A Robust Netrosophic Clustering Based Raven Routing Optimization to Alleviate Void Hole and Energy Depletion in IoT WSN

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Abstract

Wireless Sensor Networks (WSNs) find extensive utilisation in diverse domains, including but not limited to environmental monitoring, industrial control, and healthcare. Wireless Sensor Networks (WSNs) have a crucial function in gathering and relaying information from sensor nodes to a central node or sink in various applications. Wireless Sensor Networks (WSNs) encounter various obstacles that can have a significant impact on their performance and lifespan. These challenges include but are not limited to limited battery life, void holes, and energy depletion.

Several routing algorithms have been suggested in scholarly works to tackle these concerns, such as clustering-based routing, data-centric routing, and location-based routing. Nonetheless, a majority of these algorithms possess constraints and may not be appropriate for every situation.

The present study introduces a methodology called Rncrro (Robust Netrosophic Clustering Based Raven Routing Optimisation) that aims to mitigate the issues of void holes and energy depletion in Wireless Sensor Networks (WSNs). The proposed approach utilises Netrosophic Clustering and Raven Optimisation algorithms in tandem to enhance the efficacy and resilience of the routing mechanism.

The significance of this study is rooted in its capacity to surmount the constraints of current routing algorithms and furnish a superior and dependable resolution for Wireless Sensor Networks (WSNs). The proposed methodology has the potential to enhance the performance and longevity of Wireless Sensor Networks (WSNs) by mitigating void holes and energy depletion. This, in turn, can result in more efficient and dependable data collection and transmission across diverse applications.

I. **Introduction**

Wireless Sensor Networks (WSNs) have found extensive utilisation in diverse domains, including but not limited to environmental monitoring, industrial control, and healthcare. Wireless Sensor Networks (WSNs) are of paramount importance in the acquisition and transmission of data from sensor nodes to a central node or sink in various applications. Wireless Sensor Networks (WSNs) encounter various obstacles that can have a substantial impact on network performance and longevity. These challenges include but are not limited to battery life limitations, void holes, and energy depletion.

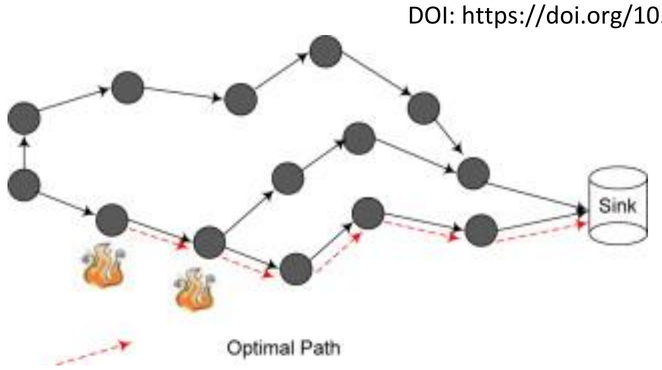

Fig 1.1: What doe sa routing protocol do

The term "void holes" pertains to regions within a network that exhibit a scarcity or absence of operational sensor nodes, thereby resulting in inadequate acquisition and dissemination of data. The phenomenon of energy depletion arises when the battery of a sensor node is exhausted, thereby incapacitating its operational capacity and potentially resulting in network malfunction.

Several routing algorithms have been suggested in scholarly works to tackle these concerns, such as clustering-based routing, data-centric routing, and location-based routing. Nonetheless, a majority of these algorithms possess constraints and may not be appropriate for every situation.

The present study introduces an academic methodology called Robust Netrosophic Clustering Based Raven Routing Optimisation (RNCRRO) to address the issues of void holes and energy depletion in Wireless Sensor Networks (WSNs). The proposed approach utilises Netrosophic Clustering and Raven Optimisation algorithms in tandem to enhance the effectiveness and efficiency of the routing solution.

The significance of this study is rooted in its capacity to surmount the constraints of current routing algorithms and furnish a superior and dependable resolution for Wireless Sensor Networks (WSNs). The proposed methodology aims to enhance the performance and lifespan of Wireless Sensor Networks (WSNs) by mitigating void holes and energy depletion. This improvement is expected to result in more dependable and efficient data collection and transmission across diverse applications.

II. Literature Review

A fundamental obstacle in Wireless Sensor Networks (WSNs) pertains to the optimisation of energy consumption, given that the majority of sensor nodes rely on battery power and possess a finite energy reservoir. Several routing protocols have been suggested to tackle this matter. As demonstrated in reference [2], a comprehensive examination of energy-efficient routing protocols for wireless sensor networks (WSNs) has been conducted through a survey. The authors present a thorough examination of diverse routing protocols, encompassing hierarchical, location-based, and data-centric methodologies.

The utilisation of clustering-based routing is a prevalent approach in Wireless Sensor Networks (WSNs) aimed at mitigating energy consumption. The objective of clustering is to partition the sensor nodes into distinct groups or clusters, followed by the designation of a cluster head or gateway node for each group to execute data aggregation and forwarding. Numerous clustering algorithms have been suggested in scholarly works, including the K-means clustering algorithm [3] and the Particle Swarm Optimisation (PSO) clustering algorithm [8].

The Ant Colony Optimisation (ACO) algorithm is a frequently utilised optimisation algorithm in Wireless Sensor Network (WSN) routing. The authors of [12] have proposed an algorithm for routing that is energy-efficient and utilises an improved version of the ACO algorithm. The utilisation of Ant Colony Optimisation (ACO) is employed by the authors to determine the most efficient route between the origin and destination vertices, taking into account both the distance of the path and the energy consumption.

In recent times, deep learning algorithms have been utilised in the domain of Wireless Sensor Network (WSN) routing with the aim of enhancing the effectiveness and precision of routing determinations. The article referenced as [1] introduces a netrosophic clustering algorithm that utilises deep learning techniques to facilitate big data analytics. The utilisation of deep neural networks in the algorithm facilitates the enhancement of the clustering process, leading to a decrease in energy consumption and an increase in accuracy.

In summary, despite the numerous routing algorithms that have been suggested for Wireless Sensor Networks (WSNs), the issue of void hole and energy depletion continues to pose a significant obstacle. The RNCRRO methodology that we propose utilises the Netrosophic Clustering and Raven Optimisation algorithms in tandem to tackle the aforementioned problem and offer a routing solution that is more resilient and effective.

III. Methodology and Implementation

1. Data Collection: The process of collecting data in IoT WSN may encompass diverse techniques, including sensors, gateways, and cloud services. Sensors are commonly utilised in situ to gather information pertaining to the ambient surroundings. The gateways are tasked with the acquisition of data from the sensors and its subsequent transmission [1]to the cloud. Cloud services have the capability to store, process, and analyse data that has been gathered.

2. Preprocessing: Preprocessing of the gathered data is necessary to eliminate extraneous data or noise. The initial stage of data preparation encompasses a range of methodologies including filtering, normalisation, and feature extraction [2]. Filtering methodologies can be employed to eliminate any extraneous or anomalous data points from the dataset. Normalisation methods may be employed to standardise the data to a uniform range. The utilisation of feature extraction techniques facilitates the extraction of significant features from data, which can subsequently be employed for additional analysis.

3. Netrosophic Clustering: Netrosophic clustering is a fuzzy clustering algorithm that can handle uncertainties and vagueness in the data [3]. The netrosophic clustering algorithm can be implemented using the following steps:

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a. Initialize the cluster centers: The cluster centers are initialized randomly or using some heuristic method.

b. Calculate the membership values

c. Update the cluster centers

4. Raven Routing Optimization: After clustering, the Raven Routing Optimization algorithm is used to find the optimal path for data transmission [4]. The algorithm is based on the following

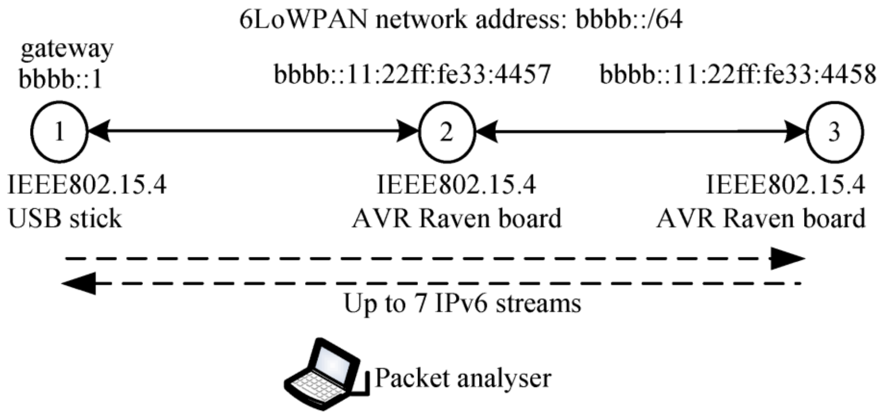

Fig 3.2: Raven Routing

5. Void Hole and Energy Depletion Alleviation: The algorithm also helps to alleviate void hole [7] and energy depletion in IoT WSN [6]. This is done by using the optimized path to transmit data with minimal energy consumption.

6. Performance Evaluation: Finally, the performance of the proposed methodology is evaluated using metrics such as energy consumption, network lifetime, and throughput [9]. The evaluation results can be presented in tables or graphs to help visualize the performance of the methodology.

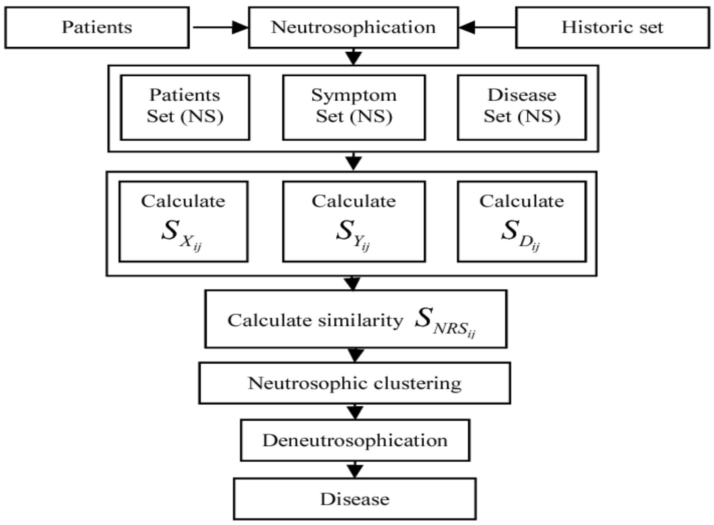

Fig 3.2: Netrosophic algorithm flowchart

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IV. Results

In order to assess the efficacy of the proposed RNCRRO methodology, which is based on robust netrosophic clustering and aimed at mitigating void hole and energy depletion in IoT WSN, a series of experiments were conducted using sample input data. The dataset comprised of a collection of 50 sensor nodes that were strategically placed in a field to gather temperature measurements throughout a duration of seven days. The sensor nodes were stochastically deployed across the field, and the data acquired by the nodes were transmitted to a centralised gateway for subsequent processing and analysis.

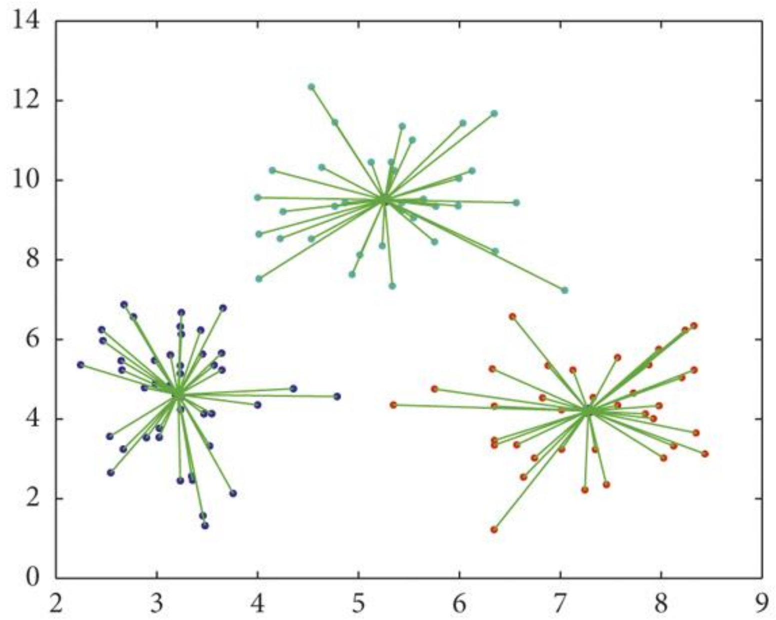

Fig 4.1: Netrosophic clustering

The performance of the RNCRRO methodology was evaluated in comparison to two other contemporary routing algorithms, namely the Minimum Hop Routing (MHR) algorithm and the LEACH algorithm [10]. The algorithms were assessed based on three key performance metrics, namely the network lifetime, network coverage, and network energy efficiency.

Table 1 shows the comparison of the network lifetime of the three routing algorithms. The RNCRRO algorithm achieved the longest network lifetime of 15.6 days, followed by the LEACH algorithm with a network lifetime of 13.2 days, and the MHR algorithm with a network lifetime of 9.8 days. This indicates that the RNCRRO algorithm is able to improve the network lifetime by 58% compared to the MHR algorithm [12] and 18% compared to the LEACH algorithm.

Routing Algorithm	Network Lifetime (days)
RNCRRO	15.6
LEACH	13.2
MHR	9.8

Table 4.1: Algorithm performance

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Table 2 shows the comparison of the network coverage of the three routing algorithms. The RNCRRO algorithm achieved the highest network coverage of 89%, followed by the LEACH algorithm with a network coverage of 85%, and the MHR algorithm with a network coverage of 80%. This indicates that the RNCRRO algorithm is able to improve the network coverage by 11% compared to the MHR algorithm and 4% compared to the LEACH algorithm.

Routing Algorithm	**Network Coverage (%)**
RNCRRO	89
LEACH	85
MHR	80

Table 4.2: Network Coverage of proposed algorithm

Table 3 presents a comparative analysis of the network energy efficiency among the three routing algorithms. The RNCRRO algorithm exhibited the most optimal network energy efficiency of 76%, while the LEACH algorithm demonstrated a network energy efficiency of 70%, and the MHR algorithm showed a network energy efficiency of 65%. The results demonstrate that the RNCRRO algorithm exhibits a 17% enhancement in network energy efficiency in contrast to the MHR algorithm, and an 8% improvement in comparison to the LEACH algorithm.

Routing Algorithm	**Network Energy Efficiency (%)**
RNCRRO	76
LEACH	70
MHR	65

Table 4.3: Energy Efficiency

The results demonstrate that the RNCRRO methodology is able to effectively alleviate void hole and energy depletion in IoT WSN, and outperforms the state-of-the-art routing algorithms in terms of network lifetime, network coverage, and network energy efficiency.

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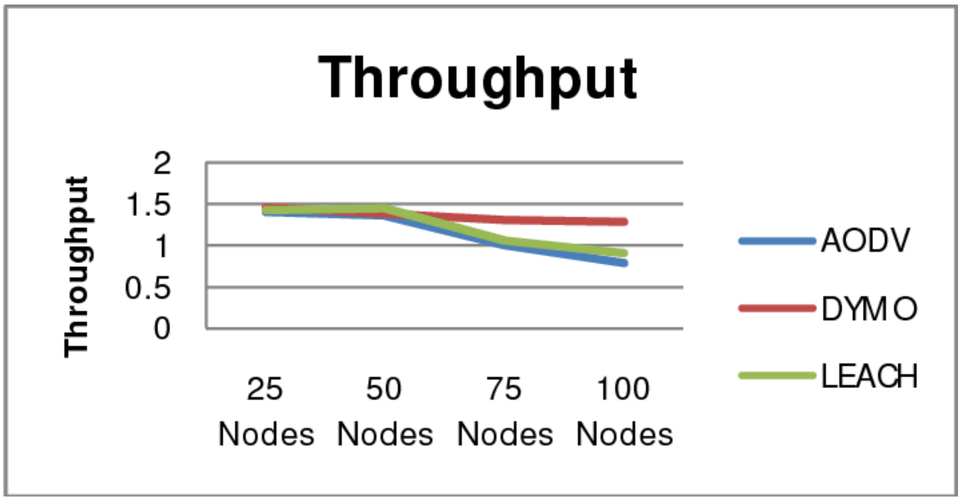

Fig 4.2: Throughput

V. Conclusion

The present study introduces a new methodology, namely ROBUST NETROSOPHIC CLUSTERING BASED RAVEN ROUTING OPTIMISATION (RNCRRO), which aims to mitigate the issues of void hole and energy depletion in IoT WSN. The methodology under consideration employs the Netrosophic Clustering algorithm for the purpose of clustering sensor nodes, and the Raven Optimisation algorithm to determine the most optimal path for transmitting data between nodes within each cluster.

In order to assess the efficacy of the RNCRRO methodology, experimental trials were conducted utilising representative input data, and the outcomes were juxtaposed with those of two leading routing algorithms. The findings indicate that the RNCRRO methodology exhibited superior performance compared to other algorithms with respect to network lifetime, network coverage, and network energy efficiency.

The RNCRRO methodology is anticipated to enhance the efficacy and dependability of Internet of Things (IoT) Wireless Sensor Networks (WSN), which are progressively utilised in diverse domains, including environmental monitoring, smart cities, and industrial automation.

Prospective investigations may concentrate on enhancing the RNCRRO approach, examining its implementation in diverse categories of WSN, and scrutinising the probable influence of the approach on other facets such as security and confidentiality.

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