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Energy-efficient geographic routing algorithm in event-driven wireless sensor networks using an enhanced TOPSIS approach

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ABSTRACT

Event-driven Wireless Sensor Networks (WSNs) are a fundamental component of the Internet of Things (IoT), reporting data only upon event occurrence to conserve energy. A critical aspect of these networks is geographic routing, where routing decisions are based on node locations rather than identifiers, reflecting the spatial relevance of detected events. However, conventional geographic routing algorithms suffer from workload imbalance, congestion, and high energy consumption, limiting network lifetime and reliability. To address these issues, this study proposes a novel geographic routing algorithm based on the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS). The algorithm introduces a new decision metric, Exclusive Routing Share (ERS), that identifies and prevents node overutilization, thereby mitigating bottlenecks. It selects optimal forwarding nodes based on multiple criteria: residual energy on the path, hop count, delivery ratio, distance, and ERS, enabling more balanced and energy-efficient routing than traditional shortest-path methods. The algorithm's effectiveness was evaluated through extensive simulations under varying network conditions and compared with the benchmark Fault-Tolerant Routing (FTR) algorithm. Quantitative results show a 15.4% reduction in packet error rate, a 14.9% increase in network lifetime, and a 1.46% improvement in packet delivery ratio. These findings demonstrate that the proposed TOPSIS-based approach significantly enhances energy efficiency, reliability, and workload balance in event-driven WSNs.

Subjects Computer Networks and Communications, Network Science and Online Social Networks, Optimization Theory and Computation, Theory and Formal Methods, Internet of Things
Keywords Energy preservation, Event-driven, Geographic routing, IoT, Multi-Criteria Decision Making (MCDM), TOPSIS, WSNs

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INTRODUCTION

The rapid expansion of the Fourth Industrial Revolution (IR 4.0) and the advent of the Internet of Things (IoT) have laid a key foundation for future industrial and technological advances (*Adday et al., 2023*; *Majid et al., 2022*). These paradigms highlight the