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Energy Efficient Multi Criteria Clustering Routing Protocol for Wireless Sensor

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Abstract

In Wireless Sensor Network, micro sensors operate collectively to gather data from environment and send to base station. Because of advancement in Wireless Sensor Network technology, these sensors can be used in a variety of applications, like Health Care Monitoring, Environment Sensing, Natural Disaster prevention and Chemicals sensing etc. Yet, one of the fundamental challenges for this technology, due to limited power energy of sensors autonomy, is to improve network lifetime. Different methods have been proposed for this purpose such as clustering technique. The basic principle of this method is to select a cluster head which is responsible for collecting information from its member's sensors and forwards it to the sink node. In this paper, we propose to use an improved method of this technique that is Fuzzy-TOPSIS, which basically chooses the Cluster Head efficiently and effectively to maximize the WSN lifetime. Results shows that the proposed scheme improves the network stability and lifetime, minimizes energy consumption and CHs change per round, less control overhead and improves Throughput as compared to the conventional Fuzzy and LEACH protocols.

Keywords: *Clustering- Fuzzy-TOPSIS model- Multi Decision- Energy Lifetime*

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I. Introduction

Wireless Sensor Networks (WSNs) consists of a large number of Sensor Nodes (SNs) that are deployed randomly to sense different environmental parameters.

These sensors are electronic machines used to detect the physical quantities which are treated and processed in order to analyze situations. WSNs are widely used for super visional and tracking purposes [1]. These sensors perform many tasks and can be deployed by chance to monitor the events, for example monitoring of vibrations and material conditions in buildings, Sound monitoring, Target tracing, Traffic congestion, Temperature monitoring, Energy and Water use, etc and all of these are together to make a wireless sensor network (WSNs). WSN consists of four main components, which consists of SNs, which are responsible for collecting data from the desired geographical area; interconnection network which is responsible for transmitting data from SN to gateway; centralized data gathering mechanism and a set of computing resources at the user end for further storage, processing and analysis.[1]

Once the nodes are deployed in the field, there is no way or it is very difficult to change or to recharge the batteries sensor nodes and this is the paramount and biggest problem in WSNs. Several routing protocols have been proposed for WSNs routing techniques. The main goal of these hierarchical algorithms planned to maximize the life of the network and minimize the power consumption.

WSNs can be used for environmental monitoring, military purposes, health monitoring, natural disaster, and traffic tracing etc [2]. The primary concern of these applications must be cost-effectiveness in both data sensing and gathering. As there is limited power and energy available for SNs, therefore, the efficient and effective utilization of energy in WSNs is required [3].

The decision making problem of engineering and science with numerous at- tribute can be solved by using the Multi-Criteria Decision Making (MCDM) **[4].** method. This technique balances and ranks several options based on degree of interest of its relevant attributes [4]. These two can be applied on decision making process. Multi- criteria optimization difficulties can be solved by using TOPSIS model [5]. TOPSIS is a multi-criteria higher cognitive process technique. The MCDM analysis contains variety of higher cognitive process steps as well as advisement of criteria and ranking of alternatives [6].

The Fuzzy-TOPSIS etc **[7].** model contains a judgment matrix with a number of various choices and n number of various attributes for every option. To solve the scenic and engineering problem Fuzzy-TOPSIS technique is used.

Routing Protocols Challenges and Drawing Issues in WSNs

The attributes and challenges in WSNs are distinct from that of conventional Wireless Ad-hoc Networks (WANETs) etc [8]. due to certain requirements and specifications. Thus, it is essential to emphasize the designing of routing protocol in WSNs. In order to develop an effective, reliable and efficient communication channel in WSNs, there are some issues which are to be considered. These include data reporting method, energy efficiency, and mobile adaptability, quality of service, data aggregation, and network topology and node linked-heterogeneity. A brief discussion on these challenges is as below:

Mobile adaptability	Majority of the WSNs uses Base Station (BS) and fixed nodes. Although, there may be a requirement of an application for sensing the sink node or mobility
Energy Efficiency	The connectivity between the base station and nodes require routing protocols with least energy consumption. The regular routing helps in updating the nodes to refresh the status and position of the adjacent nodes. These recurrent updates can reduce the lifetime of nodes due to auxiliary energy required.
coverage	SNs can detect and sense data from surrounding within a limited range. WSNs require to be deployed in such a way that can acquire most of the exposure. The routing protocol is responsible for proper coverage and choosing other nodes in case of failure, in order to ensure the coverage.
Data agregation	In order to avoid the redundant transmission of data, there are various techniques such as copying suppression, minima- maxima, and median are used for data aggregation in routing protocols. These methods are useful in reducing the traffic and enhancing the throughput.
Quality of service	In order to avoid the redundant transmission of data, there are various techniques such as copying suppression, minima- maxima, and median are used for data aggregation in routing protocols. These methods are useful in reducing the traffic and enhancing the throughput.
Clustering in WSNs	Hierarchical based routing use clustering technique. In this technique, network is divided into small chunks known as clusters. These clusters are managed by n cluster head (CH). This CH is important for providing Communication Bridge between base station and the member nodes. Clustering protocol is based on the formation of clusters and selection of cluster head. This clustered routing leads to aggregation of data which is easy to handle. Although hierarchical clustering is good for many reasons, but the energy consumption of this type of clustering is very high due to additional functionalities of the cluster heads. The formation of clusters and selection of cluster head are more energy consuming and requires more computations. Researchers have worked on many clustering protocols in last era. Some popular clustering protocols of the Wireless Sensor Network are presented in the next section.

Energy Saving Methods in WSN Clustering

As the cluster formation and selection of CH are key aspects in WSNs clustering. Thus the consumption of energy can be efficiently utilized by appropriate selection of cluster head and cluster formation. The formation of cluster and rotation is discussed in following section.

Cluster Creation and Rotation

With the development and advancement in applications of Wireless SNs, clustering is essential for managing sensors and an efficient way of maintaining its lifetime. Previous studies have shown that there are many techniques which are developed for cluster formation like RCC (Random Competition based Clustering) etc [9] . Random timer and node recognition are used by RCC for the formation of cluster which is relying on FDWR (First Declaration Wins Rule). By using this rule, any node can get the role of administrator to proclaim itself a Cluster Head to all other remaining nodes in its WSNs.

Cluster-Head Selection and Turning

After cluster creation, each Cluster Head (CH) etc [10]. acts as a controller in every cluster. The major task of CHs is to aggregate data where routing is performed for all of the cluster members and this data is then forwarded to the Sink/BS. Clusters which comprise more nodes have more load and responsibility due to receiving, aggregating and transmitting more data as compared with clusters having less number of nodes because network designer select CH randomly among nodes of the network. It can also be selected by keeping in view the residual energy of nodes of cluster. As CHs have higher burden than other nodes due to which CH is rotated to share its burden that is helpful for improving the lifetime of clusters.

Efficient Intra-Cluster Communication

When it comes to the energy utilization in WSN, cluster volume matters a lot in analysis of hierarchical network. When the size of cluster is small, it helps in saving power of the intra-cluster communication, but on the contrary, it enhances the complexity of the network. This small size cluster have lessened load on the network; therefore a smaller amount of complex communication will occur. However, Intra-Cluster communication utilizes extra power which highly effect the lifetime of the Wireless Sensor Network. Thus, a trade-off is required in the formation of cluster. In above mentioned research most of the protocols are cluster based but they are less energy efficient due to some of the following reasons:

– CH selection is based on single parameter; mostly residual energy
– Further data, like node density, node location, average energy etc., are out of consideration to increase CHs selection time.
– Lead to increase Control overhead
– Lead to increase processing overhead
– In single hop communication, CHs that are far away from BS consume more energy in communication with BS.

II. Related Works

Network life time in WSNs can be efficiently improved if a suitable clustering algorithm is used for CH selection. For this purpose, a lot of work has been devoted to CH selection, and many clustering algorithms have been proposed. In WSNs, data transmission is one of the consumption elements. Therefore, there is a need of efficient technique which consumes the lowest amount of energy to transmit data to the base station is essential. For this purpose different techniques can be used to improve network lifetime. Hierarchical structure in network architecture is one of the ways which helps improve energy consumption. The hierarchical structure puts network nodes in several layers. In each layer nodes have similar characteristics [7].

Clustering is another method in which network nodes are divided into smaller clusters. This approach facilitates the aggregation of data received from the environment inside sensor nodes. Clustering increases scalability, improves energy consumption and decreases routing delay [8]
[5] Proposed CH based Low Energy Adaptive Cluster Hierarchy (LEACH) etc [9].
algorithm which consists of two phases i.e. the set up phase and steady state phase.

In the set up phase, different CHs are selected among all the network nodes with fixed probability which broadcast advertisements to other sensor nodes within a specific range. Other nodes collect advertisements from different CHs and become a member of a particular CH with high radio signal strength indicator (RSSI) value by sensing an associated request. Then CH creates TDMA scheduling, which depends upon the number of member nodes.

In next phase, CHs collect the sensed information from the SNs and compress and aggregate it finally send to the sink. After some specific time re-clustering is performed. LEACH performs better as compared to other routing protocols in terms of load balancing and energy efficiency [5].

Propose a new RCC (Random Competition based Clustering) algorithm. Random timer and node recognition are used by RCC for the formation of cluster which is relying on FDWR (First Declaration Wins Rule). By using this rule, any node can get the role of administrator to proclaim itself a Cluster Head to all other remaining nodes in its WSNs.

Propose Centralized LEACH (C-LEACH) which further improve the performance of existence LEACH protocol. In C-LEACH, the sink node itself selects CHs, instead of SNs themselves. C-LEACH is suggested to increase the formation part of the LEACH protocol. In C-LEACH, in setup phase, it is essential for all nodes to send their locations, ID and information of energy to the base station. This base station makes use of its central control algorithm to assign role of CH to any member node. This algorithm specifies and identifies the energy level then match with the level of energy with the received signal energy level. The BS selects those nodes as CHs which have greater energy than average energy level of WSNs. The selected nodes IDs are sent to the base station. Now from the list of IDs, that node which has fewer gaps from its MNs is chosen as Cluster Head of that cluster. The C-LEACH approach minimizes the consumption of energy of member nodes and CH.

Propose a clustering protocol, called Distributed Energy Efficient Clustering (DEEC). It is another improvement of LEACH protocol for multi-level heterogeneous energy nodes environment. DEEC improves the issue of two levels in SEP, by multi-level heterogeneous energy node environment. The CH creation in DEEC is based on entire remaining energy of the network and remaining energy of the sensor node that desires to become Cluster Head. DEEC evaluates that if the residual energy of the node is greater than the average energy of the network, then it has more chances to become CH. Thus, energy is well distributed in the network as it evolves. Direct Broadcasting Mechanism is simple due to its implementation, but when we talk about its energy consumption, it is not that much cost effective. This is because of the fact that all sensor nodes are dependent on the CH for broadcast. In case sensor nodes are far away from the CH, even then they need to receive the broadcast, although sensor nodes are not required to respond to that particular message. However, if sensor node receive a screened from originator, the upcoming messages will be discarded and energy required for broadcasting will be underutilized.

Leach Mobile Enhancement protocol (Leach-ME) is a cluster-based protocol that is well suitable for mobile nodes environment. The design consideration is to select node that has low mobility comparatively other nodes declare itself as a CH. To ascertain the low mobility feature there are two parameters take into consideration, such as remoteness and other is time. Remoteness measurement is defined through change rate of data communication. A uniform node movement is formed where CH has lowest movement in the group. The benefit of such network formation is to uphold the minimum maintenance cost in the wireless sensor network. Remoteness is ascertained through mentioned equation.

Let n_i (t) , i = 0, 1, 2, 3..N-1, where N denotes nodes density, from node i at time t. and $d_{ij}(t) = |n_j(t) - n_i(t)|$, the distance between sensor node i to node j at time t. So the remoteness from node i to node j at time t is $R_{ij}(t) = F.d_{ij}(t)$, where F presents remoteness. Thus nodes remoteness is measured as:

Where, d_{ij} describes the total distance from node i to node j and N describes the total number of nodes in the network. The communication initiates from active time slot t1 and receives at time slot t_2. The distance M (t) = 1 $N-1$ $N-1$ $j=0$ ij $(t)|$

Discussed multi-hop broadcasting transmits a cluster advertisement note to the nodes within a specific transmission range. Any node is responsible for sending the cluster advertised message in transmission range which receives the message. This mechanism is similar to the direct broadcasting technique because it works in the same way as initiator node do for sending cluster announcement message at the start of cluster creation. A concept of minimum communication energy is used by these techniques as those sensor nodes will become part of the initiator cluster which is easiest to reach. When formation of cluster is done dynamically, they are reorganized on periodic basis. In every period, initiator is selected at the start which then broadcast messages using mechanisms which are mentioned above for cluster organization.

Mobility based Cluster (MBC) protocol is presented in that is well suitable for mobile nodes environment. MBC takes into consideration two important parameters to select CH, such as expected connection time and remaining energy. To increase longer network lifetime, CH selection is based upon a node having more energy as comparatively other nodes. Moreover, to address the problem of data loss, projected connection duration between MNs and CHs is taken into consideration. MBC algorithm assumes two most important stages for the network formation, namely steady state phase and setup phase. In the network setup phase, nodes decide their status to be either MN or CH that is based on mentioned formula.

$$T(n)new = p/(1-P\times[r\ mod(1/p)]) \times (Encurrent \times Vmax - Vn\ (current))/\ Emax \times Vmax,\ \forall\ n \in G \qquad (2)$$

P described expected percentage of CHs (e.g., p= 0.05), r denotes current trip, E_n current is current energy, v_n current presents current speed, E_{max} denotes initial energy and v_{max} denotes maximum speed of the node. The disadvantages of the algorithm are: Firstly, the cluster suffers when nodes move in different direction. Secondly, new nodes may reuse the existing messages which are not considered in the network formation. Martin et al., (2013) announced a new variety of LEACH called (TL) Two-Level LEACH. In this protocol, n CH collects data from other cluster members as original LEACH does. However, rather than transfer data to the BS directly, it uses one of the CHs in the path to the BS as a relay station. In TL LEACH, all the CHs reelect them as selves as a second level CHs and the first level CHs associate with them. The first level CHs will transmit the data to the second level CHs which will then forward that data to BS.

Introduced Virtual Grid based Dynamic Routes Adjustment (VC DRA) scheme to reduce the overheads of the network due to sick mobility. After nodes deployment in the area, virtual grid is developed. The area is divided into equal density cells that are controlled by cell-header. To control the dynamic network topology due to sink's mobility, communication policies are set to control the routes settlement process. The role of cell-header is delegated to other nodes that achieve equal energy usage, eventually enhances network's lifetime. There are various advantages of this algorithm, such as improved data delivery performance and minimum communication overheads. There are few disadvantages of the algorithm such as, minimum communication overhead and unequal size cluster division.

Grid based cluster head selection (CBCHS) is introduced in that selects the CH from nodes. The centralized manner of network formation is use[15] d to gather entire information of the network. All nodes in the network send their location information to the sink node. After collecting location information, sink node searches the middle center of every grid and send this information to nodes. Upon receiving the message of sink node, the receiver finds the distance from mid-point. Node having least distance from center point announces itself as a CH. The process is carried out in every grid. Connected dominating set based network formation is proposed in [16] in order to develop energy efficient cluster-based network. When nodes are deployed in 3D monitoring space, it searches the sink node till nodes are connected. A broadcast message is dissipated to all nodes in the network to gather the data of entire nodes. In order to form the network, nodes keep moving in the direction of sink node until ready message is received to get ensured that the node is in the communication range of sink node. Upon receiving a ready message, the node acknowledge via sending location information to sink node. Thus, the high coverage network is also achieved. After collecting all nodes information by sink node, the node executes a centralized algorithm to establish the CDS in the network and adjust a perfect location of cluster head nodes the network. Thus, the cluster head moves to the right location that is within the range of member nodes.

Consequently, it achieves high coverage network under limited energy utilization. Few disadvantages of the algorithm are; the network requires collision avoidance scheme to successfully communicate the message. Communication overheads affect the network performance badly in terms of delay and energy is the second disadvantage of the scheme.

Proposed Scheme

In this paper, we use fuzzy-TOPSIS model for CH [17] selection which is efficiently used to select a proper choice between ambiguous options. In proposed method combination of distributed and centralized algorithm are used which select some nodes called Electoral Nodes (EN) which are responsible for the selection of optimal CHP. Because of EN nodes, energy consumption and CH selection time is minimized. In this paper, we also restrict the changing of CHs in every round by defining a threshold value which decrease the control overhead and reduce the energy consume on control overhead. The reason behind using Fuzzy-TOPSIS model is that it considering four criteria for CHs selection which give us the ability to select more appropriate CHs as compared to single criterion-based CH. But considering four criteria makes the options ambiguous because almost all criteria contradict with each other. These four phases are:

Network Deployment Phase

In node deployment phase, all sensor nodes are randomly disperse in a field. In our simulation environment nodes are static, and homogenous in terms of their hardware and initial energy as shown in Figure 3.1. The BS is also static and is its coordinates are known to the sensor nodes by sending beacon message after randomly dispersed. The functionality of BS is to gather, forward and aggregate the data from the CHs nodes to the gateways or workstation.

Neighbor Discovery Phase

After nodes deployment phase, all nodes become active and start neighbor discover phase to populate their neighbor table. Every sensor node announces a hello message/packet that retains the node's ID. Entire Sensor Node (SN) in its transmission range receives this broadcast message. Every time a node receives this hello packet from other nodes it calculates the distance of the transmitter node and records its ID and its distance in its neighbor table. After a specific time when every node completes its neighbor table, it sends this information, along with the information of its distance from BS and its residual energy, to the EN nodes. After receiving these updates from all the sensor nodes in the range of EN node, the EN node updates an n matrices with nodes' IDS, remaining energy, Crl, Density of the node Cr2, Base Station distance, Cr3, Average distance between the nodes and its neighbors, Cr4. Assume that there are n neighbors of Node k, then Tk will be an n matrix, as shown below. The neighbor discovery process is repeated after some round in order to discover the dead sensor nodes in the neighbors.

CH selection and Cluster Creation Phase

CHs selection is performed in this phase in five different steps. These steps are:

Step 1: In this step, The values of all the criteria are in the same range and have different units as residual energy criterion has unit of 'joule' and its value lies between 0 and 1. On the other hand criterion average distance has unit of meter and value lies between 0 and 100. Therefore, these criteria are normalized to a similar range between 0 and 1. Criteria Crl and Cr2 are called PC (Positive Criteria), PIS (positive Ideal Solution) or Benefit criteria, because larger the values of these criteria, more are the chances of the sensor node to become CH. However, some criteria like Cr3 and Cr4 are called NC (Negative Criteria), NIS (Negative Ideal Solution) or Cost criteria. Their fewer values are more suitable for a sensor node to be elected as CH. Both types of criteria are normalized according to the Equation 4 and 5.

Step 2: Fuzzy Membership function is applied after normalization to categorize each Value of normalized matrix according to their respective weights. Weights and fuzzy member function are given in the following Table 1 and 2.

Weighted decision matrix W_k for each criterion and their respective weight from normalized matrix is determined based on the fuzzy membership function is given as:

$$\left| \quad {}_{3,1} \quad w_{3,2} \quad w_{3,3} \qquad w_{3,4} \right|$$
$$\left[\; {}_{4,1} \qquad w_{4,2} \; w_{4,3} \quad w_{4,4} \right]$$

Step 3: The maximum value in the matrix Wk for benefit criteria is called Positive Ideal Solution (PIS) and the minimum value in matrix Wk for cost criteria is called Negative Ideal Solution (NIS). The values are determined according to the Equation 9 and 10:

$$PIS = W^+_1 \dots , W^+_1 = [(max_i\, W_{i,j} | i = 1, \dots , m); j = 1, \dots , n] \quad (9)$$

$$NIS = W^-_1 \dots , W^-_1 = [(min_i\, W_{i,j} | i = 1, \dots , m); j = 1, \dots , n] \quad (10)$$

Step 4: From the weighted matrix Wk , each sensor nodes, each criterion value is compared with PIS or NIS, and determine the distance of each criterion value from PIS or NIS accordingly through separation measure using n-dimensional Euclidean distance as given in the following equations:

$D+ = \sqrt{\sum n\, Wi, - (W+)\, 2}\; j = 1,2,3 \dots m$ (11) $j\; i=1\; i$

$D- = \sqrt{\sum n\, Wi, - (W-)\, 2}\; j = 1,2,3 \dots m$ (12)

Step 5: Finally, from equation 13, Rank Index (R.I) is calculated according to the subsequent equation

In the Rank Index Table 3.3, the sensor node with highest value is selected as a CH by EN node. EN node broadcast selected CH, ID and a Time Division Multiple Access (TDMA) schedule to all the nodes in its n matrices. Due to the EN nodes, the hello overhead in minimized by exempting the broadcast message by elected CH, join request message by normal nodes and acknowledgements of join requests by CH.

After CH selection, all the normal nodes in the cluster, sense the physical parameters from the environment and forward to the CH in their Time Division Multiple Access (TDMA) slot. The CH receives their data, aggregates and forwards it to the BS. This whole process collectively completes one round. In each round the EN nodes continuously predicts the R.I until it receives new updates in neighbor table from the sensor nodes. If a new normal node makes a place at the top of R.I, its index value is compared with previous CH index value. If the difference is greater than a specific threshold value (which is 0.1 in our experimental setup) the new node is CH. The now CH information is broadcasted to cluster in the end of round so that in new round the nodes communicate with the new CH. The purpose of a threshold value is to avoid frequent CH changing and minimizing the energy consumption in CH changing process. The Cluster Head change flow graph is indicated in Figure 3.

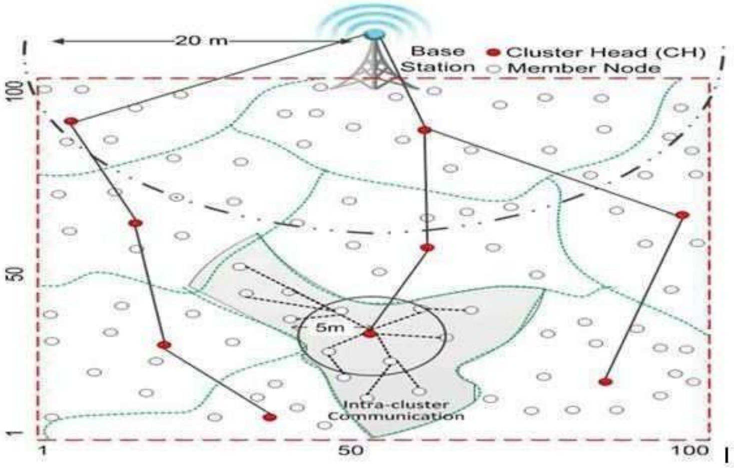


Fig. 4 Inter and Intra-cluster Communication

Communication Phase

After Cluster Head assortment and cluster development, communication phase started. The multi-hoping communication model is measured by our projected scheme because it is the additional realistic and practical one. Sensor nodes (SN) in a range of five meters send their sensed/collected data directly to the Cluster Head. However, the SN having a space/distance of more than 5m from CH, execute multi- hoping with other SN sensor nodes approaching in their path to communicate with the Cluster Head. Same situation is also functional on CHs when they correspond with the Base Station. The CHs in a range of 20m from the BS, corresponds directly to Base Station, while the remaining CHs execute multi-hoping through other Cluster Heads. The intention of using multi-hoping is to enhance network lifetime and stability. Figure 4 indicates Intra and Inter-Cluster communication.

Communication phase starts after successful CH selection process. Every sensor node in the cluster transmits the information it sense from the surround environment to the CH in its TDMA slot. However, we proposed a different routing technique, for transmitting the sensed information to CH, from traditional clustering routing protocols. In our model each sensor node communicated directly with the CH if it is in 5 meters range. However, if the CH is at more distance then 5 meter, then the sensor node forwards its data to the nearest node between the CH and itself. The same technique is adopted by CHs that is, CHs communicates directly with BS if it is situated in 20 meters range of CH otherwise the CH communicates in multi-hop manner with the BS. Overall communication phases are depicted in Figure 4.

To explain the data flow diagram as described in Figure 5, randomly nodes are deployed. Initially, every node checks that it is electoral node (EN) or normal node. When the node is EN then it waits for information from node(s). After receiving the information from normal nodes, the EN selects the CH through Fuzzy-TOPSIS model. The EN nodes broadcast the CHs along their ID and TDMA slot to all nodes in the network and thus the communication initiates only for this round.

However, if deployed nodes are not EN node then the neighbor discovery phase is executed as describe in Figure 5. Every node that is not EN node forms a neighbor table that is sent to EN node where it contains average distance from the neighbor, residual energy, distance from the BS and node density. The EN node executes the CH selection after receiving the mentioned information from normal nodes. Thus, every node will be either a CH or MN declared by EN. When a node is CH and received data from MN then it checks the distance from BS in order to send data to BS. If the CH distance is up to 20 meters from BS, then direct communication is perform else the data go through intermediate nodes existing between CH and BS. Moreover, refer to Figure 5, when the node is a MN nominated by EN, wants to send data to CH then either direct or indirect communication is performed between CH and MN. The MN sends the data to CH when the distance between MN and CH is within 5 meters; otherwise MN sends the data through intermediate nodes.

III. Simulation results and analysis

Sensors nodes are randomly dispersed in a 100 X 100 meter of area with the BS located at the top of the field. Some of the assumption is made in our simulation which is given below.

- All sensor nodes (SN) are homogeneous.
- Nodes and Cluster are motionless.
- The same initial energy is provided to all nodes.
- Sensor nodes send data directly to their HN (head node) within a cluster These simulation parameters are shown in Table 4.

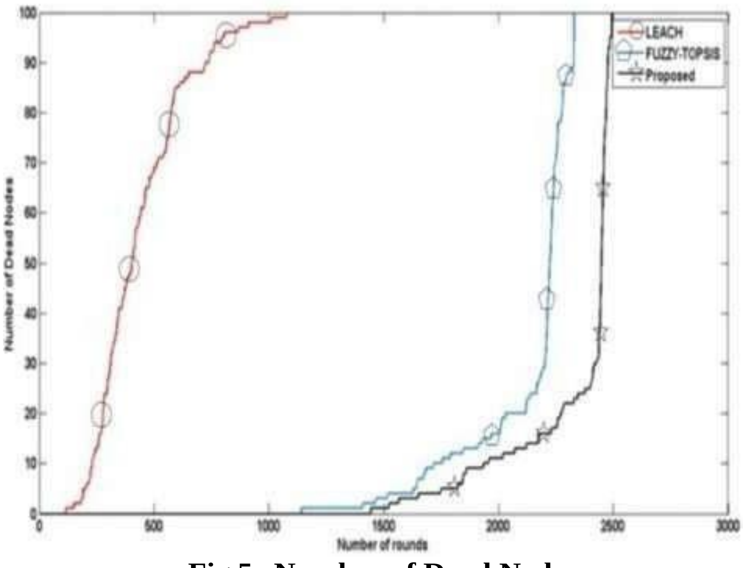


Fig 5. Number of Dead Node

Simulation Results

The simulation results are compared and analyzed with LEACH protocol and Fuzzy- TOPSIS in terms of the following performance parameters.

Network stability and lifetime

Figure 5 shows the simulation results number of dead node vs the number of rounds. The graph in this Figure 5 clearly shows that the energy of first node in LEACH, falls around 170 rounds and in Fuzzy model, first node energy falls around 1200 rounds whereas in our proposed scheme, first node energy falls around 1400 rounds. Thus, it clearly shows that network lifetime and stability in our proposed scheme is much better as compared to the clustering schemes in previous model. It is because LEACH is single criteria-based technique and fuzzy-TOPSIS method selects the CHs without the consideration of nodes position. The efficiency of our proposed scheme EN takes decision considering four different criterions to declare CHs.

Alive nodes in Figure 6 clearly describes the lifetime of the network. From Figure 6, it is cleared that LEACH algorithm, last node energy falls around 1000 number of rounds and fuzzy model energy falls around 2300 number of rounds, whereas in our proposed scheme, network last node energy falls after around 2500 rounds. As shown in Figure 6, Network stability and lifetime of the proposed scheme is more stable than other compared previous schemes because of using multi-hop communication.

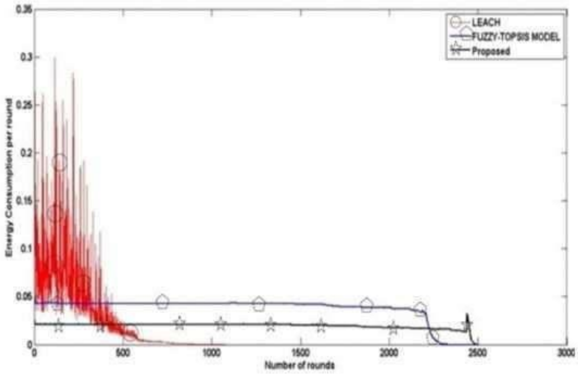


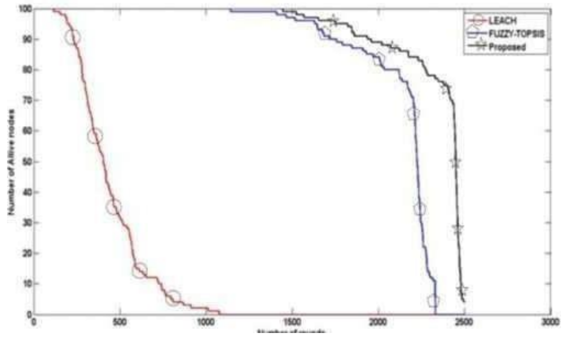
Fig. 6 Number of Alive Node

Energy consumption per round

Figure 7 shows the average energy consumption of nodes per round. It can be clearly analyzed from the Figure 7 that in the proposed model the nodes consume less energy than the previously proposed schemes. In a WSN, almost seventy percent of energy consumption is because of node's transferring its sensed data to the BS or CHs. So a proper CH selection technique and communication model is obligatory for an energy efficient clustering protocol. Because of intra and inter cluster multi-hop communication criteria is introduced in proposed algorithm, is the main reason for less energy consumption than LEACH and fuzzy based scheme. Furthermore, a node at suitable distance from BS and neighbors can also be considered as criteria for becoming CH that also reduces energy consumption in communication process as compared to other competitive schemes.

Change of Cluster Head

Figure 8 clearly shows that in our proposed scheme, traditional CHs switching is avoided. Instead of that, CHs are switched when a certain threshold values are exceeded. Eventually the node is not appropriate for CH's responsibilities. However, in other traditional approaches, like LEACH and C-LEACH [18], CHs changes in every round, which increase the control overhead by broadcasting beacon messages. This broadcast of beacon messages increase unnecessary energy consumption by nodes and depletes energy dissipation of the network as shown in Figure 8. There is much variation in average energy consumption per round in other protocols especially in LEACH, this is because of non-suitable nodes are selected as a CHs as describe in Figure 8.



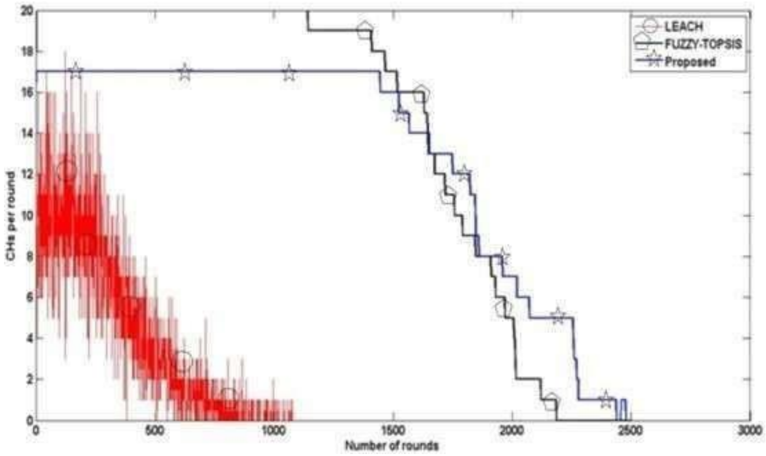


Fig. 7 Energy Consumption per Round
Fig. 8 Cluster Head selection per round

Control Overhead Packets (Hello)

The hello packets or control overhead are the beacon messages necessary for sharing information with other nodes or neighbor discovered by a node to find the distance from BS or its neighbor node, etc. However, this control overhead increases the energy consumption over a node, eventually reducing the lifetime of the node. High control packets are proportional to energy dissipation, describes that maximizing the energy lifetime requires less control messages. In this simulation results, control overhead can be minimized by introducing EN node, which performs the CHs selection process and limiting the CHs switching, as every time a node is elected as CH. The CH informs all the neighbor nodes about its current status by broadcasting control messages. All non CHs nodes acknowledge the beacon messages to join the CH. In proposed scheme, only EN node selects the CHs, no other nodes send or broadcast beacon messages. As shown in Figure.5 the proposed scheme has much less control overhead than current schemes shown in the Figure 9.

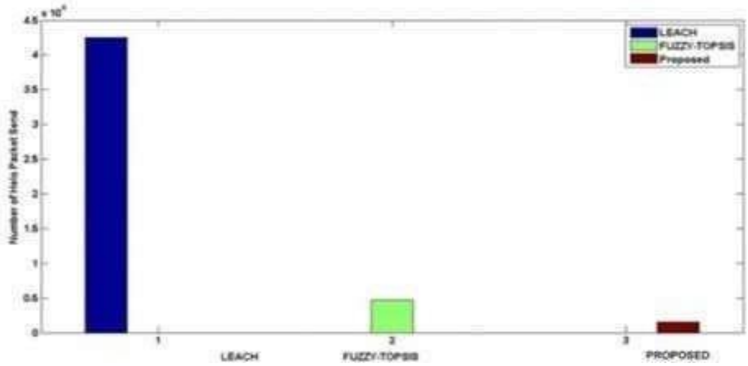


Fig. 9 Control over head

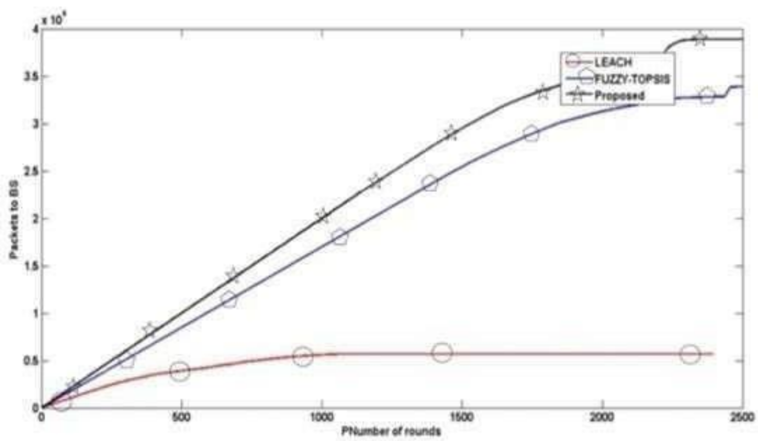


Fig. l0 Packets Sent to Base Station (Throughput)

Packets Sent to Base Station (Throughput)

Packets to BS are the data sensed by the nodes from its surroundings and transmitted to the BS. The successful data delivery to BS is greatly dependent on the suitable selection and optimal node of CHs. As if non suitable node is selected as a CH, it may die in middle of transferring of data or it may not be able to transfer the data to the BS because of its geography. In the proposed CH selection technique, a proper communication model is introduced that consider multiple criteria for CH selection. Figure 10 shows that proposed method outperform than other approaches in terms of throughput (Packet to BS).

IV. Conclusion

In this paper, we recommend a new clustering routing [20] technique for Wireless Sensor Networks (WSNs) to minimize the energy consumption and increase the lifetime of the WSNs to achieve the targeted goal. The main aim of the research is to examine the issues related to lower lifetime of WSNs and resolve the issues. In this paper, we use distributed clustering technique, considering four different criteria, which are distance from BS, Number of neighbor nodes, residual energy, and average distance between a node and its neighbors, for selecting the CHs. Frequently CHs switching is avoided. by restricting the CHs change to a specific threshold value. The CHs selection process is conducted by EN nodes. These EN nodes do not take part in transferring data to the BS until ten percent nodes remain in the network after which these nodes take part in communication process. Because of the EN nodes, conducting the CHs selection process, control overhead and CH selection time are greatly reduced, consequently increase the stability and network lifetime. Furthermore, inter and intra-cluster communication is introducing an increase throughput and lifetime of network. Analytical and simulation comparison shows that our proposed technique performs much better and accurate as compared to the other clustering techniques.

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