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Employing Grey Wolf Optimizer for Energy Sink Holes Avoidance in WSNs

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Abstract
Many efficient data gathering approaches have been proposed utilizing a mobile sink (MS). MS significantly alleviates the energy holes that result from multi-hop data dissemination near the stationary sink in wireless sensor networks (WSNs). However, most of those approaches design a predetermined MS trajectory that may encounter changes in sensor nodes status during the MS roaming. Thus, this paper proposed two MS methods called fuzzy *A*-star sink mobility (FASM) and grey wolf mobility (GWM). Both methods aim to alleviate the energy holes and data latency by considering the residual energy, sensor density, source sensors angle, and traffic load as guiding parameters for the next potential position. FASM uses a grid model with a fuzzy inference system, while GWM uses the grey wolf optimizer to explore the optimal MS position precisely. Both methods utilize fuzzy*A*-star routing protocol to run all sensors even if they were far from the MS to reduce the buffers overflow and provide a balanced energy consumption during data routing. The effectiveness of the proposed schemes for prolonging the WSNs lifetime is confirmed through strict simulations as they have been compared with two efficient existing protocols which are WRP and DBRkM.

Keywords WSNs · Grey wolf optimizer · Fuzzy inference system · Mobile sink · Routing protocol

1 Introduction

WSNs are large-scale ad hoc networks that consist of tiny, inexpensive, and battery-powered devices which densely distributed in the field for sensing the desired physical properties, aggregating data, and wirelessly transmitting it to a data collector center known as the sink [1–3]. WSNs have widespread applications in different fields such as natural disaster prediction, military monitoring systems, and healthcare [4].

Over the past few years, prolonging the network lifespan has revolutionized the state of the art, since the data throughputs are very low in wireless communication model, and conventionally, thousands of limited battery-powered sensor nodes (SNs) are distributed randomly over dangerous unreachable environments; therefore, it is hard to replace or recharge the dead battery of SNs [5]. In the context of power-saving, the communication distance plays an essential role in the energy consumption issues, where the quantity of energy depleted by the source SN increases super-linearly with the distance between the source SN and the destination [6].

In multi-hop data transmission techniques, SNs collaborate to deliver the packets hop by hop to a stationary sink which forces the SNs near the sink to take charge of transmitting the packets from the entire network to the sink, thus their energy is dissipated more quickly than any other SNs, due to a significant traffic overhead near the sink [7–9]. This problem was called "Energy sink-holes problem" [10], or "bottleneck problem" [1]. Hence, the nearest SNs are to the sink, the more their battery drains out, whereas those situated remote to the sink may preserve more than 90% of their initial energy [11]. As a result of such non-homogeneity in the energy consumption, if those overloaded SNs die, the sink would not be able to collect any data packets, although a tremendous number of away SNs still retain an abundant amount of energy, and will lead to forming a disconnected WSN that suffers from a bad coverage and connectivity [11, 12].

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