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# Evaluation of Fuzzy Based Route Sorting Algorith for Wide Area WSN

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***Abstract*— Wireless sensor networks (WSN) are widely used, hence new strategies must be developed to assure their continued good operation. Wide-area WSN networks have historically employed traditional performance evaluation and improvement methodologies. For WSN routing, the fuzzy set-based routing approaches are often employed. Therefore in this Paper, a modified fuzzy logic-based route sorting technique was created in order to assess the time and effort required to create the network. This prime objective is to build and assess the wide-area network (WAN) configurations for such a sensor network. The suggested methodology has increased the network's dimensions by around 2 to 4 times along with design contains in order to improve the efficiency of wide-area WSNs in terms of total energy ration energy and packets delivery time.***

## I. INTRODUCTION

Sensor network quality enhancements in a dense wide area network environment have received little attention. Many sensor networks are already using a significant portion of the spectrum. As a result, network density is likely to improve in the future. As a result, the purpose of this paper is to evaluate IOT-based wide area sensor networks (WASN) from the standpoint of wide area deployment. The power source of the sensor nodes is one of the major constraints when designing such a large WSN. Allowing only some nodes to interact directly with the base station (BS) will reduce the amount of energy used. The creation of a fuzzy network can help to improve network performance by gathering random data transmitted from each cluster node, compressing it, and then transferring the combined data.

Automatic routing protocols must be designed to improve WSN performance. The Fuzzy set of rules or influence systems (FIS) may be used to meet the automation requirement. This is the primary focus of this paper's research. The majority of current protocols seek to improve the WSN's energy and life efficiency. (Adaptive Clustering Hierarchy Based on Low Energy) LEACH [1 and 3] is a fundamental routing protocol. Fuzzy logic-based modified LEACH protocols for cluster head (CH) selection have recently been proposed [2, 4, and 5].

Many routing methodologies have been developed in the past. Figure 1 depicts a broad classification of these routing protocols based on network structure. The initial classification is based on the structure of a flat and hierarchical network. The hierarchical design of network protocols improves energy efficiency and network life. This paper's primary goal is to design and evaluate the performance of fuzzy logic-based WSN routing. Paper considered the four difference case of wide area WSN network for evaluation with increased area of network.

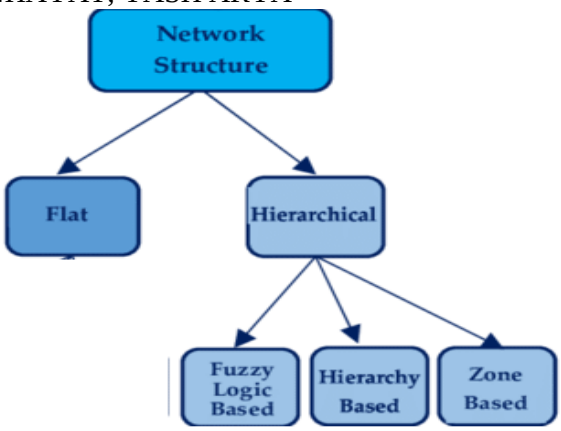


**Fig.1. Classification of WSN routing protocol based on Network Structure**

There are some zone-based routing approaches, such as one proposed by S. Faisal et al [6]. They have proposed a novel zonal SEP protocol that is expected to improve the Network life based field division in zones. Certain protocols are classified as hierarchical based on the energy levels of the nodes. The most basic clustering-based hierarchical routing protocol, low energy uses for adaptive clustering based hierarchy (LEACH) [7], is widely used. This category includes the stable election protocol (SEP [8).

***Contribution of Work***

The issue of WSN's excessive energy consumption has yet to be resolved. To address this issue, the paper describes a fuzzy logic-based routing strategy for WSNs. The main contributions of this paper are the design and evaluation of the performance of a modified LEACH protocol based on fuzzy logic in a highly dense wide area WSN. The goal is to extend network life by improving the route selection process with fuzzy descriptor rules or variables. The paper validates the basic LEACH protocol first, and then compares fuzzy based routing. Energy and node position are used as fuzzy descriptors to improve performance. The node architecture, packets sent to the BS, and alive nodes are used to evaluate the results.

***Fuzzy based Routing***

WSNs are the most rapidly evolving technology, and they are used in a wide range of networks. The combination of fuzzy and WSN has resulted in the creation of a massive network system. Improving energy conservation is also critical for increasing WSN lifetime.

The fuzzy routing protocols are created to increase the longevity and energy efficiency of the WSN design. Fuzzy logic is a method based on degrees of truth. The most energy-efficient logic is used to operate fuzzy logic systems. An algorithm based on maximum energy is used to obtain a fuzzy systems-based routing technique. The real-time route selection decisions made by fuzzy logic

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control can be made even with insufficient network data. There are a lot of issues with choosing the route simply based on the local data of the nodes. First off, because each path must be determined probabilistically in order to be selected or not, there may be situations where the incorrect route is chosen for transmission, thereby wasting energy over the entire network. As a result, it is rhe energy usage metric, E, in this study's fuzzy set can be defined as

$$E = Fuzzy\ set\ (\{Sn, s\}, \{En, u\}, \{Ms, v\} \quad (1)$$

Where, s stands for status constraint, u for energy of nodes, and v for message transmitted. These constraint and based Fuzzy influence system (FIS) is shown in the Figure 2.

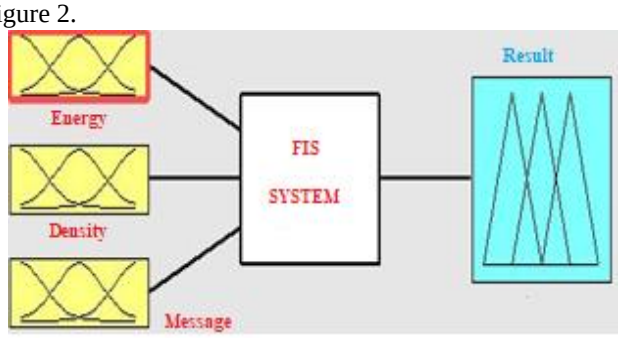


**Fig.2. Set of WSN Fuzzy Influence System (FIS)**

## II. LITERATURE REVIEW

Many researchers have worked for performance enhancement of WSN routing protocols. Artificial Bee Colony Method, a novel technique introduced by S. Rizwana et al. [1]. it is an energy-dependent algorithm used to improve network node efficiency. This extends the network's lifetime by increasing energy consumption, either directly or indirectly. When sensor nodes are used densely, according to P. Nayak et al. [2], battery life is decreased, and the LEACH protocol performs worse. In order to improve performance in terms of first node deaths and better lifetime, they proposed a super clustering head (SCH) based protocol.

Fuzzy logic was used in the WSN design process by D. Pal et al. [3] to extend battery life and improve transmission efficiency. Fuzzy CH's election has also been implemented to extend battery life. It can be used in upcoming work for efficient wireless communication to improve security objectives. To enhance and research the lifetime of the network, S. Bagga et al. [4] present a FLBCR protocol that uses fuzzy logic to analyze an appropriate node as CH. By using these cluster protocols, the network is distributed, and information is sent directly from clusters to base stations. This decreases the amount of energy used while also minimizing delay times and system delays. It also comprises the node's density, its distance as from sink, or its energy to weight ratios.

To address the issue of node energy limitation and energy usage, T. Wen et al. [5] offer a fuzzy based LEACH protocol. Secondly, the lifespan of the network could be enhanced and prolonged by using Cluster Head (CH). Thus, the results demonstrate that CH-based protocols enhance not only from the nodes centrality, nodes concentration, and node energy of the system, but also the network longevity. A LEACH-FIS, which was presented by Y. Zhou et al. [6], is an enhanced LEACH variation that can be utilized to increase the mobility of WSNs. The FIS comprises the density, speed, and direction of the nodes' leftover energy.

To choose CHs and create clusters, a new FIS is employed. A modified CH technique is suggested by L. Zhao et al. [7] to reduce excessive energy use. To maximize the CH threshold equation, the residual energy and network addresses of nodes are taken into consideration. This strategy of cluster head competition boosts energy effectiveness and profitably restores network burned.

To get over LEACH's drawbacks, A. K. Dwivedi et al. [8] suggest the FEECA protocol. Four parameters are used by FEECA based on CH nodes to produce an effective result. All non-CH nodes use FIS to choose their CH during cluster formation. This protocol is used to move base stations around. For creating healthcare IoT applications, M. Nasri et al. [9] suggest fuzzy based routing protocol and cross layer routing protocol. These algorithms support a paramedical architecture and provide a variety of cloud-based services. In order to address these issues and improve wireless IoT network performance, a fuzzy logic-based energy-efficient routing protocol is examined.

## III. PROPOSED FUZZY LOGIC BASED LEACH PROTOCOL

This fuzzy route sorting technique operates in two sets, each of which includes an initialization and steady state phase. The fuzzy decision for route sorting and packet insertion is arranged after the fuzzification process is completed the round during the setup phase using fuzzy knowledge processing. The cluster gathers the aggregated data during the steady state phase and carried out signal processing operations to combine the data into a single message. Destination node receives this composite signal after path selection. The fuzzy descriptors rules are used to express specialized knowledge:

- Message strength: is the input amount of message strength that is available within every node and is represented by fuzzy descriptor message.
- Node energy status: the input status of nodes energy in defined area is indicated by a fuzzy descriptor status.
- Decision: denoted by the fuzzy output constraint and has a value that categorizes routing paths decision according to single or multi path to the cluster.

The respective FIS I.O are shown in Figure 3.

***The Proposed Fuzzy Set of Rules***

1 If the communication is routine and the status is bad, the decision is to discard= (1)

2. If both the status is bad and the message is

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important, the decision is multiple= (1)

3. If status is bad and the message is flash, the result will be a flood =(1)

4. If the status good and the message Routine, then decision is Single=(1)

5. If the situation is favourable and the message is urgent, multiple decisions will be made=(1)

6. If both the status and the message are Flash, then (decision is Multiple) (1)

7. If the status is excellent and the message is routine, only one decision will be made (1)

8. If the status is excellent and the message is urgent, just one decision will be made (1)

9. If the message is Flash and the status is outstanding decision is set to Multiple

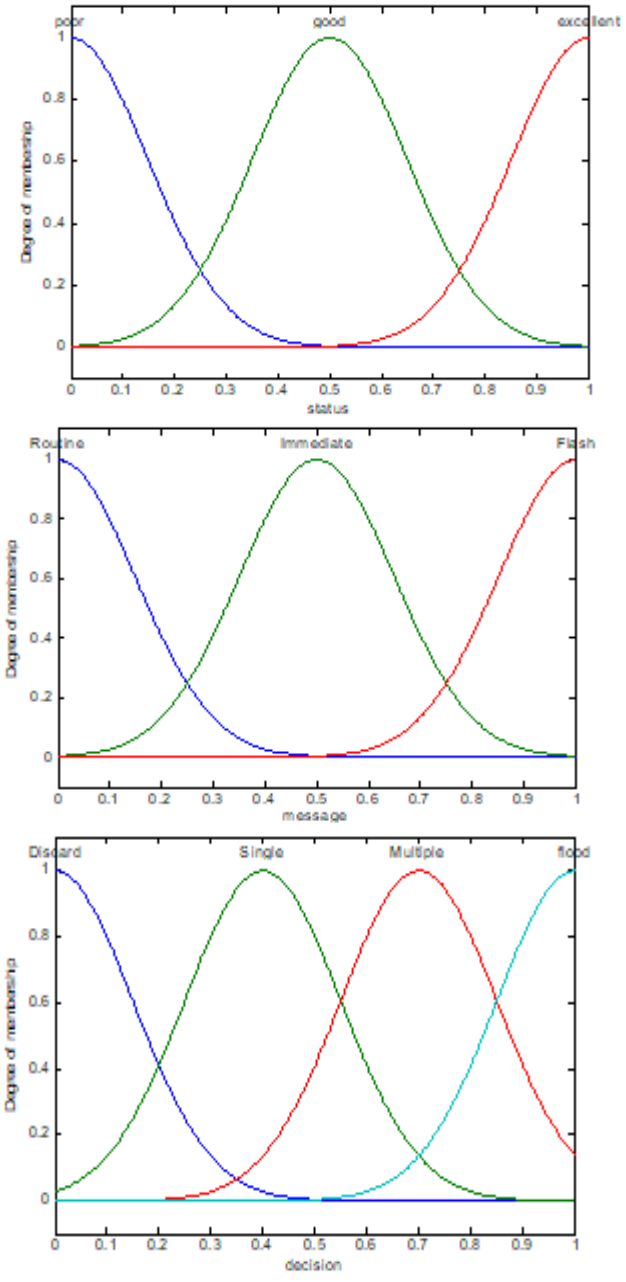


**Fig.3.Input and output constraints of proposed Fuzzy system**

## IV. RESULTS AND DISCUSSIONS

Paper proposed to evaluate the performance of fuzzy logic based results of the basic shortest path routing for WSN design are validated and implemented first. The random allocation of 50 new nodes considering the dense wide 100x100 sq m area deployment the mesh estimation is shown in Figure 4.

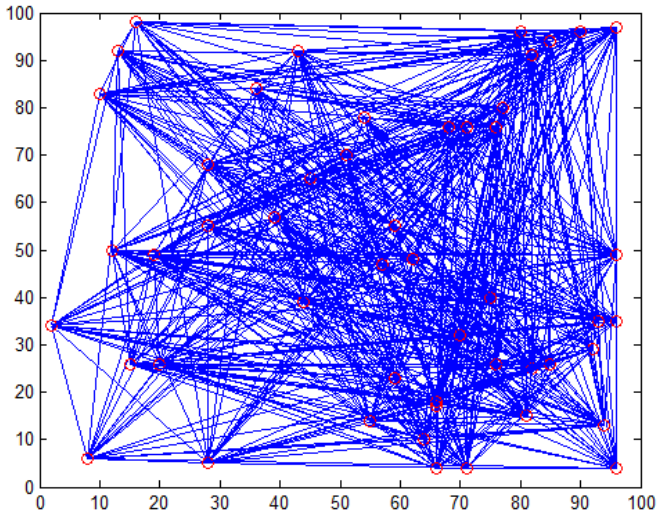

**Fig.4. Routing paths estimated among the mesh network of 50 nodes**

In the proposed WSN the each node is expected to connect to other network using the dedicated link and the routing path is also sorted based on the calculation of estimated energy and time of delivery.

***Results of the Wide Area Networks***

In this paper the experimentation is performed to evaluate the performance of the Fuzzy logic based route sorting under the consideration of the wide area networks. It is proposed to estimate the total energy consumption and message delivery time.

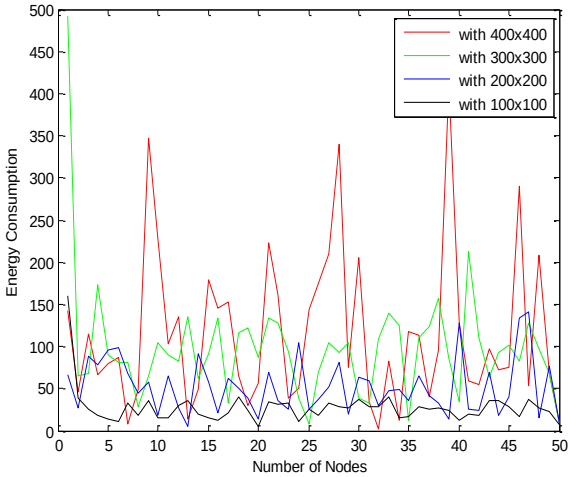


**Fig.5.The comparisons of the energy consumption for Fuzzy based route sorting**

The comparison of the estimated energy consumption among the various paths of mesh networks for 50 nodes evaluated for various size of the WSN network are shown in the Figure 5. The network dimensions are varied from 100 to 400 at an interval of 100 nodes and the

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communication energy consumption is estimated for fuzzy based routing.

It can be observed from the Figure 5 that increasing the dimension may leads more distance and less dense nodes, thus the consumption of energy required to communicate data among nodes increases significantly.

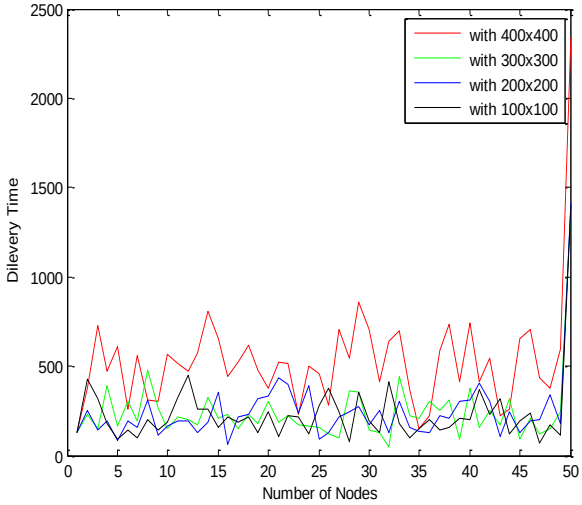


**Fig.6.The comparisons of the Time delay for Fuzzy based route sorting**

It can be observed from the Figure 6 that time delivery to communicate data among nodes increases significantly as network dimension increases, It can be observed from the Figure that the variations in time for neigh our nodes differ significantly for larger network dimensions.

The relative extension ratio of the data packets Delivery time and the total sum of the energy consumption from source to destination nodes in the network are given in the Table 1. It can be noted that the delivery time and the energy requirement scaled up with the increased network dimensions. The energy is scaled by around 8 times when network is scaled by 16 times.

**Table 1.The results of Time and energy Relative Ratios**

| Parameter | **100 x 100** | **200 x 200** | **300 x 300** | **400 x 400** |
|---|---|---|---|---|
| Total Energy Rario | 1.8593 | 2.1420 | 2.2254 | 2.3441 |
| Delivary Time Ratio | 1.1088 | 1.394 | 5.4361 | 8.4031 |

## V. CONCLUSION AND FUTURE WORK

In this paper the Fuzzy set of rules are used to form the FIS system for estimating the WSN paths. This study's objective is to build and assess the wide-area network (WAN) configurations for such a sensor network. The suggested strategy is to change the network's dimensions and design characteristics to improve the wide-area WSN's energy and time performance using a fuzzy set of rules. The status and the message are considered as input parameters of the FIS to take the decisions of path selection. There is a possibility of single path or multiple paths in the network from a node. Performance is evaluated for wide area network keeping node density fixed.

The random allocation of 50 new nodes is considered for the dense wide 100x100 Sq m area deployment. It is concluded that increasing the dimension may result in more distance between nodes and less dense nodes, which increases the amount of energy needed to convey data among nodes. It is also concluded that time delivery to communicate data among nodes increases significantly as network dimension increases.

In the future it is proposed to design the mesh fuzzy network using the various clustering based routing protocols. Also, the optimization techniques like ACO may be use future for performance improvement.

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