art schemes. Simulation results reflect an average gain of 51.85% in network lifetime under the variable network configurations in an ideal environment. Moreover, a thorough statistical analysis is performed to prove the efficacy of the proposed fitness function by obtaining confidence intervals under two different network scenarios with variable node counts.

1. Introduction

A wireless sensor network (WSN) comprises a large number of tiny devices capable of sensing the surrounding, processing the collected data as per the application, and communicating the processed field information to the centralized base station (BS) [1]. However, the sensor nodes deployed (either randomly or deterministically) in the sensing field suffer from several constraints. They are limited in processing abilities, storage abilities, power, and other allied restrictions [2]. Among all these restrictions, limited power is the most severe one as the node drained of all the energy and frequent recharging and replacement cannot be facilitated, especially in remote applications of WSN like habitat monitoring, environmental monitoring, industrial monitoring, and military surveillance systems [3, 4].

Typically, transmission and route allocation consume most of the nodes' energy and are very much responsible for the power drainage of the sensor nodes. Thus, to solve this issue, energy-efficient network layer operations have been targeted by researchers for many years. Routing is the main functionality of the network layer, and hence,