

RESEARCH ARTICLE

Energy-aware intelligent hybrid routing protocol for wireless sensor networks

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Abstract

Designing a wireless sensor network (WSN) energy-aware routing protocol is a thought-provoking mission. Thus, this article presents an energy-saving routing protocol for WSNs. The proposed protocol considers the energy level of sensor nodes and the distance to the base station to optimally determine the best route. It also takes advantage of the inherent complementarity of clustering techniques. The proposed routing scheme also exploits data aggregation to improve energy utilization and reduce communication costs. To choose the flawless route between a source node and the base station, ant colony optimization and A* algorithms are integrated. Finally, the performance of the proposed routing technique is compared with those of other existing up-to-date protocols. The results show that the proposed routing protocol outperforms them in terms of total energy consumption, network lifetime, stability period, and goodput.

KEYWORDS

a* algorithm, ant colony optimization, data aggregation, routing protocols, wireless sensor networks

1 | INTRODUCTION

WSNs are used in a wide range of applications, including, but not limited to, military, environmental, health, and commercial applications.^{1,2} However, WSNs encounter many challenges, among which the most significant one has to do with the limited power resources of the sensor nodes since these nodes are equipped with a battery. Moreover, recharging or replacing batteries is very hard and costly.^{1,3} Routing data packets inside a WSN is one of the main sources of energy dissipation. Thus, recently, developing energy-aware routing protocols has gained great prominence. Various factors affect the energy dissipation in routing packets, such as idle listening, redundant data transmission, direct versus multi-hop transmission, and so on. In large networks, multi-hop routing consumes less energy than direct routing. However, the main issue is that there are many alternative paths between the source and the destination nodes. Therefore, routing protocols should effectively and efficiently determine the best path.

Recently, many researchers have developed swarm intelligence (SI) based routing algorithms to determine the best path to send data packets from a source node to a base station (BS).⁴ SI-based protocols are inspired by the behavior of various creatures, such as birds, bees, and ants. Among various swarm intelligence-based algorithms, ant colony optimization (ACO) has been the most commonly used in WSN routing protocols.⁵ It is used to find the route from a source node to the BS that consumes less energy while not considering the distance to the BS. Therefore, some other researchers selected the shortest route to the BS, regardless the energy consumption. A* is one of the most famous algorithms to find the shortest path between two nodes. For further energy saving, clustering schemes readers can refer to Reference 6, where nodes are assembled in clusters of equal or unequal sizes. Only one node in each cluster is chosen as cluster head (CH), which collects data packets from member nodes, removes data redundancy, and transmits an aggregated packet to the BS.