**Iraqi Journal for Computers and Informatics**
**Information Technology and Communications University**
**Vol. 50, No. 1, 2024,**

**DOI:** https://doi.org/10.25195/ijci.v50i1.472

**Print ISSN: 2313-190X, Online ISSN: 2520-4912**

**Research Article**

# Routing Protocol Mechanisms in Wireless Sensor Networks using Fuzzy Interface Algorithm

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**ARTICLEINFO**
Article History
Received: 20/01/2024
Accepted: 01/05/2024
Published :01/06/2024

## ABSTRACT

Numerous sensor nodes make up a wireless sensor network. Sensor nodes work together to send information about the environment to the base station. Nodes are susceptible to failure during these operations due to power failure, hardware or software failure, etc.. Consequently, delivering dependable packages necessitates achieving two important objectives: energy efficiency and minimized error rate. A novel approach is proposed to distribute the workload among each sensor node to accomplish these objectives. When estimating the scope of communication between nodes, uncertainties are dealt with using the fuzzy logic method. During some weather hazards, the features and cables are particularly challenging to monitor with simple devices in the WAN area. Remote sensing units are used to check and display the feature conditions to resolve this issue. Using machine learning algorithms, the collected data will be analyzed and processed to create a prediction horizon that will be useful for environmental studies and early warning systems. The MatLab2020b simulation program, which has useful tools and learning applications, will be used to carry out this task. The FIS algorithm obtained a cost distance of just 629 m out of the total WSN sensor lengths of 2600 m, which is the best cost among all implemented routing protocol techniques in this study.

***Keywords:* *Routing Protocols; Nodes Sensor; Machine Learning; Fuzzy Interface Algorithm and Internet of Things.***

## 1. INTRODUCTION

A wireless sensor network (WSN) typically consists of a base station or sink and small sensor hubs that utilize defined communication dimensions. However, software and hardware impairments, unstable transmission links, battery depletion, dislocation, and other factors can all cause sensor hubs in WSNs to fail. Consequently, an effective fault tolerance technique is needed to handle or represent a fault and take the necessary action whenever it exists [1]. A collector node has definite capabilities for sensing and gathering useful climate info within its range. The sensed and combined info are commonly sent to the base station. Meanwhile, the sensor hubs consume power when sensing, processing, detecting, and sending info [2]. These hubs have the same amount of energy, so they cannot be replaced, or the battery cannot be replaced [3]. Accordingly, a wireless sensor network’s power performance is a necessary structural objective. The network might be clustered or divided toward the sum of clusters to efficiently aggregate and send sensed info. Every cluster in the network has a head. In utmost cases, the head aggregates the sensed info along members of the cluster before communicating it to the base station [4]. During clustering, a suitable cluster head muse be selected because it might minimize the amount of power utilized by sensor hubs and extend the wireless sensor network’s lifespan [5]. Clustering approaches typically utilize dual techniques to balance the power depletion of the sensor hubs across the network and extend the lifespan of the network (Figure 1): selecting cluster heads against higher staying energy while rotating them in a periodic manner. The effectiveness of a wireless sensor network is enhanced by utilizing intelligent strategies [6]. Fuzzy logic is the utmost efficient algorithm for the clustering procedure because it is an intelligent method. This algorithm might be utilized to choose the appropriate cluster heads in WSNs [7].

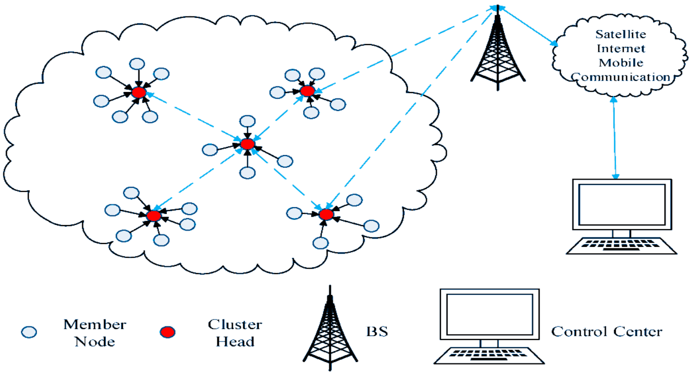

Fig. 1. Schematic of the routing mechanisms for WSNs.

## 2. RELATED WORK

S. Rana et al. [10] were inspired by Gupta's method. The rest of the clustering method is comparable to the Gupta method, except for the input variable. The advantage is: i) similar to the Gupta strategy. The disadvantages are: i) apply to small scale networks and ii) periodically sink the control network.

Alami and Najid et al. [9] mentioned about a method that goes beyond the LEACH and LEACH-ERE approaches. They utilized a novel method of routing for CH selection and clustering. The benefits are as follows: i) CH selection when the node is close to the sink. Dynamic clustering is: ii). Despite the disadvantages: i) each sensor's residual energy is not separately calculated; ii) CHs concentrate on specific subjects, such as LEACH.

M. Toloueiashtian and H. Motameni [10] utilized fuzzy logic to select a CH technique. Three input parameters make up this novel energy-enhanced clustering method. The benefits are as follows: i) The best cluster head is chosen based on threshold. Dynamic clustering is: ii). The drawbacks are: i) The maximum amount of information exchanged to form a cluster takes the shortest amount of time; ii) A maximum time is required for each input parameter.

Guo, W., et al. [11] presented a zonal based clustering technique in which clustering is implemented at every zone as a clustering approach. This technique has the following advantages: i) improves the network life time because of the zonal strategy: ii) enhances the network stability period. The disadvantages of this approach are as follows: i) lacks the algorithm for creating clusters: ii) problem of hot spots.

Aziz Mahboub et al. [12] produced clustering based on the Stable Election Protocol by centralized clustering works where the clusters started. The advantages are as follows: i) dynamic clustering: ii) WSN's performance is enhanced by the new selection criteria. The drawbacks are as follows: i) CHs are chosen at random: ii) the issue of hot spots.

## 3. MATERIALS AND METHODS

The suggested technique focuses on providing the tentative primary cluster heads using a suitable communication range. The introduced fuzzy interface system (FIS) routing (FISR) interface approach is composed of a fuzzy logic inference system and considers the distance to the base station against the sensor nodes' remaining power during the simulation instant to make informed selections concerning the primary cluster heads (PCHs). In addition, every primary cluster head will choose the non-cluster head with the highest remaining energy locally, as its backup cluster head (BCH). Each BCH will monitor the status of the corresponding PCH to ensure fault tolerance based on the beacon signal it detects along its PCH at every interval. We compare the effectiveness of the FISR mechanism against that of the informer homed routing (IHR) and dual homed routing (DHR) mechanisms in terms of the early hub's death, the lifespan of the hubs, and the network's overall residual power state at different counts. The findings illustrate that the proposed FISR mechanism is superior to the IHR and DHR mechanisms. The proposed FISR mechanism is power-efficient and stable for WSN fault tolerance.

The proposed system from Chapter One has been simulated in this study using MatLab2020b Simulation software. The Internet of Things (IoT) model will be implemented using a group of WSNs with a large number of "nodes" spread out over a few hundred to thousands of plans. Each node will be connected to a specific sensor (or multiple sensors, in some cases). In addition, the grid's width will be set to h = 2 * n and the grid's distance to w = 2 * n. The smart allocation technique in this project will be implemented using the fuzzy logic algorithm, which has excellent features for improving network operation and mission scheduling. The proposed structure was used to simulate and test the allocation strategy against the use of the wireless sensor network with N = 50 nodes. In addition, a specific energy for each sensor is proportional to its geographical location and the nature of its work (Figure 3). The batteries that are included with each sensor will determine the energy of the sensors. Accordingly, each sensor will have a specific energy.

### 3.1 Routing Utilizing Fuzzy Inference System (FIS)

Reference [8] presented a network with sustainable power sources using a load unit for the administration of the energy stockpiling network using an FIS. The proposed framework was compared with a standard-based control method. The result showed that the proposed FIS could really reduce variance by expanding the pattern of power stockpiling (ESS). A fuzzy rationale-based control scheme for the battery energy storage system is proposed, and the reasonableness of the fuzzy controller for DC transport voltage control was demonstrated [9]. Offline smart planning conducted against verifiable network input-yield data may automatically fine-tune the enrollment capabilities of a fuzzy controller, achieving a higher level of precision than heuristic approaches. The fuzzy controller has a higher evaluation weight as the fuzzy subsets grow, and it has the advantage of being applicable in a wider range of working conditions than conventional controllers. Hence, implementations of converter control for WSN [10] and IoT cloud networks [11] achieve an ideal balance between accuracy and cost.

The above-mentioned writing survey demonstrates that predictive control's ability to handle boundary variety and crisscross may be enhanced by auto-tuned boundary assessment. In addition, neither the IoT-cloud boundary assessment nor the WSN use the fuzzy strategy, which is a hybrid of the master information and information-based plans. Additionally, numerous suggested arrangements are based on a single working standard, necessitating adjustment for varying working conditions. Accordingly, this strategy proposes two novel methods for boundary auto-tuning for cloud WSN: first, a fundamental method of evaluating a specific working point; second, a fuzzy-based evaluation of boundary variety that may encompass a further extensive functional range [12].

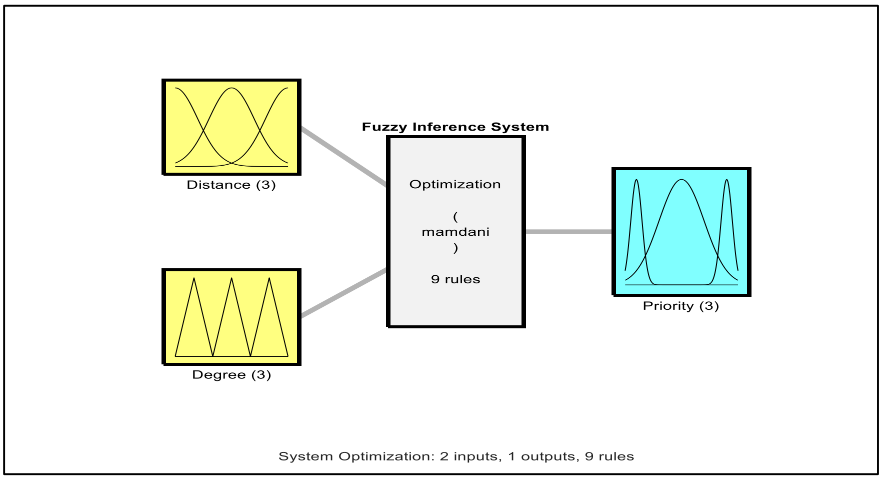

Fig. 2. Block diagram of the FIS

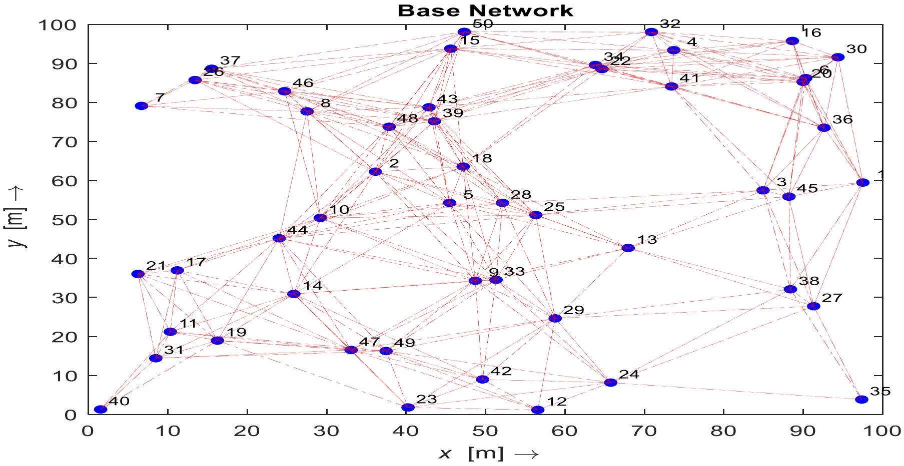

Fig. 3. Model of the N = 50 nodes wireless sensors network.

The FIS will be designed to operate with two inputs and one output using nine membership rules (Figure 2). Figure 8 provides a detailed illustration of the first situation, which yields three rules out of nine rules, and the subsequent cases follow suit. The distance length values between each of the WSN model's nodes will serve as the FIS unit's initial input. The program will randomly specify the degree values of the node energies as the second input to the FIS model. The priority function at the FIS structure's output will be incorporated into the membership's rules. Figures 4, 5, and 6 depict the membership's functions of the FIS' first input, second input, and second output, respectively.

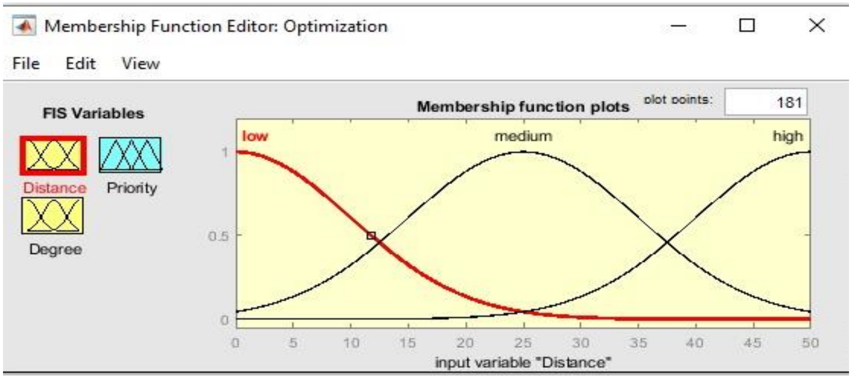

Fig. 4. Membership function of the first input of FIS.

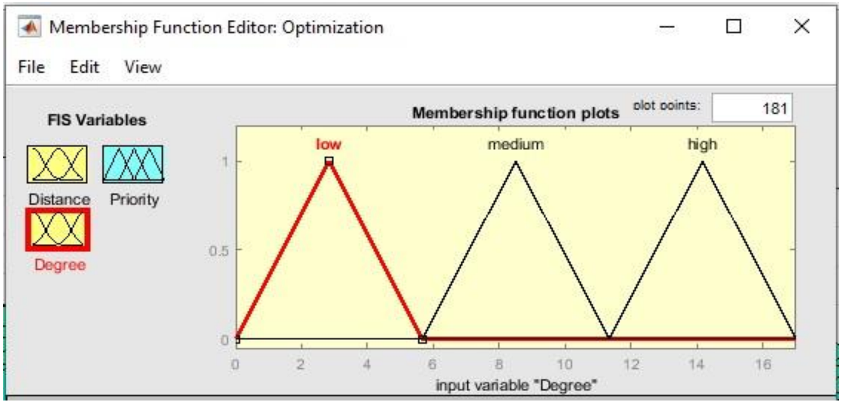

Fig. 5. Membership function of the second input of FIS.

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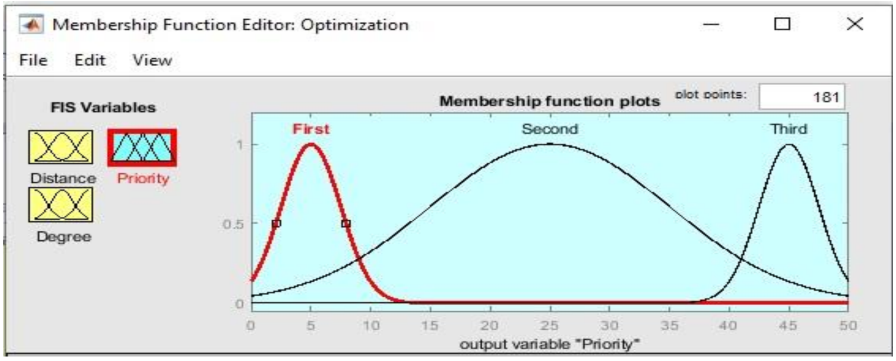
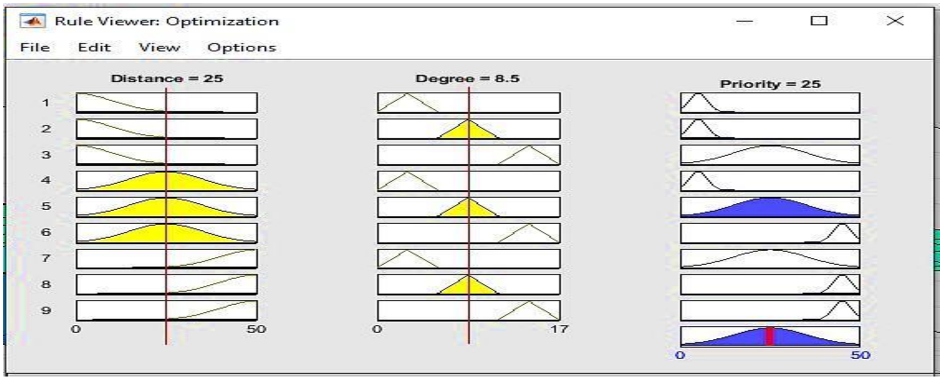


plot points: 181

Fig. 6. Membership function of the second output of FIS.

The FIS structure's design procedure for membership rules has now been optimized to carry out the tasks depicted in Figure 6 and 7.



Distance = 25
Degree = 8.5
Priority = 25

Fig. 7. Membership rules performed by the FIS structure.

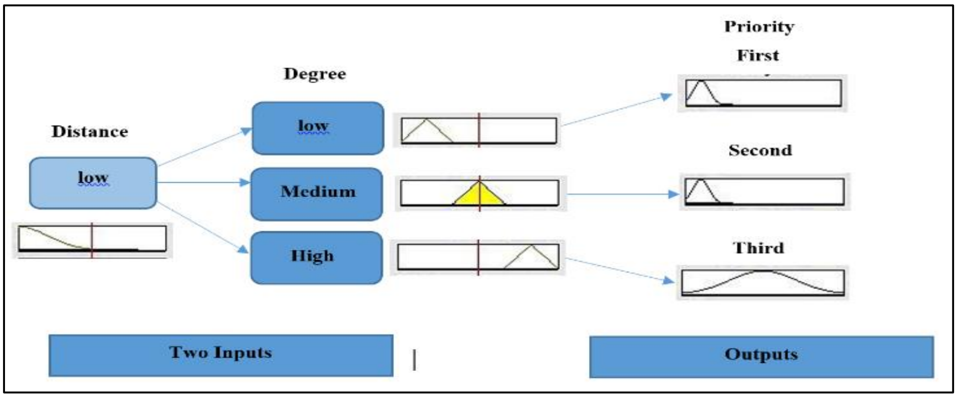


Fig. 8. Illustration of the membership rules.

## 4. RESULTS AND DISCUSSION

The proposed model has been used to simulate and carry out the routing procedure. The resulting data are presented in the following tables and discussed. Figure 8 depicts the base wireless sensing network with N = 50. Figure 9 displays additional results.

The normal consequences of the proposed scheme will be introduced and dissected in this part to comprehend the action of the recommended model and assess the last reaction of the proposed framework. This chapter demonstrates that the proposed scheme will be effective in locating the WSN's best displacement (cost) among nearby hubs.

### 4.1 Outcomes

The four phases that will be used to implement the software are summarized as follows:
1) Comparison of the best displacement and energy (cost) of the adjacent hubs with zero reference.
2) Identification of the optimal displacement and energy (cost) between two adjacent hubs, such as between the first and the last hub.
3) Utilization of the traveling sealer problem (TSP) algorithm to identify the optimal displacement and energy (cost) at each hub.
4) The utilization of the FIS technique (algorithm) to find the best energy (displacement) and displacement (cost) among hubs. The outcomes of each result will be compared to control the best energy (displacement) and displacement (cost) that can be obtained by using the necessary strategy.

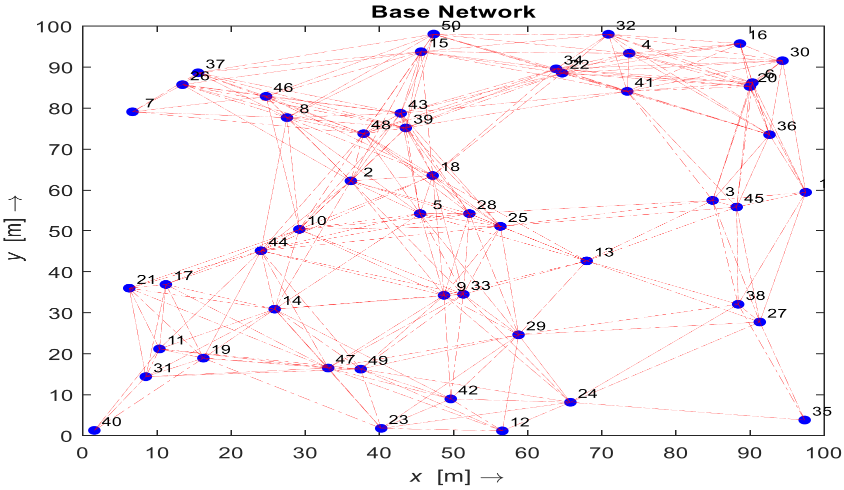


Fig. 9. Wireless base sensing network model using N = 50 hubs.

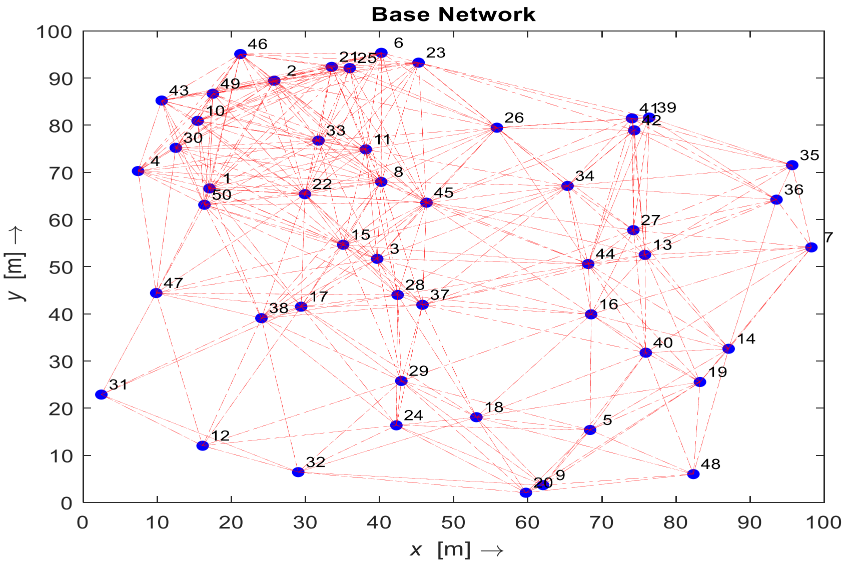


Fig. 10. Alternative wireless base sensing network model using N = 50 hubs.

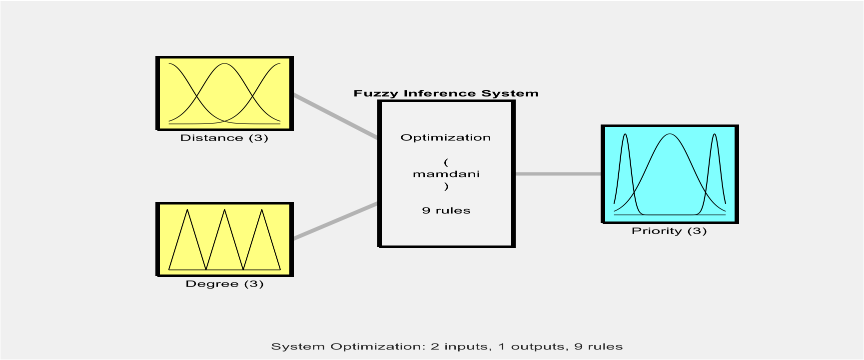


Fig. 11. Fuzzy logic algorithm simulated for optimizing the task off-loading for the WSN.

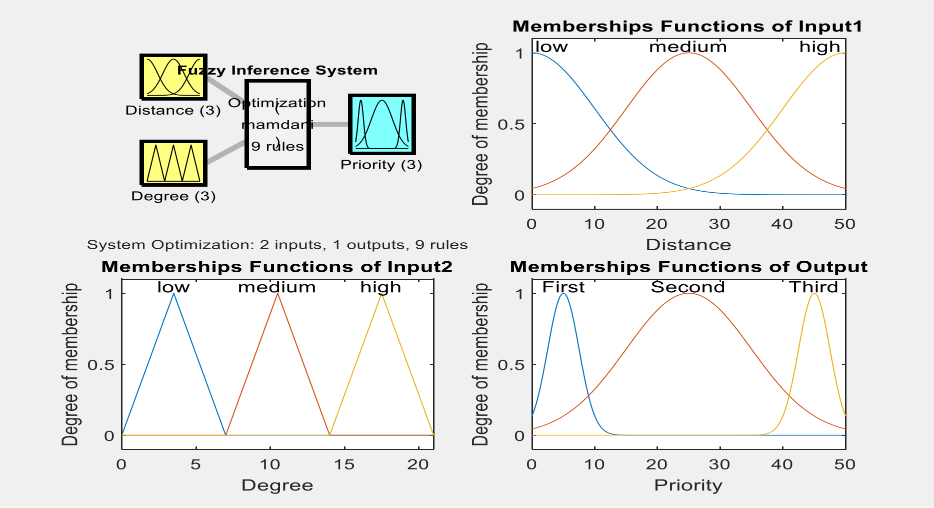


Fig. 12. Membership function utilized in the fuzzy logic algorithm design.

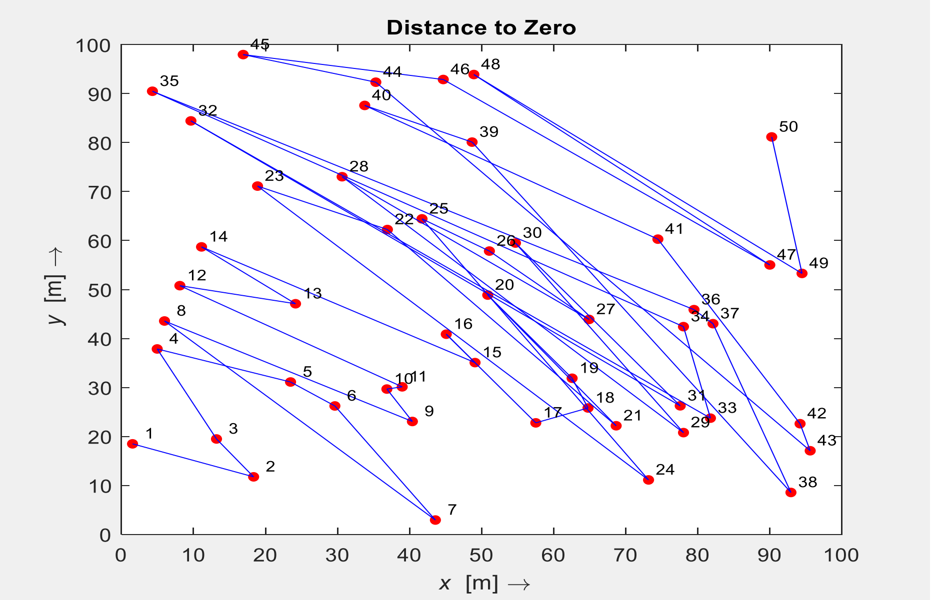


Fig. 13. Random routing protocol mechanisms for the base wireless sensing network with N = 50 with distance to zero.

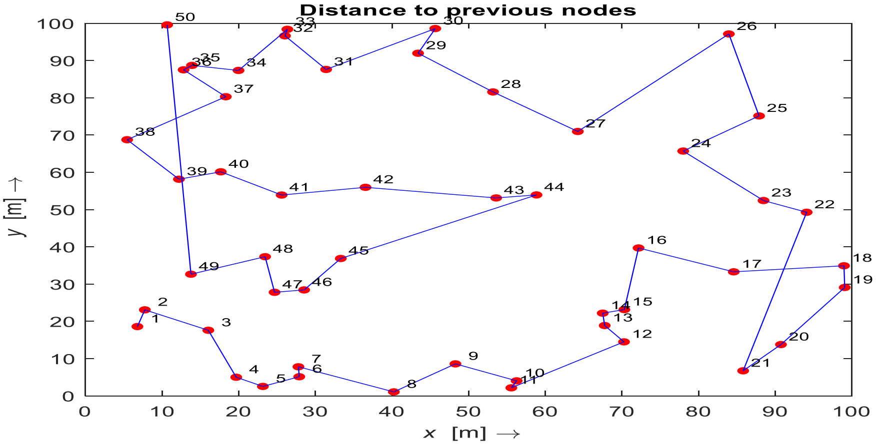


Fig. 14. Ordered routing protocol mechanisms for the base wireless sensing network with N = 50 with distance to previous nodes.

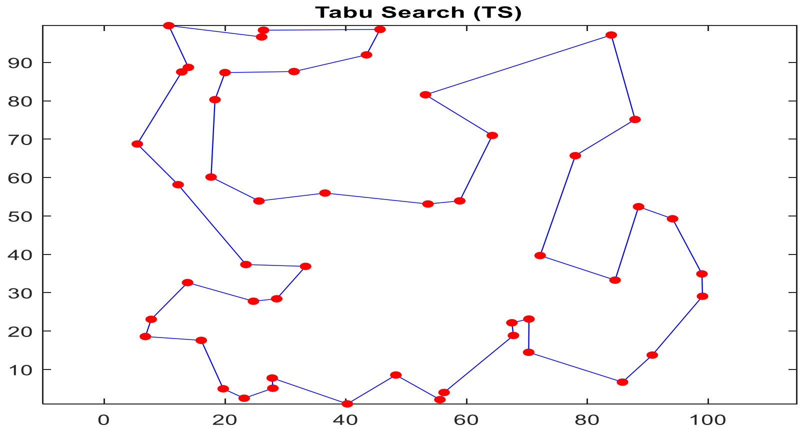


Fig. 15. Ordered routing protocol mechanisms for the base wireless sensing network with N = 50 with turbo search (TSP).

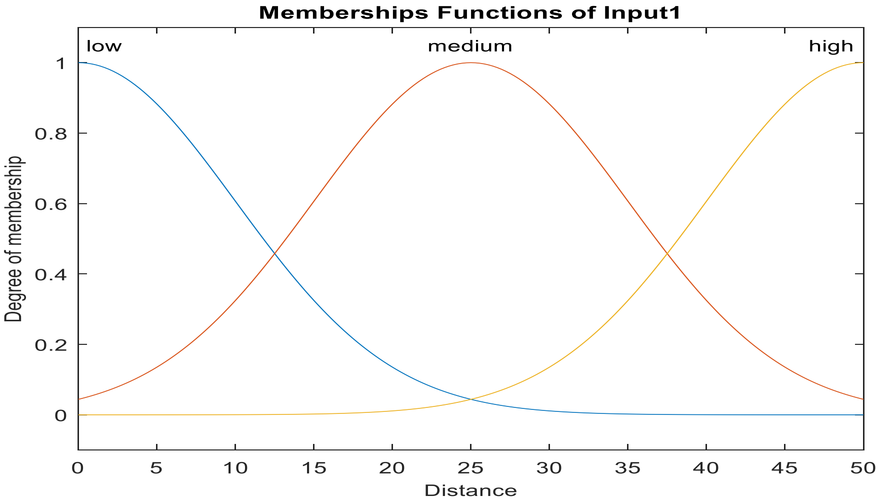


Fig. 16. Input1 membership function utilized in the fuzzy logic algorithm design.

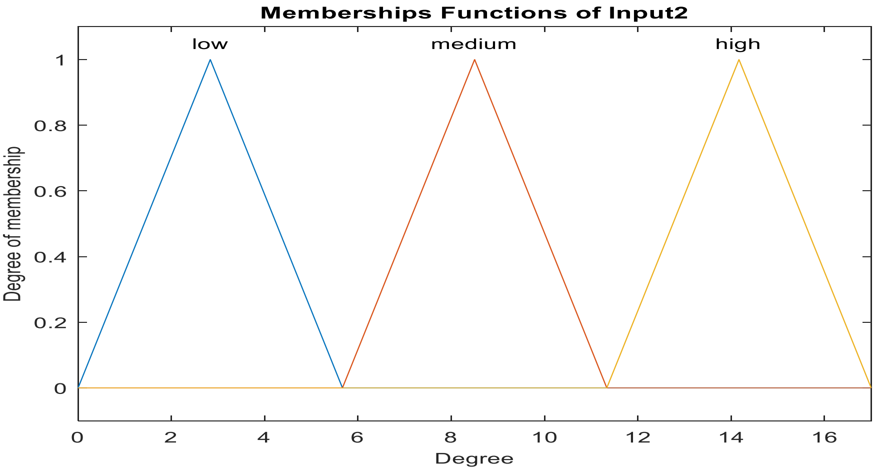


Fig. 17. Input2 membership function utilized in the fuzzy logic algorithm design.

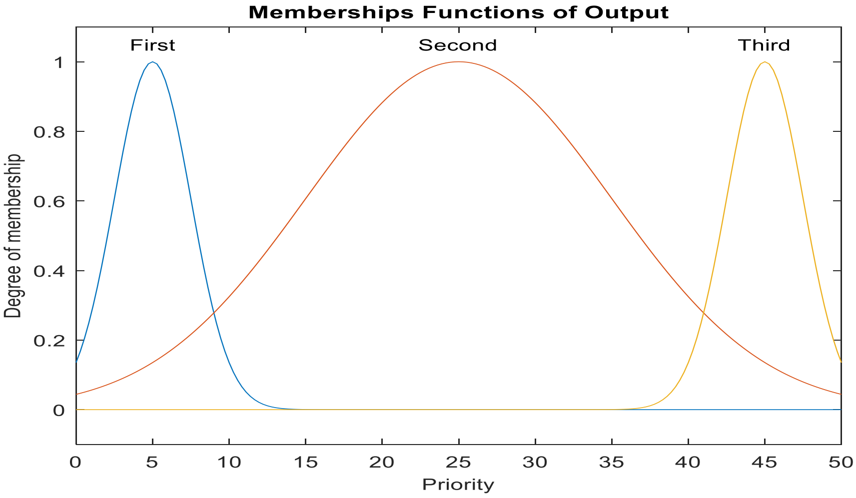


Fig. 18. Output membership function utilized in the fuzzy logic algorithm design.

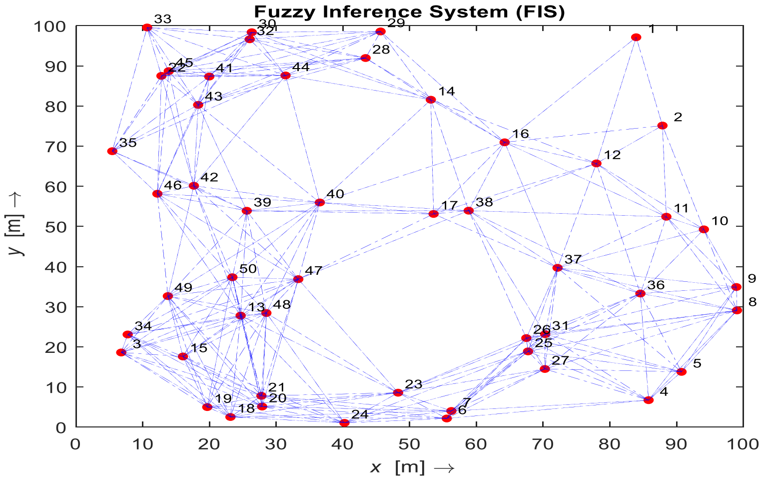


Fig. 19. Results of the routing protocol mechanisms for WSN with N = 50 using FIS technique.

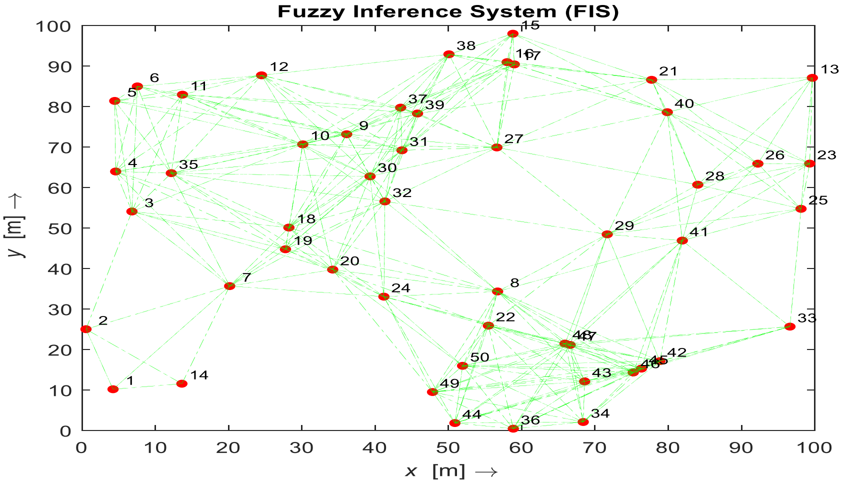


Fig. 20. Another results of the routing protocol mechanisms for WSN with N = 50 using the FIS technique.

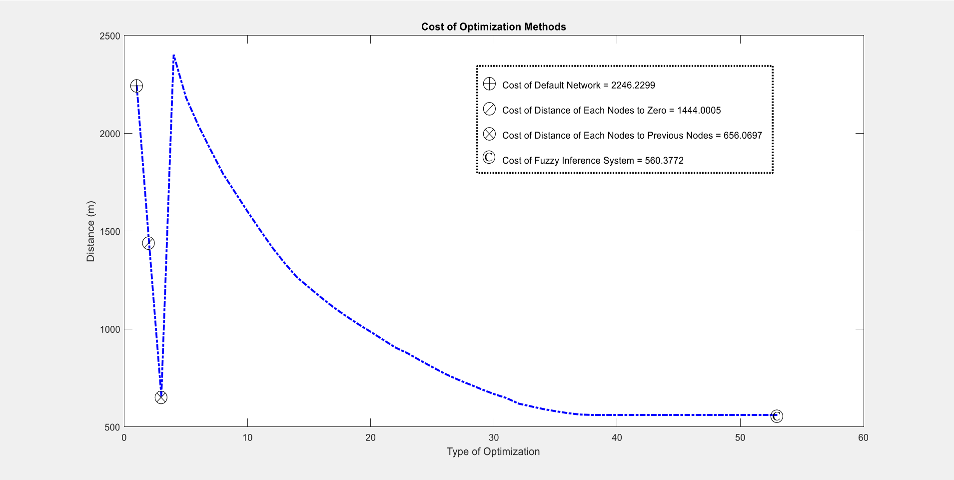


Fig. 21. Optimization method costs for routing protocol mechanisms in the WSN.

Finally, the overall WSN latency (delay time) might be obtained by computing the overall computations and processing time required for the certain approach divided by the total rounding iterations.

## 5. CONCLUSIONS

Along the achieved simulation outcomes, we might observe the response of the different routing protocol mechanisms implemented in such experiment along the IoT fog cloud WSN simulation. The action of the WSN nodes connections is observed through comparing the FIS optimization algorithm to the other strategies applied to the WSN in this examination, such as the TSP investigation, length to previous nodes, length to zero, and the base network (Figure 17). Figure 18, which exhibits the best cost, has been accomplished through utilizing the FIS controller that performs the best optimization for the task distributions and sustaining ultimate power saving for the WSN batteries among all alternative implemented techniques. The FIS algorithm obtained a cost distance of just 629 m out of total WSN sensors lengths of 2600 m, which is the best cost among all the implemented routing protocol techniques in this study.

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