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DEC-LEACH: AN ENHANCED LEACH PROTOCOL FOR LIFESPANENRICHMENT IN WSN

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ABSTRACT

Wireless sensor networks (WSN) has cluster of nodes whose major constraint is to monitor various ambient parameters in the environment and transfuse it to the base station. As this conduction is the pivotal issue for energy depletion in the network, hence designing the network with minimal energy depletion is negotiated, which further increases the robustness of the network. In this paper, algorithm for LEACH protocol is propounded with revamping. The modified protocol called DEC-LEACH (Density-Energy-Capacity) focuses on amending the continuance of the sensor nodes by opting the cluster head formation based on locus-intercourse and residual energy with its neighbor nodes. Here the cluster head preference is congruous rather than arbitrary. Entire nodes assert to be cluster head corresponding to the pre-defined standard. The Cyclic Redundancy Check (CRC) is employed to check whether the data from the cluster head reaches the Base station or not. These functions assist to enhance the wireless sensor networks (WSN) in terms of lifespan and throughput.

Keywords: density, energy, capacity, leach, CRC.

1. INTRODUCTION

Wireless sensor networks (WSN) are the rank of traditional ad-hoc networks which has autonomous sensors which are spatially distributed across the networks. Advancement in the MEM'S based sensor technology routed to the deployment of wireless microsensors. Low power microsensors achieves high quality and high fault-tolerance. The microsensor networks consists of many number of sensors scattered around the environment to measure various parameters such as optical, biological, inertial, infrared, magnetic, radiation, acoustic and seismic and directs it towards the Sink / Base station. Sensors have transceivers, a microcontroller and the power source,
viz. mainly the battery. Unfortunately battery is neither rechargeable nor easily replaceable. It is not possible to improve the amount of charge available by the node. Nevertheless, it is possible to improve the amount of work that can be performed with the same amount of charge. Consequently, designing a routing that exploits the lesser amount of charge for communicating with the Base station should be sustained.

Three different types of routings are developed such as routing based on flat way, routing based on hierarchical way and routing based on location defined. In Flat-type routing, all the sensor nodes assert same functionality, thus they work together for communicating. Whereas in Hierarchical-based routing, work is reduced into sub-groups. One such prominent Hierarchical related routing is expressed as Low-Power Adaptive Clustering Hierarchy (LEACH) that exploit the cluster based routing. Since, power attenuation is directly coherent with the square or strong range of the spacing interval of sender and the receiver, the cluster heads (CH) are selected which aggregates the data information amid cluster members which further delivers it to the sink, which reduces the power attenuation to the greater extent. However, cluster head drains maximum amount of energy than other nodes. If the node is dead by draining all its energy, then it would become useless which cannot transfer data anymore. Thus cluster heads are selected randomly across the network to improve the node's lifetime.

LEACH protocol operates in two phase, firstly, the cluster head and its corresponding cluster members are selected. Whereas in second phase, Time-Division multiple Access (TDMA) schedule is afforded by the head of the node (CH) for the element nodes of the cluster head, which (CH) then collects informative data from other group members and hand downs aggregated data to the Sink , the place these data is required by utilizing Code-Division Multiple Access (CDMA)

While in Location-based routing, the routings are formed on the groundwork of placement of the sensor nodes. Locations of these nodules are determined by Global Positioning Systems (GPS).

1.1. Leach Protocol

The first hierarchical protocol implemented is Low-Power Adaptive Clustering Hierarchy (LEACH). In this class of protocol proposed, one among the node is chosen to be as cluster head (CH) which must be accepted by all its neighbour nodes. The main function of the cluster heads is to assimilate the information from all of its element nodes and propels it to the base station after aggregation of these received data. Since, the cluster head spends large amount of energy comparatively others, due to the extra responsibilities, the node (CH) may die early than others. Thus Randomization technique is utilized , which randomly selects the cluster head among the network at each round. This drastically improves the network lifetime. Cluster head is given superiority independent of the other nodes present in the network. Once the particular sensor node is discriminated as the cluster head at foremost round, then it is neglected at the next round. Therefore, the node which doesn't opted as

cluster head during its previous round is predominantly preferred[7]

The suggested percentage for the selection of the node as the cluster head is 'p'. The node which is not discriminated as the cluster head for the past 1/p rounds will be generating a arbitrary number between 0 and 1, if this number is less than that of boundary value, then the node would be able to perform the role as head. Threshold value is expressed as the cluster head.

$$T(n) = \begin{cases} \dfrac{p}{1 - p \times (r \bmod 1/p)} & , \text{If } n \varepsilon G \\ 0 & , \text{otherwise} \end{cases}$$

Thus every node is said to have uniform energy dissipation and the selection of individual node as cluster head is of equal preference.

Low-Power Adaptive Clustering Hierarchy (LEACH generally operates in two types of phase. namely.,

1. Setup phase,
2. Steady phase.

I.1.1. Setup Phase

Here, the node is preferred as the head independent of the other nodes. The node which tends to come into existence as cluster head for that particular turn sends its advertisement ID's to the other nodes. Nodes analysis the advertisement and responses on the keystone of signal having or marked by great physical power. The nodes further sends the acknowledgement packets and its ID's been returned to the selected head of the group (CH)by employing CSMA. After the node of a higher grade or quality than the ordinary is chosen as the head, it then publishes the Time-Division multiple Access (TDMA) program for its individuals composing a group.

1.1.2. Steady Phase

The Steady phase concentrates in the transmission part. Cluster head selects the particular node by choosing its ID using Time-Division multiple Access (TDMA) schedule to collect the data from it. While at the same time, other nodes tends to be at off state. Moreover, head of the cluster (CH) scoop up various data from its unit nodes by following the Time-Division multiple Access (TDMA) schedule. After getting all the information from its group members, cluster head besides summates all the information gathered and further conveys to the destination (BS).

1.1.3. Limitations

Though Low-Power Adaptive Clustering Hierarchy (LEACH) protocol opted as the efficient way of transmitting data to the destination (i.e., Sink), it also has some manner of disadvantages such as.,

* Since the selection of cluster head is defined with no aim or direction, uncertainly the node with less amount of energy can be chosen. In such case certain node might die early due to the less availability of energy.
* Single hop transmission of data from cluster head to Base station leads to the wastage of vast amount of energy.
* Only 5% to 7% of nodes are formed as cluster head, which is not suitable for large amount of data amount of data transmission.
* In each round, each node rearranges repeatedly which leads to the loss of huge amount of energy.

Thus various types of Low-Power Adaptive Clustering Hierarchy (LEACH) protocols have been evolved to cater such problems mentioned above, which will be discussed in the next section.

2. LITERATURE SURVEY

E-LEACH

Energy leach (E-LEACH) is the advancement of Low-Power Adaptive Clustering Hierarchy (LEACH) protocol where the residual energy is taken into regard for the picking of the cluster head. At first cluster head is selected randomly, since entire nodes have same power level. But in the next corresponding rounds, the nodes differ in their energy level. So the node with highest energy is given priority to be selected as the next cluster head[2]

TL-LEACH

Two-Level Leach (TL-LEACH) is the new proposed algorithm of Low-Power Adaptive Clustering Hierarchy (LEACH) protocol in which Sub-cluster head is formed. Some of the cluster heads situated far from the Base station may found it difficult and spends more energy for transmitting towards the Base station. Thus Sub-cluster head is formed which aggregates the data from other cluster heads and sends it towards the Base station[3]

M-LEACH

In Low-Power Adaptive Clustering Hierarchy (LEACH) protocol, every information proceeds from cluster head to that of destination, irrespective of the spacing between them. Whereas in M-LEACH (Multi-hop Leach) protocol, the cluster head selects the optimal path to have contact with the destination (BS). The cluster head by a broad interval from the destination (BS) selects the appropriate nearest cluster head which helps to transmit data through it. Thus energy consumption is reduced to a huge extent[3]

C-LEACH

Centralized-cluster leach (C-LEACH) is proposed as a enhanced protocol over Low-Power Adaptive Clustering Hierarchy (LEACH) protocol. Closer to this protocol, at the time of Setup phase, entire individual node throw instruction about its presently elapsing spot and residual power degree to the destination. Base station verifies the average energy among these nodes and

eliminates the nodes with lesser energy (than that of average energy) to make selection for the cluster head. New head is formed through the midst of other nodes. Thus it doesn't matter where the position of the cluster head is situated[3]

V-LEACH

In this protocol, the network contains cluster head (CH) as well as vice-cluster head (Vice-CH) (which performs the operation of cluster head at the time it dies). The major role of cluster head is to convey organized data from its members and transmits it to the destination (BS). Cluster head might be rowed down from the Base station in some specific case. Thus there maybe a possibilities of node death in such case. Thus Vice-CH is selected which performs the operation of cluster head at this critical situation. By doing this, information will be always available to the Base station without the need of re-electing a new cluster head at the time of cluster head death [4].

F-LEACH

In Fixed Leach (F-LEACH), once the clusters are decided they remain fixed. And by deploying the centralized cluster algorithm as in C-LEACH, the cluster head is formed. This cluster head is dynamic and rotates among the network. This protocol eradicates the problem of re-clustering.

L-LEACH

This is the kind of advancement in M-LEACH. It is suitable for long distance transmission. The cluster heads located near to the destination communicates directly. Whereas, the cluster heads at a definite distance from sink / base station communicates by multi-hop way. At each round, cluster heads are elected and the load is allotted between the nodes of the network at pre-period.

B-LEACH

Balanced leach (B-LEACH) is used by decentralized algorithm. Each sensor node knows only about its own position and the final receiver. And it doesn't know about the position of all other sensor nodes. By evaluating the energy dissipated on transmission between the node and the final receiver, it selects the cluster head[1]

LEACH-M

In Mobility leach (M-LEACH), mobility has striked the major issue. Both the element nodes as well as the cluster head involves in mobility. That nodes which has the lowest degree of versatility and lowest depreciation is terminated as the head.

S-LEACH

The Solar status of each such nodes in the network is sent to the sink along with the residual energy. This station further selects the preferred node as the head based on the higher energy crisis. The performance of sensor network increases with sun duration.

CELL-LEACH

In this method proposed, sensor networks are divided into cells which has several sensors. The Cell head is elected in each cells and cluster head is selected for a group of seven cells. Both of it generates a Time Division Multiplexing (TDM) schedule for its members and sends data from both cell head to cluster head and sensor nodes to cell heads after the aggregation of data.

3. PROBLEM STATEMENT

In E-LEACH, however cluster head is affiliated with the higher residual energy rather than random selection here, it continues to have the same problem with that of LEACH protocol in the case of Single-hop transmission, that leads to wastage of large energy. Only 5% to 7% of nodes are formed as cluster head, which again follows here (not suitable for huge data transmission)[6]. Each round has the repeated re-arrangement. Whereas in TL-LEACH, instead of single hop transmission to the destination (BS), it makes use of one of the cluster heads that lodge between corresponding cluster head and the sink (BS). Due to this, the cluster head which collects additional data from other cluster heads (which further aggregates and transmits to base station) spends more amount of energy. Since it continues for each and every round, there may be a chance of death of the node soon (which collects additional information from other cluster heads). ie. the same head (which summates data from other heads) is selected at each round. On considering C-LEACH, closer to this protocol, at the time of Setup phase, entire individual throw information about its presently elapsing spot and residual power degree to the destination. Base station verifies the average energy among these nodes and eliminates the nodes with lesser energy (than that of average energy) to make selection for the cluster head. New head is formed through the midst of other nodes. Thus it does not matter where the position of the cluster head is. By doing so, the selected cluster head might be at a wide distance from other element nodes. The selected CH wastes huge energy by aggregation, processing and transmitting the data information to destination (BS). Thus it might die early, which makes it useless for further transmission of data.

4. PROPOSED SYSTEM

In the LEACH algorithm discussed earlier, the formation of cluster head is random which may select the cluster head anywhere in the network irrespective of its location, whether it is at the center or at the corner or somewhere in the network. In case the cluster head is formed at the edge of the network, then many other nodes is made to spend more energy to propel data to the head., since it spaced wider from its following counterparts. This may lead to the wastage of node's energy at the very first round. That cause may reduce the network's lifetime to a greater extent. In order to cater this problem, the enhanced LEACH protocol is propounded which is called "DEC-LEACH". This protocol alters or adjusts the selection of cluster head so as to bring to some standard or required

condition. i.e., enhanced network lifetime. In this case of algorithm all the nodes sends its information related to its location and energy stability to base station and every other nodes. All nodes get to know every other nodes information. This algorithm also contains two types of phases for its operation.

1. Setup Phase

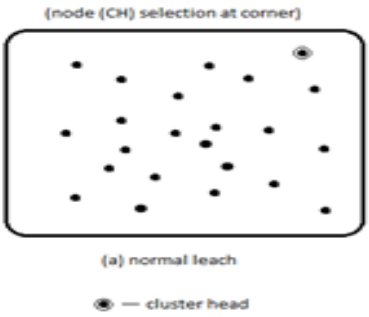
The formation of cluster head is dependent on three major priority cases which are.

*ENERGY STABILITY

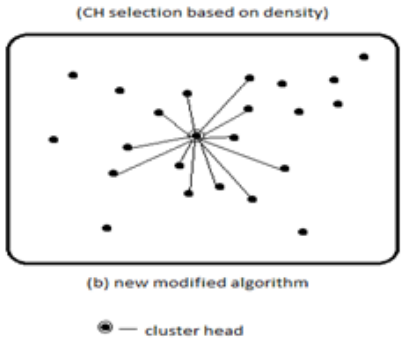
Energy is considered to be the most essential factor and is need to be checked. If the node with low energy stability is chosen as cluster head at the first round, then it can't withstand for large time by draining large energy. Its lifetime gradually gets reduced at the very foremost round. In DEC-LEACH algorithm all the nodes drive forwards the information regarding its locality and energy stability to that of the sink. Then the head is formed by considering this energy stability criterion. When the node of high stability is formed as cluster head, then it would be capable of withstanding for a long period. Thus there would be no data loss as well as lifetime of the network tends to improve.

*NODE DENSITY

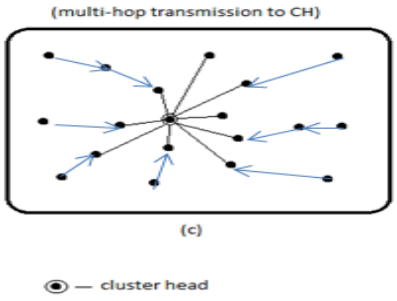
Formation of cluster head also advance toward an objective of node density. A situation in which node at poor density is opted as cluster head at the first round, then majority of the other nodes have to spend enormous energy in the very foremost round. This is a reason for the diminishing of lifetime. In order to cater this problem, the node which is close to many other nodes in the network is recommended as the formation of cluster head. Thus majority of the nodes spends average amount of power source for reference with cluster head. This amends the duration of the existence of a node in the network for long-standing. Further it increases the stability of the network.



The diagram(a), reveals that in normal leach there is possibility of picking up of cluster head at the cornerback of the network. In such quality implied, other element nodes spend enormous amount of energy to reach cluster head.



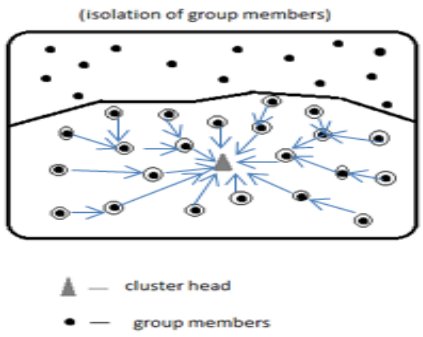
In the above defined diagram, the algorithm is been employed in accomplishing the privilege of choosing the fit cluster head. As mentioned above, the node with maximum density (i.e., close to many other nodes) is opted to perform as cluster head. By doing this, majority of the nodes in the group spends an average amount of energy to reach cluster head. Thus lifetime of the network is achieved in this case.



In the above diagram, it clarifies that some nodes which are having a site little wider from the cluster head sends its information by means of some other nodes closer to cluster head. Here, simple multi-hop routing is undertaken. The act of executing this algorithm attains the result of satisfying lifetime.

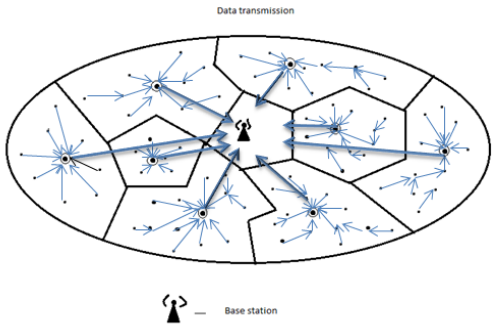
*CAPACITY OF NODES

Last but not least case is the potential (or) suitability for holding, storing or accommodating of information in the node. The node which endures such capacity can be opted as cluster head. Certain node can withstand up to some extent. So, based on its capacity criterion, the group is divided. For example., in the case of 30 nodes, if one node is induced to come to a choice as cluster head which can withstand only 24 nodes, nothing more than that. Then, only 24 nodes are isolated as the group members of that particular cluster head. This isolation is again depending upon the energy standard of the node.



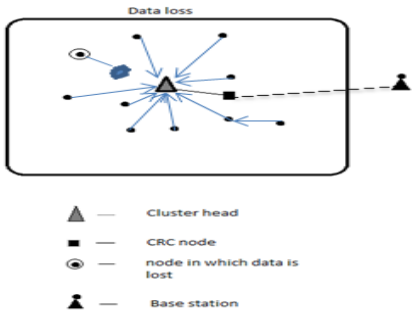
Data Transmissions

After the accomplishment of the revelation of cluster head, it then comes the steady phase which direct toward a common objective of transmitting of data. The cluster head disseminates the TDMA timetable to its element nodes. The majority of nodes which are sited closer to the cluster head, forwards the information directly. While others quite distance from the cluster head follows the multi-hop routing for forwarding. Because of which network's lifetime is enriched. Transmission of data to cluster head is pursued based on the TDMA timetable. by selecting the nodes ID, cluster head seek out and obtains the information. Behind that, cluster head makes the collection of unit data's into a mass or whole data which then communicates with base station. In this manner data information from every sensor is linked with base station.

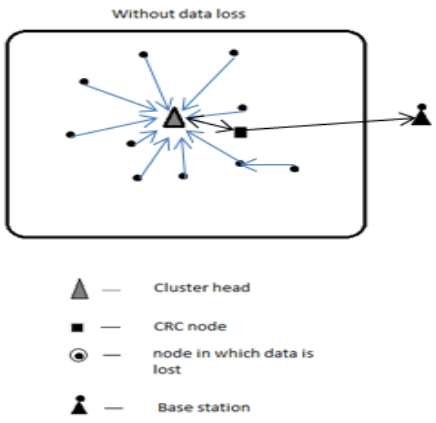


Cyclic Redundancy Check

The accretion of data information in the cluster head needs to be extended to base station. There may be case in which destruction of data information come into existence, because of which complete data information fails to reach base station. In some crucial applications like in the field of military, industries etc., such ruin in data information leads to a big impact. Hence, data for transmission has to be examined for any loss. In case, if any loss is found, the node is requested to send back the data again. The loss in data transmission may happen due to many cause like energy deficient which leads to destruction of information (or) node's failure to transmit data. Here is the case in which cyclic redundancy check concept is introduced in the protocol to check whether the data is properly transmitting to the base station (or) not. In case if the data transmission has any type of destruction in its information, then a negative acknowledgement is sent to the node for re-transmitting the data again. So that no data escapes from reaching base station. Cyclic redundancy check node is brought into play which is responsible to verify the data loss. The node doesn't produce any data information instead it only verify and transfer it to the next level.



In this case, the data is lost at one of the transmission. However, the cluster head collects every other data and sends it through CRC node. CRC node here takes up the verification and founds an error in the received signal. Thus the CRC node sends the negative acknowledgement to the cluster head which request the cluster head to re-send the data again.



When the CRC node founds no error with its signal, then it passes the data transmission to the destination (BS). Hence no data is avoided from reaching base station. Overall, the performance of a work is carrier out successfully.

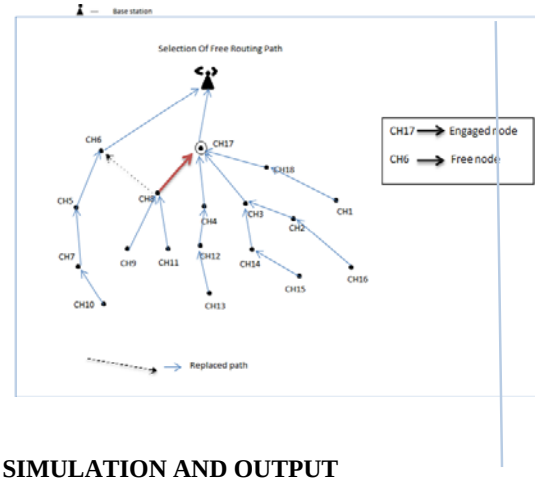
Cognitive Routing

The data from the cluster head reaches base station directly in case of LEACH protocol. The new routing protocol has been imposed which enhances the

right selection of routing path to the destination. The cluster head spaced at a quite long distance instead of sending data directly to the base station, it selects the efficient path in which the free node is taken into account for routing. i.e., the node which is engaged in some other action is neglected instead of which the node which is free of any action is considered for the routing path. This reduces the complication of the routing path and increases the better data transmission

In this flow diagram, the encircled cluster head (CH17) has already three data from three other cluster heads which makes it more engaged (CH3, CH2, CH1).

Therefore the data from CH4 instead of selecting CH17 as its routing path (which is more engaged already), the routing path is replaced to CH6 (represented by dot lines), which is free way to reach to base station. In this way, the complexity of the data transmission is controlled and energy is efficiently spent.



5. SIMULATION AND OUTPUT

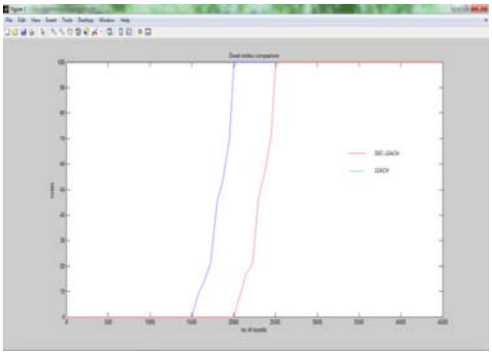
Here we are going to implement the DEC-LEACH in matlab and also in order to give the comparative analysis between LEACH and DEC-LEACH protocol. In this case, we have total number of 300 nodes, in which the Base station is positioned at x=100 and y=100. The channel is assigned with the bandwidth of 1 Mbps. The initial energy is presumed to be 50 nJ /bit and the energy drain on transmission is found to be 100 pJ /bit /m2 (for the distance lesser than that of 85) and 0.0013 pJ / bit / m4 (for the distance greater than that of 85). And for the aggregation of data information, the energy utilized is found to be 5 nJ / bit / signal.

Advantages

1. Overall lifetime of the network is enhanced.
2. Data loss is reduced which further improves the performance of the network.
3. Efficient routing path is exploited for easy transmission of data information to the destination (BS).

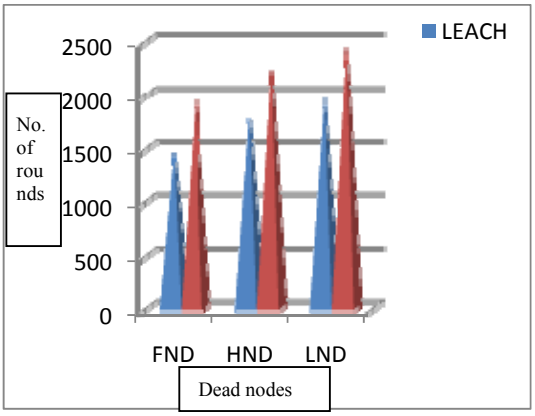
Graph I

(REPRESENTATION OF DEAD NODES)



The above graph shows the comparative study of LEACH and DEC-LEACH in terms of no. of nodes vs no. of rounds.

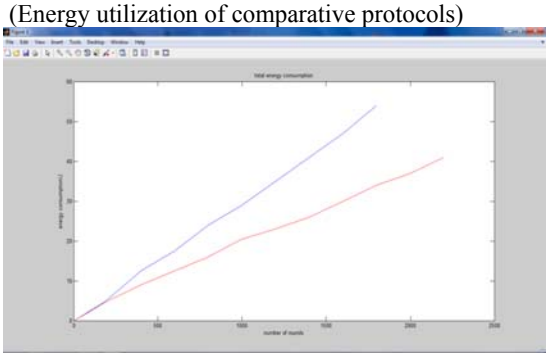
Bar Graph



And the above corresponding BAR GRAPH is shown which represents the no. of dead nodes at respective rounds.

Graph II

(Energy utilization of comparative protocols)



Ultimately, the major constraint of energy is also employed in comparison with LEACH protocol. The comparative energy constraint graph implemented in MATLAB is shown above.

Table-1. Comparative Improvement.

ENERGY (Initial 0.5J)	**FND** (first node dies)	**HND** (half node dies)	**LND** (Last node dies)
LEACH	1500	1850	2000
DEC-LEACH	2000	2300	2500

The above table shows how the Lifetime of nodes is enhanced by the newly propounded DEC-LEACH protocol which is clearly known by comparing the First Node Die (FND), Half Node Die (HND) and Last Node Die (LND) at both the cases of LEACH and DEC-LEACH.

6. CONCLUSIONS

Wireless Sensor Networks (WSN) are been employed in accomplishing multi operations. Energy constraint is the considerable part to be overviewed. So many energy efficient protocol is being proposed and in this paper, the modified leach protocol known as DEC-LEACH (Density-Energy-Capacity) is introduced. In this newly propounded leach, the discrimination of cluster head (CH) is based on its exertion of power, density of nodes and the potentiality for accommodating information. While on the contrary, leach protocol choose the cluster head (CH) irrespective of the above mentioned criteria. Simulation output shows how the DEC-LEACH is accomplished in terms of energy and correspondingly its employment in the interconnected node's lifespan in an effective manner which is prior to LEACH protocol. And also it gives the comparative intercourse between LEACH and DEC-LEACH.

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