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DISTANCE BASED MODIFIED LEACH ROUTING PROTOCOL

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Abstract:- *A Wireless sensor network (WSNs) is defined as a self-configured and infrastructureless wireless networks which monitors physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and thus cooperatively pass their data through the network to a main location or sink where the data can be observed and analyzed. A sink or base station acts like an interface or link between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink. There are various routing techniques for providing path to the traffic in a network. Routing techniques are required for sending the sensed data between the sensor nodes and base station. The routing protocol focused in this paper is modified LEACH routing protocol that leads to increased network lifetime and decreased energy consumption. Furthermore, the same modified LEACH protocol is enhanced by using the effective distance parameter. Simulation results reveals that the proposed algorithm outperforms the modified LEACH protocol in prolonging network lifetime.*

Keywords: *-Wireless sensor network, LEACH, Modified LEACH, Distance based Modified LEACH*

Introduction:

Due to recent technological advances, the manufacturing of small and low cost sensors have become technically and economically feasible. The sensing electronics measure ambient conditions related to the environment surrounding the sensor and transforms them into an electric signal. Treating or processing such a signal tells some properties about location of the object and/or events happening in the vicinity of the sensor. A Wireless Sensor Network (WSN) contain hundreds or thousands of these sensor nodes. The sensor nodes have the ability to communicate either among each other or directly to an external base-station (BS). Each node consists of four main units: Sensing Unit, Processing Unit, Communicating Unit and Power Unit [1]. In sensing unit one or more sensors are placed to sense different environment parameters like sound, temperature, vibration, pressure, motion and etc., based on application requirement. The need for energy-efficient infrastructures for sensor networks is becoming increasingly important. Wireless sensor networks are networks consisting of many sensor nodes that communicate over a wireless media. Since the battery limits the lifetime of the sensor nodes it also limits the lifetime of the sensor network, thus energy efficiency is a major issue for sensor networks. An important goal in many sensor networks is to monitor an area for long time. Hence, it is important to distribute energy consumption evenly across the network. When the energy consumption is evenly distributed, the major part of the sensor nodes will stay alive for long time. This enables continued information gathering throughout the whole network area during the lifetime of the network. The most power-consuming activity of a sensor node is typically radio communication [2]. Hence, radio communication must be kept to an absolute minimum. This means that the amount of network traffic should be minimized. In order to reduce the amount of traffic in the network, clusters are build for sensor nodes as proposed in LEACH [3]. Some sensor nodes become cluster heads and collect all traffic from their respective cluster. The cluster head aggregates the collected data and then sends it to its base station. When using clustering, the workload on the cluster head is thus larger than non-cluster heads. The cluster heads should therefore be changed several times during the lifetime of the sensor network in order to distribute the extra workload and energy consumption evenly.

Low Energy Adaptive Clustering Hierarchy (LEACH) Protocol:

Leach is an energy efficient routing protocol for wireless sensor network which was proposed by Heinzelman, Chandrakasan and Balakrishnan in the year 2000 [4]. LEACH is one of the popular hierarchical routing approaches for sensor networks and mostly all clustering algorithms are derived from LEACH algorithm. LEACH is based on an aggregation technique that is, it aggregates the similar data and also the data that carry only meaningful information of sensors. LEACH divides a network into several clusters of sensors. It forms the cluster based on received signal strength and uses cluster head nodes as routers to base-station. This algorithm gives every node a chance to become a cluster head. The normal nodes join the corresponding

cluster head nodes and deliver their data directly to cluster head nodes. The Cluster head receives the data and send it to base station after aggregating it.
In order to achieve the design goal the basic task performed by LEACH are [5]:

i. Randomized rotation of cluster head
ii. Local aggregation of data to reduce global communication
iii. Localized coordination and control for cluster setup and coordination

The operation of LEACH protocol consists of several rounds with two phases in each [6]. First one is the set up phase and second one is the steady state phase.

1) SET UP PHASE:

In set up phase the main goal is to make cluster and select the cluster head for each of the cluster by choosing the sensor node with maximum energy. Set up phase comprises of three steps:

a) For organizing the network into clusters
b) Advertisement of the cluster heads
c) Transmission scheduled creation

In this phase it decided whether to become a cluster head or not for the present round. Every sensor node select a random no. between 0 and 1. If this random no. is less than the threshold T(n) that node is chosen as cluster head for the current round.

The equation of T(n) is given as:

$$T(n) = \frac{P}{1 - P \times (r \bmod \frac{1}{P})} \forall n \in G \qquad (1)$$

$$T(n) = 0 \forall n \notin G$$

P= percentage of choosing CH
r= current round
G= group of sensor nodes that have not been CH the 1/P round
2) STEADY STATE PHASE:
Steady state phase is comparatively longer in duration than the set-up phase. The steady state phase mainly deals with the aggregation of data at the cluster head and then the transmission of the aggregated data to the base station. In this phase nodes send their data to the cluster head using TDMA schedule. TDMA schedule allots time slot to every node. Then cluster head aggregates the data and send it to the sink.

Modified LEACH (MOD-LEACH):
Modified LEACH is an "Improved cluster head replacement scheme". Here modification of LEACH is done by introducing a well cluster head replacement scheme and dual transmitting power levels. Modified LEACH, when compared with LEACH protocol performs well by using metrics of cluster head formation, throughput and network life [7]. In modified LEACH if the existing cluster heads has not spent much energy during its period and has more energy than required threshold, it will remain cluster head for the next round. So from this, energy wasted in routing packets for new cluster head and cluster formation can be saved. If the cluster head's energy is less than the required threshold, it will be automatically replaced according to LEACH algorithm. Besides limiting the energy usage in cluster formation, it also introduced two different levels of power for amplifying signals according to nature of transmission. Basically there can be three modes of transmission in a cluster based network [8].
1) Intra Cluster Transmission
2) Inter Cluster Transmission
3) Cluster Head To Base Station Transmission
Intra Cluster Transmission deals with all the communication within a cluster i.e. cluster member, sense data and report sensed data to cluster head. The transmission between two cluster heads and the reception between two cluster heads (i.e transmission and reception between two CHs) can be termed as inter cluster transmission while a cluster head transmitting its data straight to base station lies under the caption of cluster head to base station transmission. Minimum amplification energy required for inter cluster or cluster head to base station communication and amplification energy required for intra cluster communication cannot be same. And so finally the soft and hard threshold schemes are implemented in MODLEACH to get the improved and better results.

- Hard Threshold (HT): It is an absolute value of sensed attribute after or beyond which node will transmit data to CH. When the sensed value is equal to or greater than this threshold value, node turns on its transmitter and sends that information to CH [9].
- Soft Threshold (ST): The smallest sensed value at which the nodes switch on their transmitters and starts to transmit.

Proposed work:

Distance Based Modified LEACH (DMOD-LEACH)

When, in LEACH algorithm the cluster formation takes place, at that time some nodes have to select cluster heads which are at longer distance to BS as compare to them. In this case, data is sending to cluster head in backward direction and then that data has to travel a longer distance to reach to BS. Thus the transmissions which occurs are called extra transmissions and it affects on network's lifetime by wasting node's energy.

The proposed method is a modified LEACH-based CH selection algorithm i.e DMOD-LEACH in which nodes are selected to become CHs with a criterion that determines the minimum required residual energy in a node based on its distances with the BS, such that CH selection can be made nearly optimal [10][11].

In this method the CHs for the first round is selected based on the probabilistic model of LEACH using threshold T(n) as eq(1). After the first round is done the residual energy in all CHs are checked and the nodes are allowed to continue as CHs for the next round if it possess the minimum required energy, but if the energy of CH is less then the required energy needed in a node to be CH then it will not remain CH. From the round in which new CH is elected the residual energy of the node and distance of the node from base station is considered. The node with smallest distance from base station will be elected as CH. Both the parameters are taken into consideration.

The formulae in which the proposed algorithm work:

For SET UP PHASE:

$$T(n) = \frac{P}{1 - P(r \bmod \frac{1}{P})} \times \left(\frac{d\ avg}{d}\right), \forall\, n \in G \qquad (2)$$

'd' is the distance between a node and the base station

'd avg' is the average distance of nodes from the base station

Result and Simulation:

The performance of MOD-LEACH is compared with DMOD-LEACH. For evaluating the performance of proposed algorithm, performance simulation of both algorithms is done in matlab For simulation 100 x 100 square meters region with 100 sensor nodes is used as shown in Fig 1. Parameters used for the simulation are given in Table 1.

Parameters	Description	values
p	Probability of node to be a cluster head	0.1
sink.x , sink.y	Location of the base station	50,50
n	No. of nodes	100
ETX	Transmit energy	50*0.000000001
ERX	Receive energy	50*0.000000001
EDA	Data aggregation energy	5*0.000000001
Efs , Eamp	Transmit amplifier energy	100e-12, 0.0013e-12
rmax	Maximum number of rounds	4000
Eo	Average energy of the nodes	0.5
H	Hard threshold	100
S	Soft threshold	2

Table 1. Parameters used for simulation

The performance of MOD-LEACH and DMOD LEACH is compared by various plots such as:

Figure 2 shows the plot of no. of active nodes per round. Active nodes basically defines the efficiency of a network. Efficiency of network lies on for how long the nodes are active. As we can see that DMOD LEACH have more active nodes and for longer time. Figure 3 shows that first and last node dies later in DMODE-LEACH as compared to MOD- LEACH. Thus network stability period and lifetime of DMOD-LEACH is more than MOD- LEACH. Figure 4 shows that total number of packets send to base station per round is more in DMOD-LEACH than MOD- LEACH. Figure 5 is the plot of total number of packets send to cluster head per round. We can see that no. of packets sent to CHs in DMOD-LEACH is

more than MOD- LEACH through this it is clear that throughput of DMOD-LEACH is more than MOD-LEACH. Figure 6 is the plot of total number of cluster heads per round.

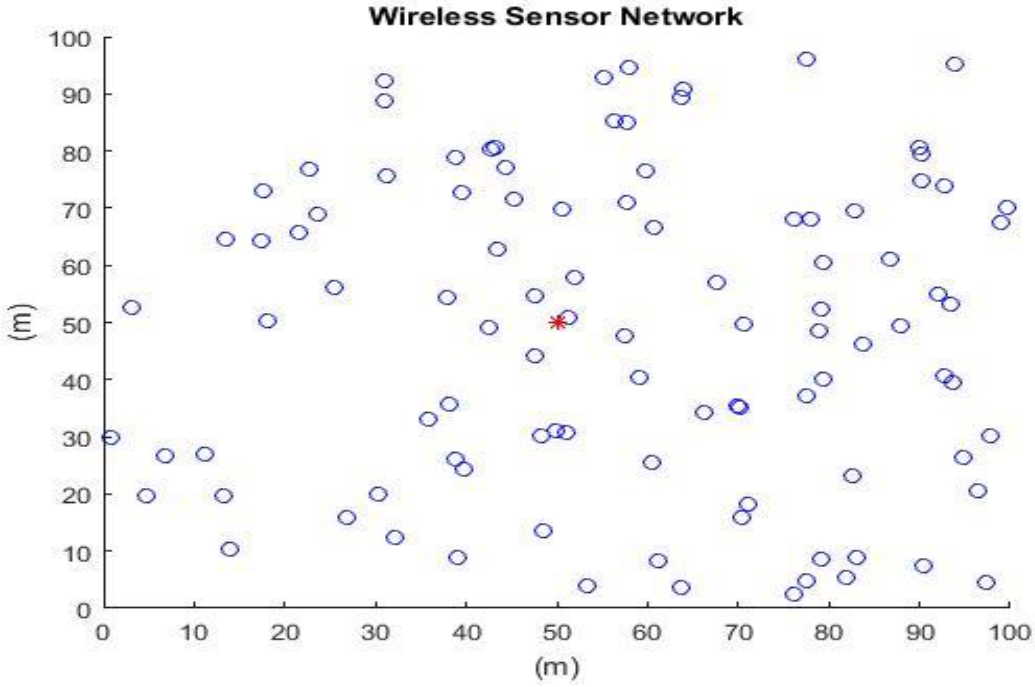

Fig 1: Random deployment of wireless sensor network

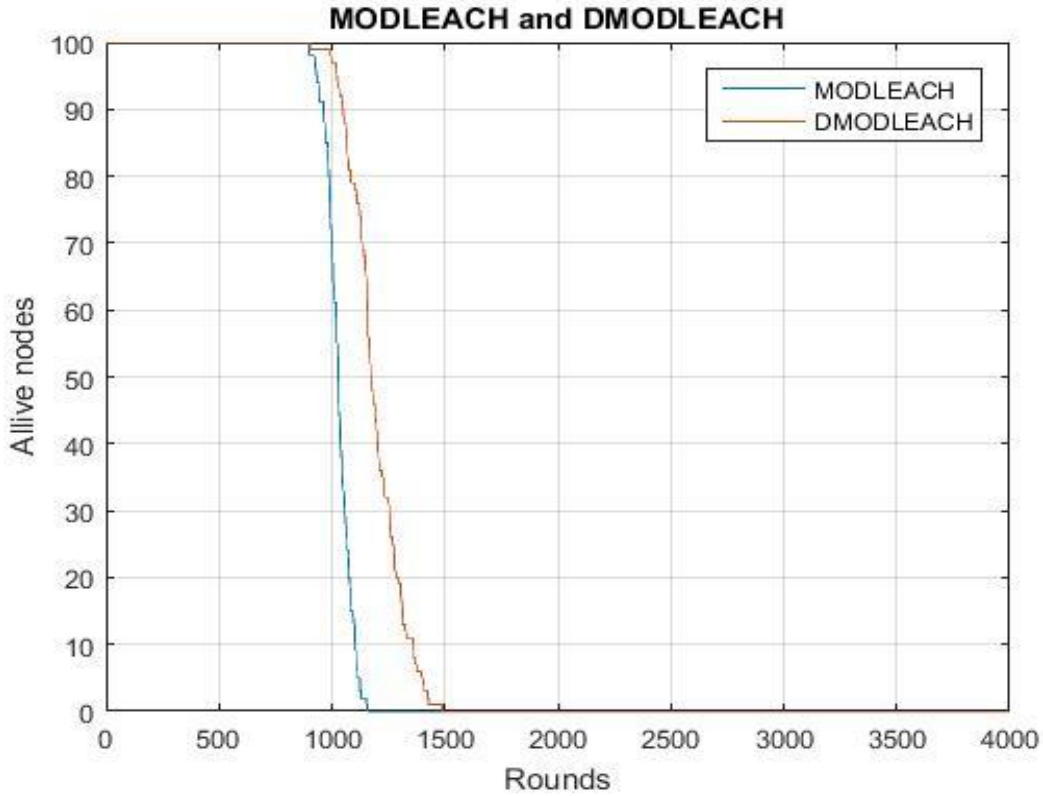

Fig 2: Comparison of Number of Alive Nodes in MOD-LEACH & DMOD-LEACH

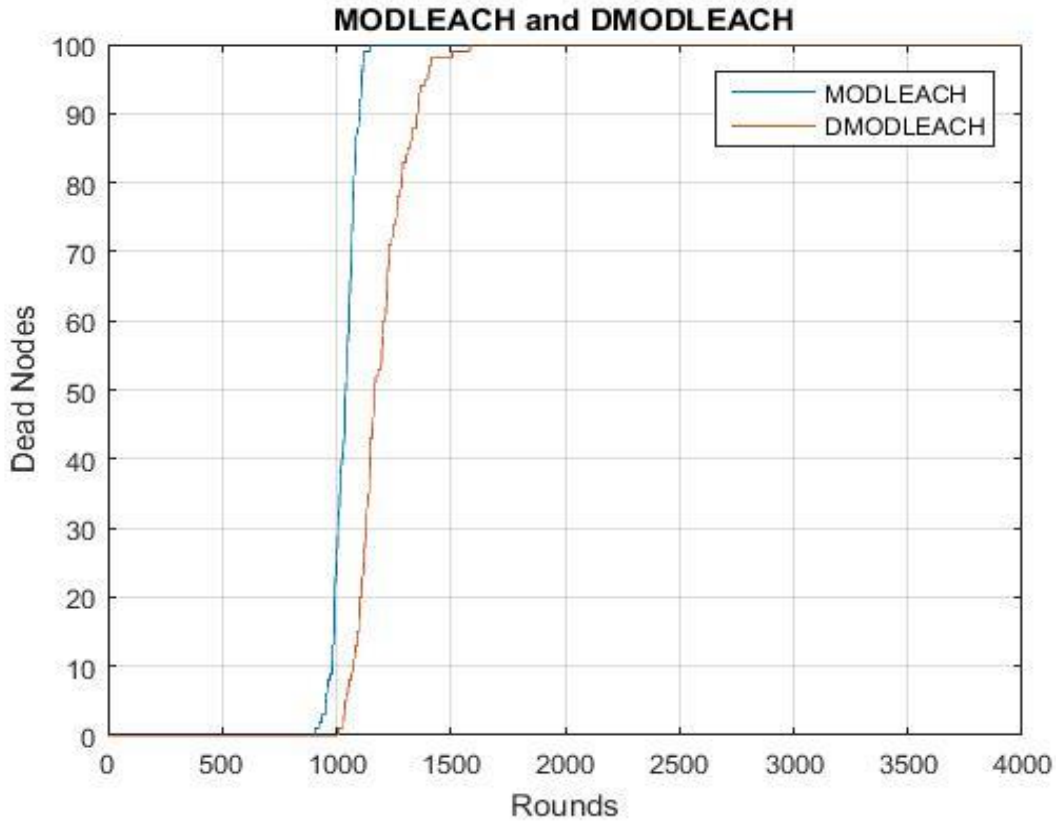

Figure 3: Comparison of Number of Dead Nodes in MOD-LEACH & DMOD- LEACH

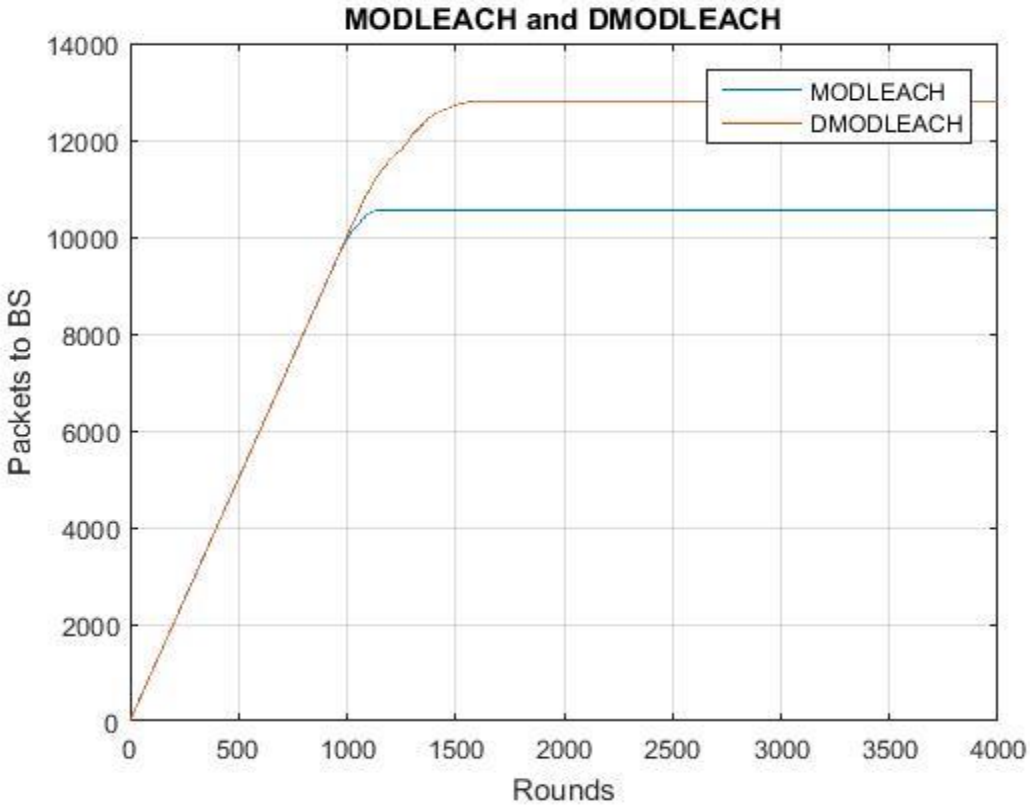

Fig 4: Comparison of Number of packets sent to base station in MOD-LEACH & DMOD- LEACH

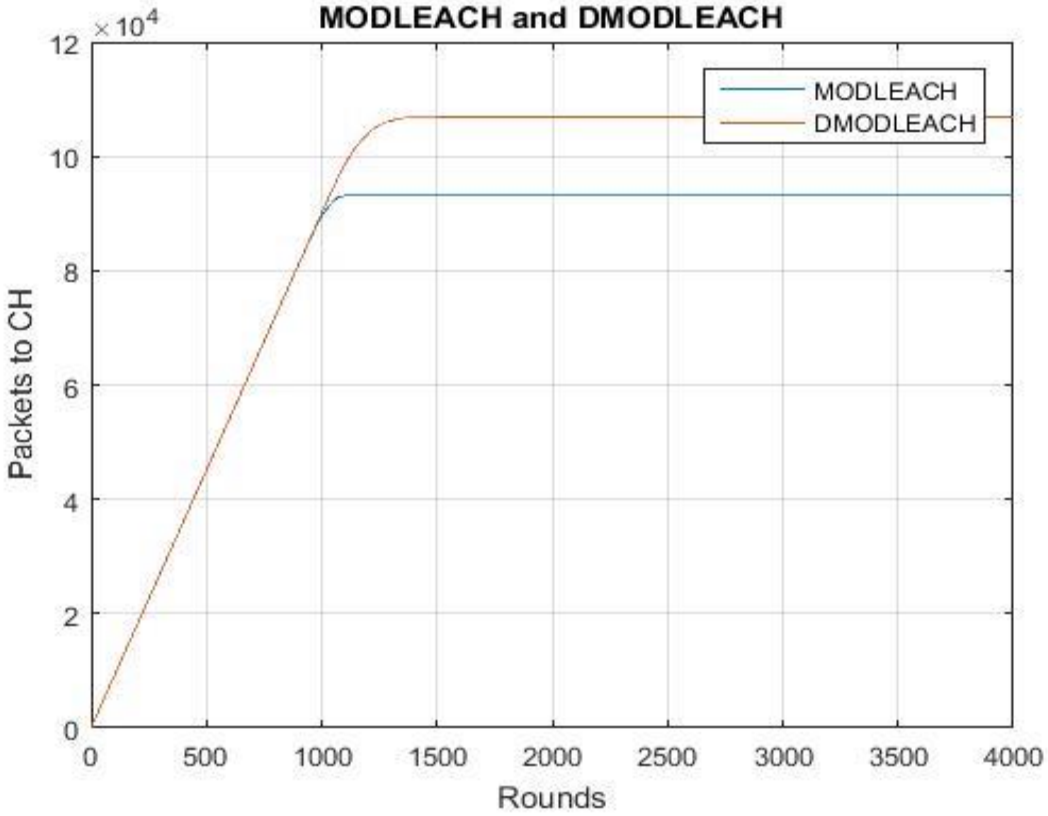

Fig 5: Comparison of Number of packets sent to cluster head in MOD-LEACH & DMOD- LEACH

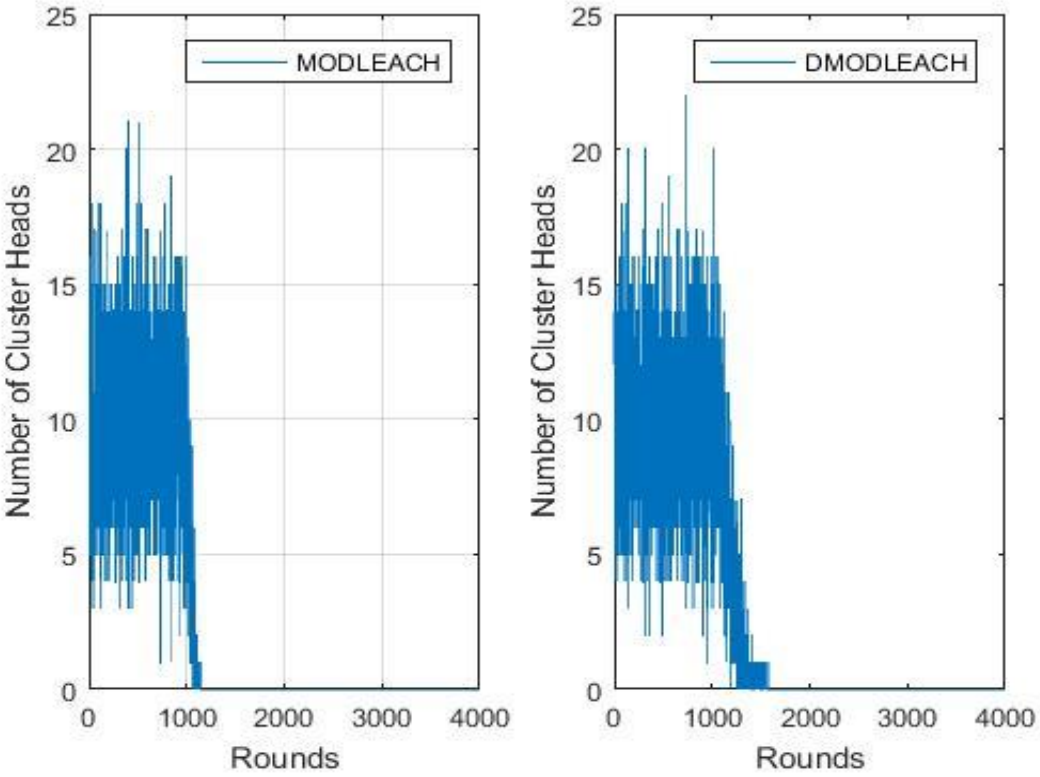

Fig 6: Comparison of Number of cluster heads in MOD-LEACH & DMOD- LEACH

Conclusion:

In this paper, we have studied well known energy efficient LEACH routing protocol. Base of the work proposed is an improvement in Modified LEACH routing protocol to enhance network lifetime. The distance of the node from base station is considered as an important factor in cluster formation. So the improvement is done taking the distance parameter into consideration which will reduce the extra transmissions in existing MOD-LEACH protocol. Analysis of simulation result proves that the DMOD-LEACH outperforms the MOD-LEACH. In every aspect DMOD-LEACH is more efficient then MOD-LEACH.

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