A Modified Approach For Energy Efficient Clustering Mechanism Using LEACH In Wireless Sensor Network

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Abstract: ***Wireless sensor network (WSN) is playing an important role in the information industry in the 21st century and is widely applied in military, medical care, environmental monitoring, smart home applications, and in many other fields also. WSN is a distributed system consisting of many sensor nodes and a sink node that collects data from the sensor nodes. Sensor nodes of a WSN have limited power and energy constraint so it is mandatory to efficiently use these resources. Therefore, sensor nodes have emerged as a research hotspot. The most important power consuming component in WSN is the routing protocol as it require power when receiving and transmitting the data of other nodes. This drawback revealed the requirement of tailored routing protocol which reduces the power usage to prolong the lifetime of sensor nodes. A cluster-based network structure can balance the energy consumption of network nodes. Low-Energy Adaptive Clustering Hierarchy (LEACH) protocol is one of the first clustering protocols for WSNs and is one of the most famous clustering techniques. So by using this protocol the major issue of power consumption can be solved, this is the basic protocol and research is in progress to improve its capability and improve the energy efficiency of the WSNs. In this paper we have tried to improve the energy efficiency of WSN's through a modified approach of LEACH protocol, and have derived results which shows significant improvement in the dead node ratio which indeed helps in improving the life time of sensor nodes***

Keywords: LEACH, Energy Efficient, Routing Protocol, Clustering Hierarchy

1. INTRODUCTION

A wireless sensor network (WSN) is a wireless network consisting of spatially distributed autonomous devices using sensors to monitor physical or environmental conditions. [6] A WSN system incorporates a gateway that provides wireless connectivity back to the wired world and distributed nodes. WSN has wide application possibilities, such as temperature, pressure, humidity and habitat monitoring, disaster management, military reconnaissance, forest fire-tracking, security surveillance and many more. In most scenarios, sensor nodes are randomly deployed with limited battery power. The selection of routing techniques is an important issue for the efficient delivery of sensed data from its source to the destination. A lot of energy-efficient routing protocols have been proposed and developed for WSN, depending on their application and network architecture. The flow of data transmission is a very important aspect in WSN. There are several routing protocols which are responsible for determining the flow of data across the network. The routing protocols in WSN are divided in Flat, location-aware and hierarchical on the basis of network structure.

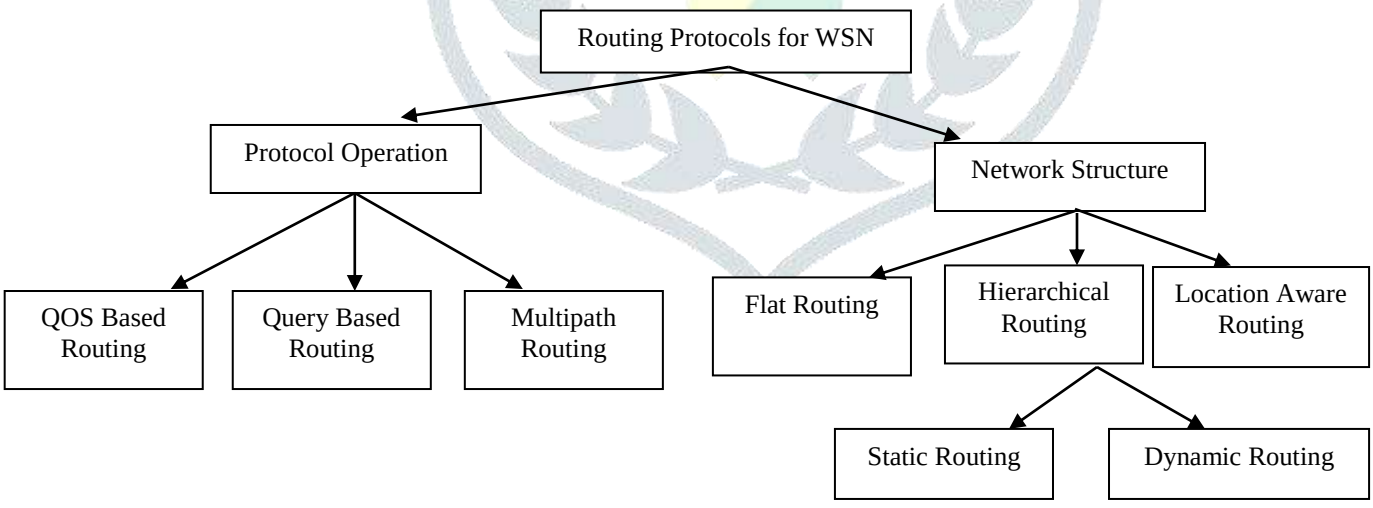

Fig.1 Classification of routing protocols [1]

Hierarchical routing provides better energy efficiency and scalability due to its architecture. In this type of protocol, the whole network is divided into clusters and some nodes are chosen as special nodes based on certain criteria. These special nodes called cluster heads (CHs) collect, aggregate and compress the information received from neighbor nodes, and finally transmit the compressed information to the BS.

The first hierarchical routing protocol was proposed by Heinzelman et al. known as LEACH (Low Energy Adaptive clustering Hierarchy). LEACH is a pioneer clustering routing protocol for WSN. The main objective of LEACH is to increase the energy efficiency by rotation-based CH selection using a random number. LEACH works in two different phases viz. set-up and steady-state phase.

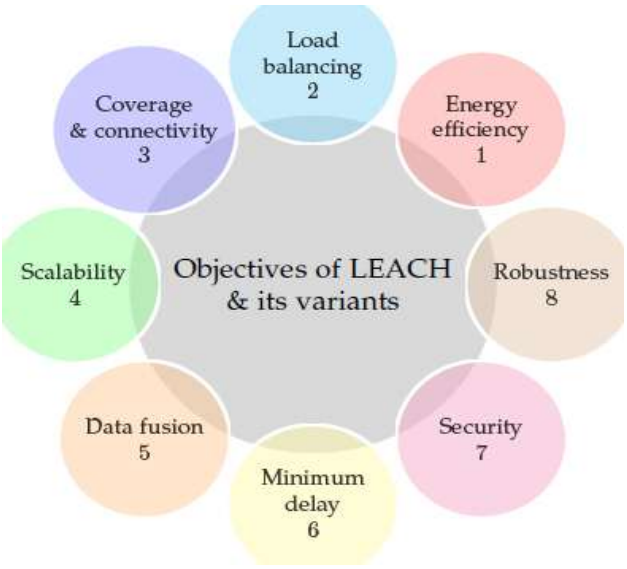

Fig.2 Objectives of LEACH [7]

In rest of the paper, section 2 gives the literature review of different research papers containing the successors of LEACH Protocol; in section 3 from the analysis of previous work we propose a modified approach of LEACH protocol. Section 4 consists of experimental results; finally in section 5 we conclude our work.

2. RELATED WORK

In Recent years, there have been many papers published on successors of LEACH protocol for energy efficiency through routing protocols in Wireless Sensor Network. Routing protocol has emerged has a research hotspot, which is attracting researchers to contribute their work in this field. Below is the brief discussion about the methods used by different researchers for routing protocols in WSN's.

Deepak M. Birajdar and Sharwari S. Solapure [1] presented the detailed working of LEACH protocol using Omnet++ simulator. LEACH works in two different phases viz. set-up and steady-state phase. LEACH periodically do the rotations among cluster-head nodes in such a way that every node gets a chance to become cluster head and distributes energy consumption between the nodes in the network which reduces the power utilization, increasing the lifetime of the network. LEACH is better than the classic approaches like SPIN, GAF, TEEN, and APTEEN etc.

Rajat Kandpal & Rajesh Singh [2] proposed a new improved version of LEACH as IL-LEACH (Improved Lifetime Low Energy Adaptive Clustering Hierarchy). Sensor nodes placed in vicinity sense correlated data which is sent to the cluster head. IL-LEACH aims to mitigating the correlated data transmissions by forming groups of nodes into virtual correlated cluster (VCC) and allowing only one node to send data. The grouping is done based on calculation of a threshold sensing coverage (TSC) and Euclidean distance. IL-LEACH improves the lifetime of sensor network at an average of 30.006% with respect to existing LEACH protocol.

Abdul Razaque [3] and his team proposed a new approach H-LEACH (Hybrid Low Energy Adaptive Clustering Hierarchy), this is used to solve problems of energy considerations while electing a channel head. H-LEACH considers residual and maximum energy of nodes for every round while electing a channel head using threshold condition. In this paper, the proposed algorithm is used to find the life time of the nodes in terms of rounds when the proposed threshold and energy conditions are considered. The nodes with energy less than to that of the (Etr) minimum energy required for transmitting and receiving signals is made to die as it lacks energy to do it. Total numbers of alive nodes are calculated for every round so as to have a track on the life time of the network. H-LEACH, being the combination of HEED and LEACH overcomes the node energy issues, which is the major disadvantage of the LEACH protocol.

Sapna Gambhir and Parul [4] proposed a new approach OE-LEACH (Optimized Energy Efficient LEACH) it aims to minimize the energy consumption in order to improve the time delay, network stability period and network lifetime of WSNs. There are many situations where the sensor nodes do not have data to send regularly as they may be event driven. So in that case data are available only when they sense the event. So, the sensor nodes do not need to listen the channel at all times. Energy is wasted more on idle listening than that dissipated in transmitting and receiving. This method takes advantage of using the slots belong to the node having no data to send. Slots are not allocated to the nodes which have no data to send and free slots are converted into useful slots, which reduce the idle listening problem, and also decrease waiting time.

Mustafa A. Al Sibahee [5] and his team proposed a new approach LEACH-T (Leach Three Layers). Power consumption increases massively as the distance between sink node and cluster heads (CHs) increases. This drawback introduces distance as one major issue in LEACH. In this work, a LEACH based protocol consisting of three layers is proposed. Each layer has its own CHs. The layers attempt to reduce the distance between sink node and CHs. The third layer is utilized if the distances between CHs and sink node exceed a threshold value.

3. PROPOSED WORK

3.1 Problem Statement

After studying above papers there are many design issues that I have came across such as mobility, energy consumption, network topology, data aggregation, localization etc. Routing protocols provides energy efficient working of the network and also increases network lifetime. LEACH has its own drawbacks so it needs to be solved and some modifications can improve in its success rate and the problem of energy efficiency of WSN can be resolved. The main factor that can help in improving the sensor nodes efficiency is the clustering mechanism of nodes; if it is done properly then it will lead in selection of optimal cluster head which indeed leads to lower power consumption of sensor nodes. So using our proposed method we will be working on modified LEACH mechanism which will improve efficiency, performance, and latency of system.

3.2 Proposed System

We have made a survey on different techniques for improving energy efficiency and which approach suits the best. From that, we have realized that we will work on routing protocols, specifically on the hierarchical clustering protocol. We will be using the basic LEACH protocol for our work. Taking the base paper as LEACH-T and adding our modification into it we would be developing a modified Leach protocol having capabilities of efficiently using the energy of nodes and improve its lifetime.

What we would be doing is for grouping the nodes and forming a cluster network we will be using cell formation and create a Hexagonal cell network of clusters. Here hexagonal cell is used for better network coverage.

Below figure shows the network structure of my proposed system consisting of hexagonal cell structures of nodes forming a pair of clusters. A single cluster consists of set of seven cells. Each cell has its own cell head and every cluster will have its cluster head and other nodes are normal nodes. Cell head's & cluster head's changes in every round.

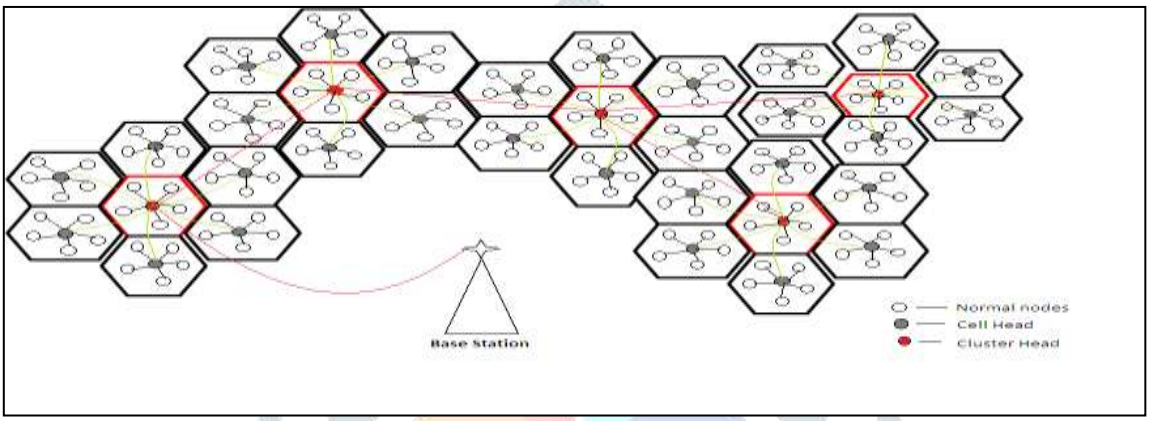

Fig.3 Cluster Network

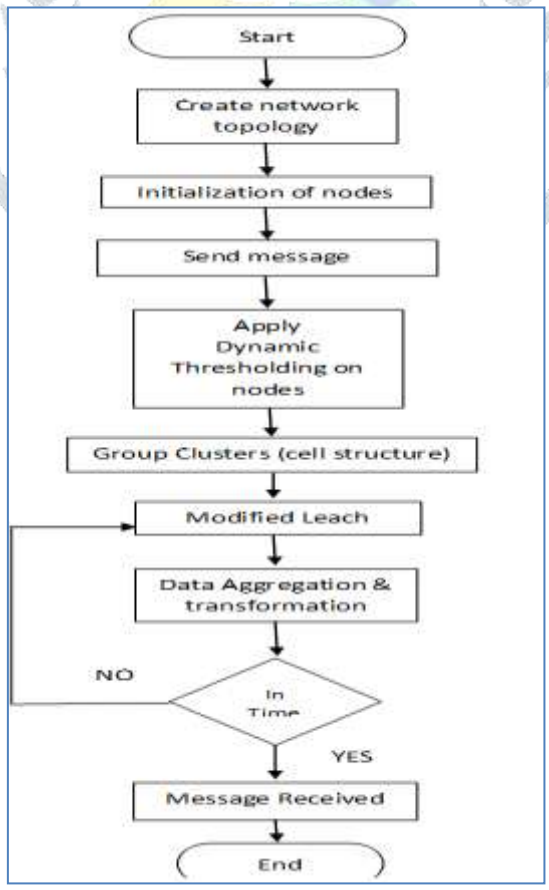

Fig. 4 Flow Diagram of Proposed System

3.3 Algorithm

Step 1: Source node start searching for destination node.
Step 2: Network topology is been defined in this step.
Step 3: In this step initialization is done of every node. Nodes power, remaining energy, routing information, etc all is initialized.
Step 4: In this step request is sent for transmission of message/data between nodes.
Step 5: Here we apply threshold value to every nodes. Based on the data bit arrival rate a threshold value is set on every nodes of the system.
Step 6: Here as explained earlier hexagonal cell structure is formed for clustering of sensor nodes. Then transmission between nodes takes place as explained earlier.
Step 7: Here the data is aggregated and are ready for transmission to the base/sink node. The transmission process is carried out and further remaining tasks are carried out for transmission.
Step 8: Here information is sent to the base station/sink node in time. If it exceeds the time constraint then again the process is directed to cluster formation stage. If it succeeds in time it is executed and process ends here.

4. EXPERIMENTAL EVALUATION

Here we have implemented our proposed work in MATLAB 2017R Simulation and carried out implementation taking into consideration a network scenario consisting of 100 sensor nodes and creating the working environment of wireless sensor network of 100X100m area. The experimental parameters used in simulation of the system are listed below:

Table 1 Simulation Parameters

Parameters	Values
Simulation Area	100 X 100
No. of Nodes	100
Initial Energy	0.5 J
Probability to become CH	0.1
No. of rounds(iterations)	3000
Sink.X	0.5*XM
Sink.Y	0.5*YM
Energy for transmission	50*0.000000001 J
Energy for receiving data	50*0.000000001 J
Emp	0.0013*0.000000000001 J
Efs	10*0.000000000001 J
EDA	5*0.000000001 J

After implementing the System the result derived is been shown in below figures. The simulation result shown below gives the comparison of dead nodes ratio with previously proposed algorithm. We compared the results with IL-LEACH algorithm which shows significant improvement in the dead node ratio which indeed increases the sensor nodes lifetime.

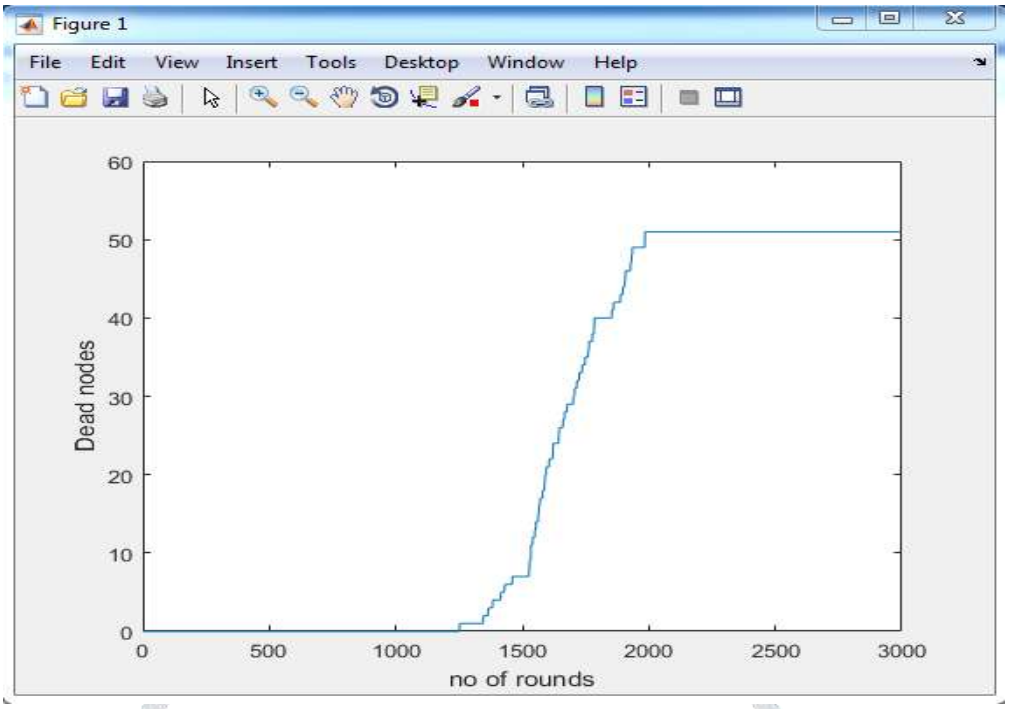

Fig. 5 Dead nodes in proposed system

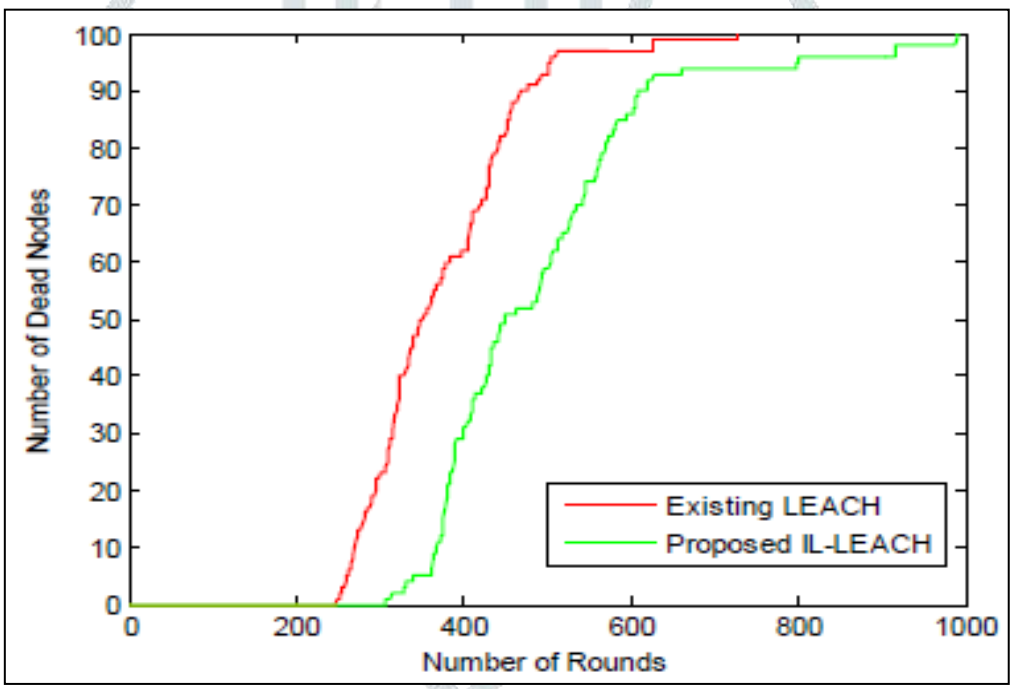

Fig. 6 Dead nodes in existing system

From the above two figures we can clearly see how our proposed system increases the network lifetime by a significant margin. In previous systems like LEACH & IL-LEACH the dead node starts from around 250th round and till 1000 round around 100 nodes dies due to lack of energy. Compared to our system we simulate the results for 3000 rounds and we see that first dead node forms around at 1200 rounds. And after 3000 rounds approximately only 52-54 nodes dies, so we can clearly see how our proposed system improves the dead nodes ratio compared to previous systems.

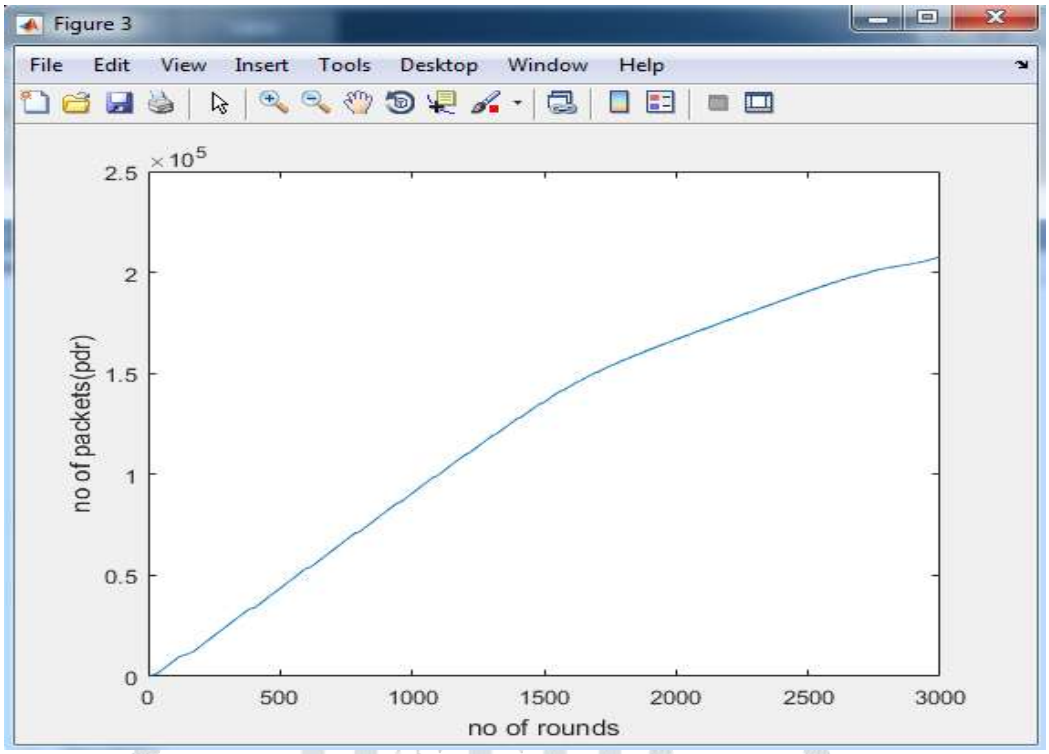

Fig. 7 Packets to Base station

Above figure shows the amount of packets transmitted to the base station after 3000 rounds of iterations. After 3000 rounds around 2.1x10^5 bits of packet data is transmitted to base station from the CH nodes. Below figure shows the amount of cluster heads formed in the duration of 3000 rounds of iterations.

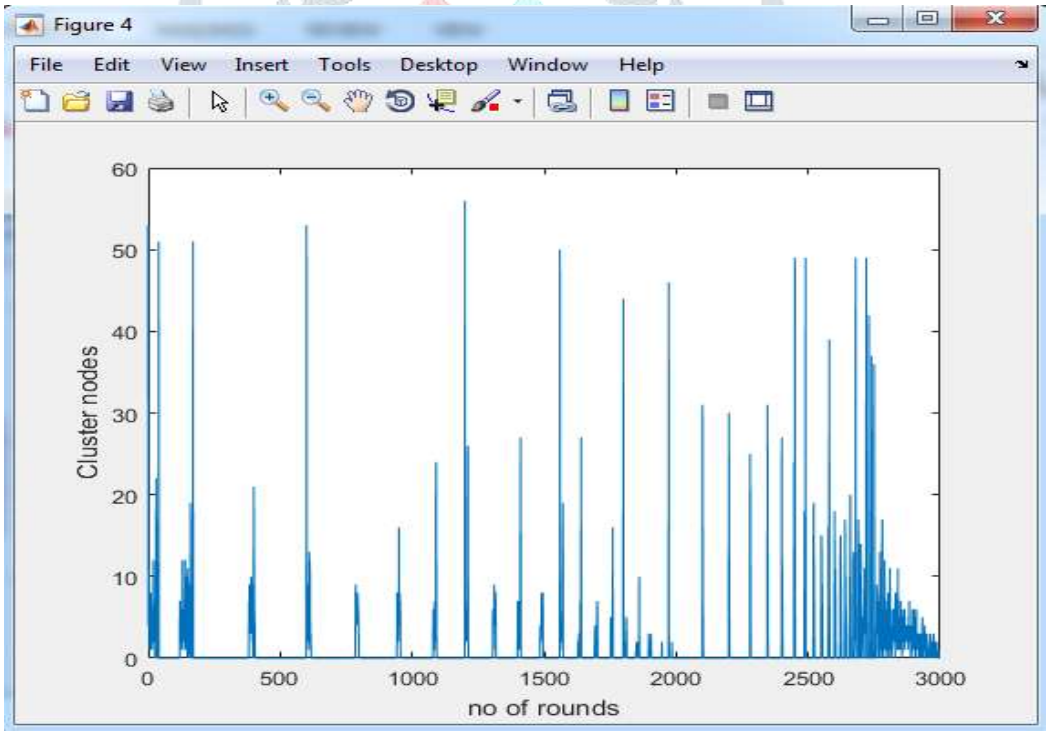

Fig. 8 No. Of cluster heads

5. CONCLUSION

In this paper, results indicate that the proposed Modified Leach is more efficient than the previous proposed algorithms. Here we are using dynamic thresholding concept which helps in improving the lifetime of sensor nodes, also the network structure is created in such a way that it helps in better network coverage. The proposed system improves the dead nodes ratio compared to the previously proposed system with a significant margin. By this it also increases the network life time as after 3000 rounds only 52-54 nodes dies due to lack of energy. So by deriving the results we can say that our system performs better than many versions of LEACH in prolonging the network lifetime of the sensor nodes which was the primary goal for carrying out our research work.

6. REFERENCES

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