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Fuzzy Rules Based Clustering Protocol for WSN Assisted By Mobile Agent to Improve Network Lifetime

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Abstract: Improving the lifetime of WSN is critical. It entails sensor implementation, cluster formation, routing, as well as effective battery unit utilization. Clustering as well as routing are critical techniques for extending lifetime of the network. Because current clustering as well as routing strategies have greater message overhead from transmitting data collected to sinks or the BS, it causes sensor premature death as well as hotspot problems. The goal of this research is to create a dynamic clustering as well as optimal routing protocol for data analysis in order to extend lifespan of the system.Mobile Agent- based application research developments have resulted as well as are used in a variety of involved areas such as Power usage, System Management, Electronic commerce, Wireless Multimedia Sensors, Grid Service as well as Grid Computing, Distributed DM , Security, E-learning, Location Tracking, Semantic Web Service, and so on. In the article, it was suggested to use a mobile agent to collect network data and also to integrate it in MATLAB.

Keywords: WSN, Energy Efficiency, Clustering, Fuzzy Logic , Mobile Agent.

I. INTRODUCTION

WSN are intended to be real-time embedded systems that are deployed in a particular region with restricted energy as well as memory resources are used to detect multiple kinds of surrounding variables including temp., pressure, gas, humidity, or so on[1]. WSN is utilized in a wide range of apps where traditional networking frameworks are impractical. A few valuable as well as diverse WSN apps include data about inhospitable environments, weather as well as climate monitoring, biological agent threats, healthcare monitoring, forest fire recognition, surveillances, as well as transport monitoring, among other things.These apps are in high demand for determining different physical variables using various sensors such as cameras, aural tools, as well as sensors [2].

WSNs are generally thickly distributed in risky areas where battery recharge or reconstruction is practically not feasible, but human tracking schemes are extremely fragile. Numerous demonstrative objections, like restricted computational power, energy necessity, open environment, and radio connectivity, result in SN being wounded numerous times. In WSN, sensor nodes have some drawbacks in regards to energy supply, bandwidth, as well as computational resources [3]. Once the system is stabilized, all nodes collect on sensing data, as well as the battery possibility increases exponentially. When a node recognizes an event, it passes the data to the other nodes or the BS. It it seems that the same knowledge is collected through adjacent SN and could be obtained by the BS, causing the system to be ineffectual. Numerous routing approaches with differing possibilities was used to avoid data recurrence as well as make the connection energy efficient [4].

One of these economic proposals is the CBRP, in which SN are composed of a set of gangs, which are referred to as a cluster. Every cluster has one gang controller, which is recognized as the Cluster Head. The controller node is information gathering. Messages to the BS can only be sent by the controller node/CH. The information has been collected by the CH nodes as well as transmitted directly

to the BS. Without a doubt, the CH nodes serve as gateways among the SN and the BS. There are two types of clustering procedures: static as well as dynamic.

Suitable cluster-head node selection could really significantly reduce energy dissipation as well as improve lifetime of the network. In LEACH, the CH is chosen at random as well as attempts to distribute the load at each SN in each revolution. The overall model of the system for clustering-based WSN is depicted in Figure 1.

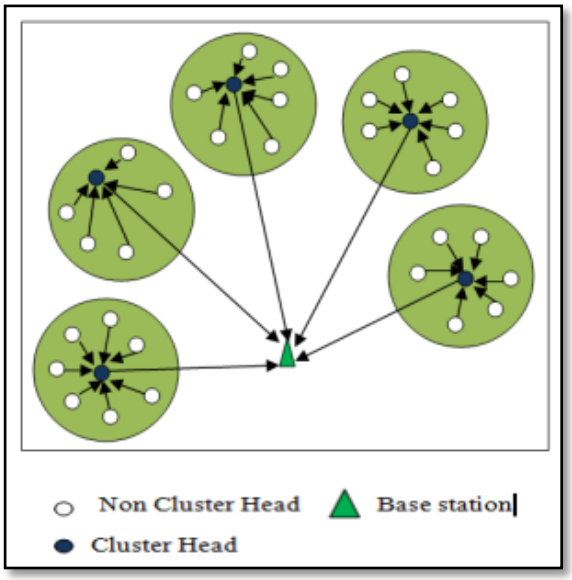

Fig 1: General System Model for clustered WSN[5]

Whereas many current studies demonstrate the strength of the LEACH algorithm, it does have some few limitations that must be discussed. Since LEACH is based solely on a simulation process, the CHs chosen might be quite close to one another at times. Because LEACH is based on a stochastic value, it may show up that even more than one CH is chosen or that no CH is select in each cycle. When the CH is chosen at the network's edge, energy allocation becomes unusable.The SCH is chosen between the CHs to gather information from the CHs but only send it to the mobile BS through selecting appropriate 3 fuzzy descriptors, like remaining battery energy, BS mobility, & cluster centrality. To pick the chance of being SCH, a FIE (Mamdani's principle) is utilized. Most fuzzy clustering procedures [6] did not precisely select the CHs, instead selecting the accelerated CHs first & then the final CHs.

The article is structured as followed: Section II basically gives the brief information about Mobile Agent. Section IIIexplain the fuzzy model. Section IV & V literature survey and proposed methodology the proposed work. Section VI explains results. Lastly conclusion is in Section VII.

II. MOBILE AGENT

A mobile agent is a node that, once initiated, could indeed travel independently via the system from node to node carrying out tasks. By analyzing information at the source as well as transferring only the appropriate results, MA can decrease bandwidth usage as well as path discovery[7]. A MA's peculiarities include the foregoing: autonomy, mobility, perceptiveness, inter-activeness, and goal orientation. MA in WSNs are also used to obtain specific goals or fixparticular problems that are critical to the accurate operation of a WSN. Their movement is advantageous for work allocated, which is completed on every node. They are main objective in the manner that it allows customers to organize the MAs; once they are configured in the WSN, they operate their various duties on their own to accomplish the required objective. The details of MAs innovation expose a few viable target issues that could be effectively enhanced in the application area of WSNs. Their intellect could be used in a variety of situations. One example is a node obstruction or a climate changes that impacts a portion of many nodes in such a way that they interact to the transformation as well as enable the WSN to operate normally.MAs could be used for routing, with routes created and operated individually by the MAs, that could roam freely within a WSN. MA is useful for the following purposes [8]:

Persistence: When a MA hikes, it is no extended linked to its originator node &is unaffected if this node unsuccessful.

Efficiency: If an participant travels via the system to the node where tools reside, emerging traffic is lowered

because this could pre-process data locally as well as determine which data is applicable to be transmitted.

Peer-to-Peer Interaction: The use of MA makes it simple to detect a node failure.

III. FUZZY LOGIC MODEL

The FL framework is made up of 4parts: a fuzzifier, a FIE, fuzzy principles, as well as a defuzzifier. Mamdani's technique is the most widely used[9]. Figure 2 depicts a graphical representation of a fuzzy interference scheme.

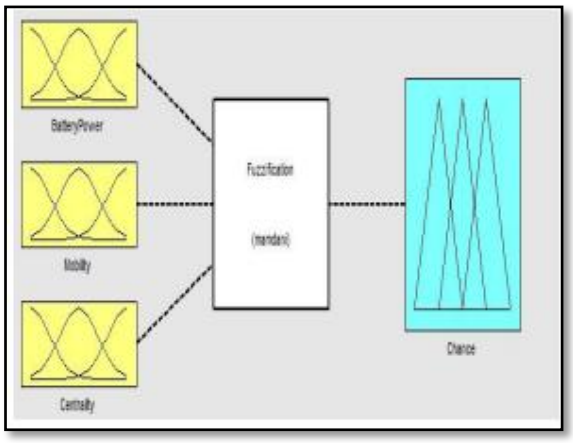

Figure 2: Fuzzy system for the Proposed Model[9]

Basic stages are needed to pass the procedure, which are listed below:

1) Fuzzification: In the fuzzifier, the input variables are deposited of with a crisp value as well as altered into a fuzzy set.

2)Rule evaluation: It keeps track of the IF-THEN principles.

3)Fuzzy Inference Engine: A FIS is a procedure that maps from given inputs to outputs using fuzzy set theory. It simulates the procedure using both input data as well as IFTHEN rules. In areas like automatic control, determineevaluations, expert devices, as well as computer vision, FID have been heavily implemented.

4) Defuzzification: It converts a fuzzy set into a crisp value. The fuzzy interference is used by 27 regulations.The regulations in the type are as follows: if X,Y,Z, then C. X represents remaining battery energy, Y indicates mobility, Z indicates centrality, as well as C indicates chance. Table 1 shows the membership function parameters for input variables & output parameters.

IV. LITERATURE SURVEY

Behera et al., (2020) WSN offers all over entry to place, the designation of various environmental organizations, as well as information management for lengthy IoT tracking. Because power is a significant limitation in the configuration of a WSN, rapid innovations may lead to the implementation of a wide range of energy-efficient procedures. Data routing necessitates a significant level of energy expenditure. The researchers proposed a modification to the established SEP, which utilizes a threshold-based CH selection for a heterogeneous environment. The TH ensures that power is distributed uniformly within member as well as CH nodes. To allocate the connectivity concentrated loads, SN are classified into three kinds: normal, moderate, as well as advanced, based on their initial energy supply[10].

Hassan et al., (2020) suggested a IEECP to extend the lifespan of WSN-based IoT, which comprises of 3 sequential sections. Namely , an finest set of clusters for the overlapping balanced clusters is motivated. The balanced-static groups are founded using an altered FCM algorithm as well as a method to reduce & alignment the power usage of the SN. Finally, CHs are chosen in ideal regions by rotating the CH function among cluster members using an innovative CH selection-rotation technique that combines a back-off timer method for CH selection as well as a rotation method for CH rotation. The outcomes demonstrate that the IEECP outperforms current practices[11].

Nayak et al.,(2016) Using the fuzzy logic principle, an EE clustering approach for WSN has been suggested. Using appropriate fuzzy descriptors, one Super CH is chosen from among cluster heads to be the indicative for sending the signal to a mobile BS. The concept of sink mobility,

combined with FL, significantly improves lifetime of the network. It is predicted to be more useful in a variety of practical uses such as health care, agriculture, disaster relief, commercial apps, and so on. The simulation experiments demonstrated that the suggested approach outperforms the LEACH approach in means of FND, HFD, LND, network stability, as well as network lifetime[12].

Mishra et al.,(2020) Apply a latestMIMO clustering approach to better used node power & increase network longevity. The regulations of the FIS serve as the foundation for an improved network consequences. Numerous rounds of simulations are used to complete the regulations. To fully describe the clustering scenario, there are three input variables as well as three output variable. To correctly load balance the overall system, researchers impose a double limitation on the length of each cluster. The capacity of a SN to bear load demand rapidly as energy is depleted. The proposed change to reduce the growth of a cluster conducts good due to CH nomination. And contrast OCSSP to the well-known clustering approaches LEACH and DUCF, which are useful for clustering in WSN. Numerical study demonstrates that the OCSSP accomplishes better results[13].

Trupti Mayee Behera et al. (2019) explains that clustering algorithms contribute in power management for energy-constrained networks, & also that choosing a CH could correctly equality the burden in the system, lowering power as well as increasing life span. The researchers wanted to choose the CH based on significant criteria like starting power, residual power of the each node, as well as the appropriate amount of CHs in the system. The authors concentrated on an effective CH election system that spins the CH location between the nodes while maintaining a positive electrical charge than some other schemes. The authors confirm that simulation study indicates that the different version outperforms the LEACH algorithm by increasing throughput by 60%, lifetime by 66%, as well as RE by 64%[14].

V. PROPOSED METHDOLOGY

- **PROBLEM FORMULATION**

The authors in have used fuzzy rules as well as coyote based optimization for selection of the cluster heads. They have analyzed the performance of the network by placing the base station at three different locations in the network. It was observed that when base station was place away from the network, the performance degraded as compared to other scenarios where BS was situated in the centre & at the corner of the network. In this scenario, the distance of communication between CH increases with the BS; this resulted in degraded performance of the network. Therefore, the data communication method needs significant improvement in the existing work.

Also, implementing fuzzy rules along with a second optimization will induce more complexity and overhead in the network. This can be restricted to single method either fuzzy rules or optimization scheme in way to minimize the difficulty of the network.

- **OBJECTIVES**

1. To study various energy efficient clustering schemes for WSN.

2. To proposed the use of mobile agent for information gathered in the network and implement it in MATLAB.

3. To contrast the performance of the proposed and current scheme concentrated on set of alive nodes, throughput &power usage of the system.

- **RESEARCH METHODOLOGY**

In the suggested approach, the CH will be chosen depend on fuzzy rules as defined in the existing scheme. However, in order to reduce complexity of the protocol we will avoid the used of coyote optimization. Once the cluster heads

have been selected, the main focus will be given upon the data collection process from the cluster heads.

In the step, we will propose the use of mobile agent in the network. The mobile agent is dispatched from the base station and its main purpose is to collect data from the CH. Moreover, CH would not be required to forward information to the BS over a longer distance which will eventually increase the network lifetime.

The BS will group the CH in order of decreasing distance from it. Then the cluster heads will be arranged in another sub-groups' equivalent to number of mobile agents required in the system to gather information. Every mobile agent needs to go to one group of CH and gathersinformation from them. Therefore, in the suggested work, every CH will collect information from its members & will send information to the mobile agent. The mobile agent will gather all the data and deliver it at the base station.

VI. RESULTS

Both the proposed MA-FZY clustering method as well as the existing technique were simulated using MATLAB. For simulation, four cases were created from the platform's 200 randomly distributed nodes. There are 10 advanced nodes as well as 190 normal nodes among the 200 nodes. Normal nodes have less energy than advanced nodes. The base station is located outside of the system, with an x coordinate of 50 as well as a y coordinate of 150. The power of advanced nodes is greater as compared to the normal nodes. We took into account the energy for advanced nodes, i.e. initial is 0.5 Joules as well as alpha is 1. The value of alpha indicates how many times more energy is present in advanced nodes. The power required, the set of alive nodes, the set of dead nodes, as well as the system's throughput were all used to analyze the network's achievement.

- **Set of Alive Nodes:** It ismeasured for every round in order to select the EE of the system. For the proposed work, x-axis indicate set of rounds and y-axis indicate set of alive nodes i.e [500,1000,1500, 2000,2500, 3000,3500, 4000,4500, 5000].

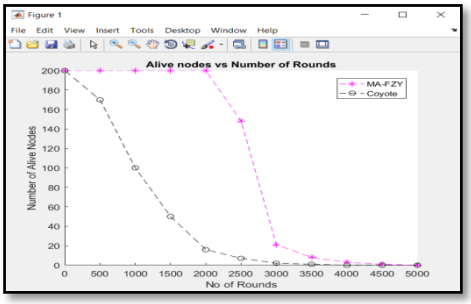

Figure 3: Alive Nodes

Table 1: Comparsion of Alive Nodes

Technique	Number of Rounds
Coyote	346
MA-FZY	2191

Table 1 shows that for existing technique, the first node dies on the 346th round, or for suggested technique, the first node dies on the 2191th round. So, it is clear that network stability is improved in the suggested technique because we use a mobile agent strategy in which it gathers data from all nodes as well as passes it to the cluster head, which requires more energy than the existing system.

- **Number of Dead Nodes:** It is measured for every round in way to select the EE of the system. For the proposed work the set of dead rounds consists is [500,1000,1500, 2000,2500, 3000,3500, 4000,4500, 5000].

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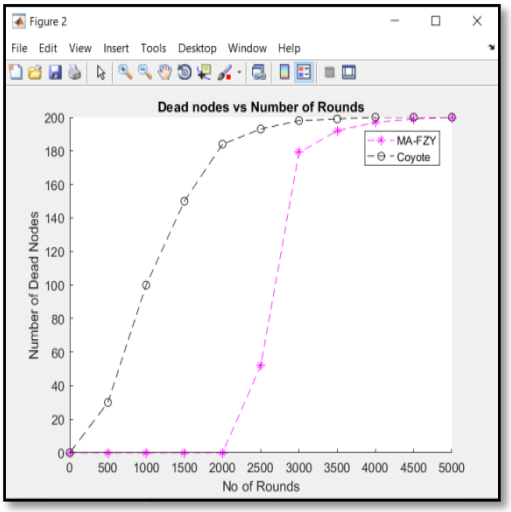

Figure 4:Dead Nodes

Table 2: Comparsion of Dead Nodes

Technique	Number of Rounds
Coyote	500
MA-FZY	2000

Table 2 shows that, for existing design, the first node dies after 500 rounds since the base paper utilized fuzzy rules and also coyote-based optimization for CH selection. They examined the platform's achievement through locating the BS in 3 different locations throughout the system. It was discovered that when the BS was placed away from the system, the achievement degraded when contrasted to other occurrences in which the BS was located in the network's centre & at the network's corner. In this circumstance, the distance of communication among CH and BS increases, resulting in degraded network connectivity or for suggested technique, the first node dead on 2000 round so it uses a mobile agent that individually gathers data from every node when the distance decreases, the energy instantly absorbs less, as well as the network's lifetime rises. As a result, it is clear that the suggested work outperforms the existing strategy on the basis of network throughput.

- **Throughput:** The volume of successful data transmission in the system is typically characterized as throughput. The mentioned equation is utilized to determine throughput in this regard:

$$\textbf{Throughput} = \frac{\text{Total Number of packets successfully transferred}}{Total Number of packets transferred}$$

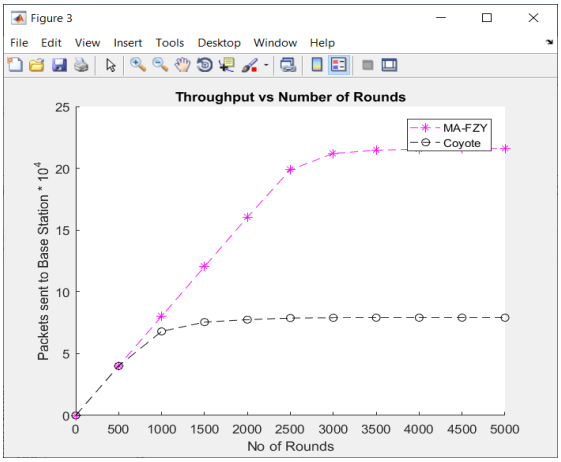

Figure 5:Throughputvs Number of Rounds

From Fig 5, it shows that a proposed MA-FZY algorithm increased the total Number of packets successfully transferred which is more than existing algorithm because if alive nodes exists in the network for a long period it provides a better throughput.

- **Energy:**It is the main origin of WSN nodes, & it accomplishes the lifetime of system.

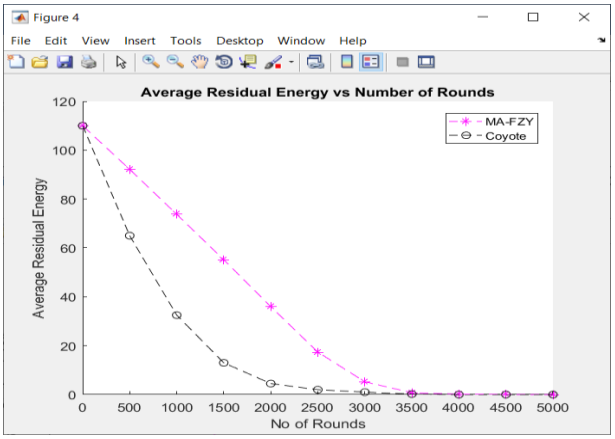

Figure 6: Average Residual Energy vs Number of Rounds

Figure 6 shows that the current procedure has steeper drops in average residual energy than the suggested method, with steeper drops indicating greater energy depletion.

Figures 3 to 6 clearly demonstrates that the suggested MA-FZY method enhances the qualities for all four variables such as residual energy, throughput, the set of alive nodes, as well as the set of dead nodes so because principle of single path will not be used as it will raise load over the CH forming the route. The CH will forward the data to the BS, but because the suggested work BS is located outside of the system, the distance is greater as well as the energy consumed is greater, so we use a mobile agent method to collectinformation from all nodes and pass it to the CH, which saves more energy than the existing technique.

VII. CONCLUSION

Energy is a critical issue in WSN, and various energy-aware routing methods have been suggested to power usage in WSN. The majority of the energy-aware scheduling techniques described in the literature used only the residual storage capacity as a cost metric when calculating a path. The suggested study in this paper considers simulation scenarios in which MA- Fuzzy logic could be parameters i.e alive nodes, dead nodes, energy and throughput are used to enhance the system availability by optimizing CH in WSN. It was also discovered that the suggested approach outperforms in means of network lifetime as well as power consumption.

In the future, the study could be expanded by enhancing the work with additional primary factors. Suggestions for future research for improving the suggested approaches to offer enhanced multipath transmission in WSN include the use of more new systems and advanced methodologies. Another future research direction is the use of distinct multipath routing strategies, such as the transfer of data packets from extra versions, the use of backup paths as well as concurrent path usage.

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