Energy Conservative Clustering in Wsn Based on Node Cooperation

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Abstract- *Wireless Sensor Networks are widely used to create a smart and intelligent environment that relies on sensory data from real world. The sensor nodes contain a battery constraint, which limit the network lifetime. Therefore, the deployment of WSNs will be requiring advance techniques to maintain the network lifetime. Dynamic clustering is considering as one of the energy conservation techniques; LEACH is a hierarchical dynamic clustering protocol. In LEACH protocol, residual energy of node is does not considered and highly variable number of sensor nodes involved in event reporting and random selection of CH tend to drain out the network energy. Main objective of the thesis is to implement a dynamic cluster formation, node cooperation and cluster head selection scheme and that leads to increase the lifetime of the sensor network. A node cooperation method will compare the residual energy to soft or hard threshold value. Each sensor nodes are send the data to CH, and aggregated data are send to the Base Station. The cooperative property of the proposed method makes it robust against time-varying behavior of the propagation environment and improving the lifetime.*

Keywords- CH selection, Hard threshold, LEACH protocol, Node Cooperation and Soft threshold.

I. INTRODUCTION

Energy consumption is a major issue in wireless sensor networks (WSNs). In sensor networks, common nodes will be expected to communicating for many years without battery replacement. Battery life of sensor nodes is limited and difficult to recharge. Nodes communicate to sink node via direct or multi-hop transmission. Different tasks performed by the sensor nodes are sensing, processing and communicating to nearby nodes. However, most of the energy consuming process is CHs (Cluster Heads) transmitted the data to the Sink. Energy consumption is directly proportional to the area or distance of the communicating node to the sink node therefore longer distance consumes more energy.

Wireless sensor networks composed of large number of tiny sensor nodes and which are sense to collect data periodically. Sensor nodes having different constraints like battery power, computation capacity, communication range and memory. A WSN consist of spatially distributed sensor nodes are cooperatively monitor physical or environmental conditions such as temperature, humidity, pressure. Source nodes transmit their data to destination nodes through several intermediate nodes. This destination node is connecting to a Sink or Base Station (BS) in Fig 1. It provides a connection to the wired world where, the sensing data has been collected and processed, analyzed.

The WSN components:

- Base station(BS) or Sink
  - Which act as an internet gateway in WSN
  - Provide Link between the sensor network to another network
- Cluster head(CH)
  - Data aggregation
  - Aggregated data send to BS
- Sensor node or common nodes
  - Proceeds to sense, communication, process information
  - Measure the changes in physical environmental parameters
  - Sensor node support a multi-hop routing algorithm

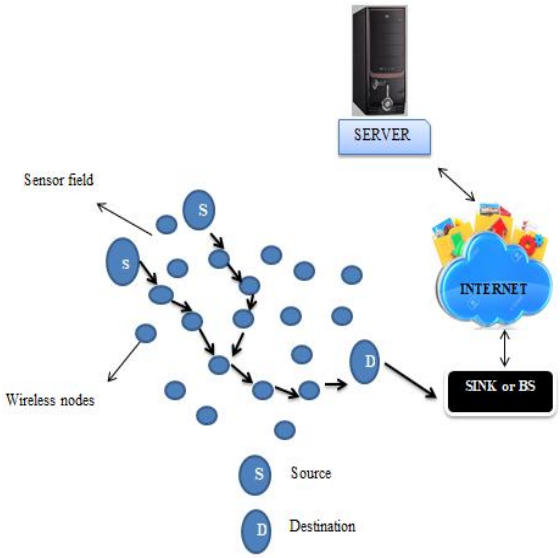

Fig.1. Architecture of WSN

One of the recent technologies that allows energy saving is based on node cooperation. In node cooperation, sensor nodes are dividing into different categories. In cooperative networks, maximize the coverage of network. Each cluster is independent to one another. Data must be exchange to coordinate their effort.

Aim of this paper is to propose an energy efficient dynamic clustering and cooperative communication to the sensor nodes. Power consumption of a sensor node is faster during the aggregated data transmission of CH. Accordingly the networks are drained quickly and difficult to recharging the battery. However, problems arise in Wireless sensor network is network lifetime decreases do not get sufficient data user. In proposed work, dynamic clustering optimizing number of sensor nodes in event reporting and node cooperation reduces the energy consumption.

II. RELATED WORK

The research studies that provide solution to resolve the issues within WSNs are discuss in this section. There are different energy efficient schemes are provides the literature, that try to decreases energy consumption and introducing the improvements in different protocol.

Low-energy adaptive clustering hierarchy (LEACH) by Heinzelman [1] is one of the most popular distributed cluster-based hierarchical routing protocols in wireless sensor networks. The operation of LEACH is divided into rounds, where each round begins with setup phase for cluster formation, followed by a steady state phase, when data transfers to the base station or sink occur. LEACH randomly selects a few nodes as cluster heads and rotates this role to balance the energy dissipation of the sensor nodes in the network. The cluster head nodes fuse and aggregate data arriving from nodes that belong to the respective cluster and send aggregated data to the base station in order to reduce the amount of data. Data collection is centralized manner. CH send to aggregated data send to base station and performed periodically. The LEACH protocol is energy efficient but the expected number of clusters is predefined. Another disadvantage of LEACH is that it does not guarantee good cluster head distribution and assumes uniform energy consumption for cluster heads. The major drawback of LEACH routing protocol is concerned with the one-to-one connection between the cluster head and does not consider the residual energy. It prevents the growth of the cluster size, thus reducing the scalability of the protocol.

PEGASIS (Lindsey &Raghavendra) [2] is an improvement of the well-known LEACH protocol for dynamic clustering based communication in sensor networks. Rather than forming multiple clusters, PEGASIS forms a chain from sensor nodes so that each node receives from and transmits to a neighbor and only one node is selected from that chain as leader node to transmit to the base station. The main objectives of PEGASIS [8] are to increase the lifetime of network and allow only local Coordination between nodes that are close together so that the range of bandwidth consumed in communication was reduce. PEGASIS eliminates the overhead caused by dynamic cluster formation in LEACH, only one node can communicate to the BS. Avoid the number of transmissions and receptions by using data aggregation. However, this achievement faded by the excessive delay introduced by the single chain for the distant node.

DeepaliVirmani Introducing a dynamic cluster head selection technique, Secure and Fault Tolerant Dynamic Cluster Head (SFDCH) [3] Selection algorithm. The proposed algorithm selects the nodes having the threshold value greater than the average value. The cluster head have a maximum available energy and throughput, at a minimum distance. This selection of cluster head is refreshing periodically. The Proposed SFDCH is compare with existing K-sep and K-means methods using netsim simulator. The results to be prove the efficiency of SFDCH in terms of accuracy, energy efficiency and enhancement of network lifetime over the existing methods. The WSN are composed of large number of tiny sensor nodes, which are battery driven and area subtype of distributed systems. They are employing in the system without any infrastructure mainly with a view to the WSN's. These networks are composed of large number of tiny sensor nodes, which are battery driven, and are a subtype of distributed systems. Battery life of this sensor node is

impossible to recharge as compared to the sink nodes whose batteries are rechargeable and there is no energy constraints. Sensor nodes can communicate with the sink nodes direct data transmission or through various multi-hop transmissions.

Muhammad Kamran Naeem, Mohammad nuruzzamanpatwary [4] introducing a Cooperative transmission schemes for energy efficient collaborative wireless sensor networks. Energy conservation process is one of the major problems in wireless sensor networks and having some application specific challenges that includes combining distributed data synchronously, performing power aware signal processing, defining communication methods that can provide progressive accuracy and, optimizing processing and communication for signal transmission. A cooperative resource selection and transmission scheme was propose in this method to improve the performance of collaborative wireless sensor networks in terms of maintaining link reliability. A measure of Channel Quality Index (CQI) used to obtain dynamic adaptively and to optimize resource usage within wireless sensor networks according to environment conditions. The cooperative transmission scheme along with collaborative beam forming to be creates a virtual MIMO system. An adaptive transmission scheme is save additional energy requirement.

In Systematic energy-balanced cooperative transmission scheme in wireless sensor networks was proposed by [5] LI Xi, JI Hong, focused on minimize energy consumption and balance energy dissipation throughout the network, that solves by a systematic energy-balanced cooperative transmission scheme. The three main steps included as, namely nodes clustering, data aggregation and cooperative transmission, corresponding measures are forward to save energy. A half-controlled dynamic clustering method is use to avoid concentrated distribution of cluster heads caused by selecting cluster heads randomly and to get high spatial correlation between cluster nodes. Improving the data correlation by dynamic data compression will performed in the cluster heads. Cooperative multiple input multiple outputs (CMIMO) with an energy-balanced cooperative cluster heads selection method is used to transmit data to sink node. In this scheme can efficiently distribute the energy dissipation evenly throughout the network and achieve higher energy efficiency, which leads to longer network lifetime.

Mohammed S. Bahbahani [6] proposes a cooperative clustering protocol based on the low energy adaptive clustering hierarchy (LEACH) protocol to enhance the longevity of energy harvesting based wireless sensor networks (EH-WSN). It ensure that any energy consumption associated with the role of the cluster head (CH) is share between the sensor nodes, the CH role is changes between the nodes using duty cycling as a function of their individual energy harvesting capabilities. The sensor nodes are does not act as a CH during neutral operation. The results obtained using eventdriven simulations have demonstrated an enhanced networkperformance in terms of throughput and lifetime.

A. Reasons of energy waste

In WSNs, sensors consume energy while sensing, processing, transmitting or receiving data to fulfill the mission required by the application. Research study concludes that communication between sensor nodes, data aggregation CH selection, distance is a great amount of energy wasted in different states and that are useless from the different application point of view such as:

• Collision: when a node receives more than one packet or duplicate packet at the same time, these packets collide. All packets that cause the collision have to discard and the retransmission of these packets is required. It leads to higher overhead of the system.
• Overhearing: when a source transmits a packet, all nodes in its transmission range receive this packet even if they are not the intended destination. Thus, energy will waste when a node receives packets that are near to other nodes.
• Control packet overhead: a minimal number of control packets should be used to the data transmissions.
• Idle listening: A node is listening to an idle channel in order to receive possible traffic.
• Interference: each node located between transmission range and interference range that receives a packet but cannot decode it.

III. METHODOLOGY

In wireless sensor network, balancing energy consumption for each node is the major challenge and this leads to maximum lifetime of a network. Energy consumption of sensor network depends on many factors such as number of nodes and distance from the sink, selection of cluster head. Based on these factors different nodes have different residual energy. It leads to uneven energy consumption, which reduces the time after which the first node dies in the network. By rearranging these parameters based on threshold can enable the balancing of energy consumption among nodes thereby increasing its lifetime. This paper proposed to a very limited computing overhead and cooperative load balancing to each node. Thesis focus on overcomes the major limitations of sensor networks and to improving the network lifetime. Lifetime maximization and overall energy consumption minimization are two different problems in a WSN. Energy

consumption is mainly due to data transmission over longer distance in sensor networks. Lifetime of network depends on number of nodes supported by the cluster head node. To overcome these limitations by Implement a cooperative wireless sensor network networks using dynamic clustering scheme.

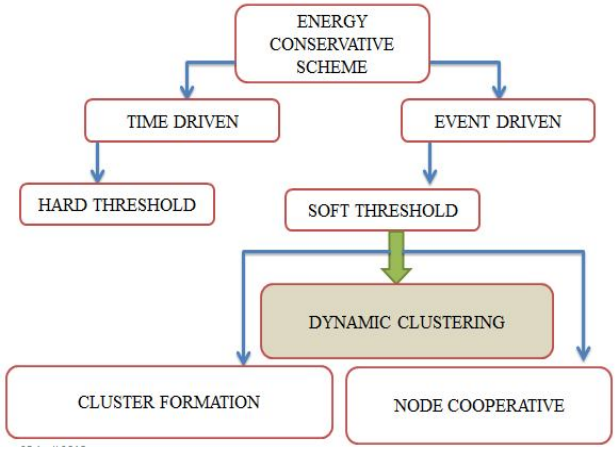

Fig.2 Proposed method

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WSNs can realize as two scenarios, time-driven and event-driven [7]. In time-driven sensing, the sensor nodes periodically sense the environment. While in event-driven sensing, the sensor nodes are responsible to detect significant awaking messages or event and report it to fusion centre receiver. Within the Fig. 2 proposed energy efficient method, different scenarios are introducing to develop a new increasing network lifetime model. Two type of scenarios such as:

A. Time-Driven Sensing

Cluster head selection scheme proposed such that all the sensor nodes that can serve the role with highest residual energy have a chance to become cluster heads. All the sensor nodes will be broadcast their location information to their cluster heads and entered into matrix. Initially all the sensor nodes are calculate their distance from each other. Initial energy of nodes is same as the all sensor nodes. Initial CH selection process is similar as LEACH protocol. As the proposed dynamic cluster scheme are expected to rotate the cluster head role and calculate distance periodically using the equation Fig 3. All sensor nodes get a chance to become a CH.

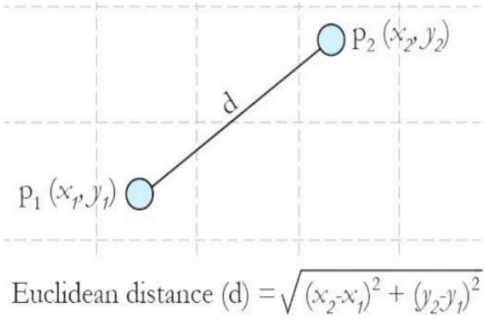

Fig.3 Euclidean distance

(a)*Hard Threshold*

Hard threshold termed as residual energy in the cluster heads. Find optimum threshold value might change throughout the lifetime of the network that can lead to, overhead in networks.Different causes the average value of residual energy considered as threshold value. Otherwise, different models are used to develop the value.

(b)*Soft Threshold*

Calculating the threshold value is the difficult process. That solves by soft threshold, however all the sensor nodes served as cluster heads then cluster head role will repeat among the nodes with energy depletion level. It is expected that by defining soft threshold energy based on initial energy andenergy will consumed and balanced throughout the network at the cost of higher rate of re-clustering than would have with hard threshold. Soft threshold divided into different modules.

B. Event-Triggered Sensing

Whenever an event to be occurred, the sensor nodes are activated to send the data to the CH. The main task of sensor nodes was to monitor the environment, detect and collect various significant occurrences of events within WSNs. The occurrence of the behavioural change that sensor nodes are expected to detect is called an event.

C. Initialization of Energy

Initialization of energy leads to each sensor nodes are participating data transmission. Battery model used to provide an operating temperature and discharge the energy. Initial energy of sensor node is similar to one another and different data transmission occurred, it will be reduces. Increasing the lifetime of battery is difficult task and overcoming the problem by using node cooperation.

D. Dynamic clustering

Proposed methods used to enhance dynamic clustering, optimizing number of sensor nodes and increasing the lifetime of network. The dynamic property of the network makes system as robust against time varying nature of propagation environment. Periodically changing the CH selection is also known as dynamic clustering [9]. One of the efficient dynamic clustering methods has carried out in the LEACH protocol. Enhancement in LEACH protocol used to implement the proposed energy efficient method.

LEACH is a hierarchical protocol in which most sensor nodes data transmitted via CH. Cluster heads are aggregated and compress the sensor data and transmitted to Base Station. Transmission will only do by CH rather than common sensor nodes. It will save the energy during the transmission. In each round CH change periodically based on threshold value T (n).

$$T(n) = \frac{p}{1-p \times (r \times \mod \frac{1}{p})} \quad \forall n \in G$$

Cluster head cannot become CH again for P rounds, P is the desired percentage of CH. Each node has a 1/P probability of becoming a CH in each round. Each sensor node selects the closest CH and joins that cluster. Set of nodes that have not become CH in the last 1/p rounds, which denoted by G and n is the number of sensor nodes. Then CH creates a schedule for each node in its cluster to transmit data in TDMA fashion. Fig.4 shows a flow chart for normal LEACH protocol.

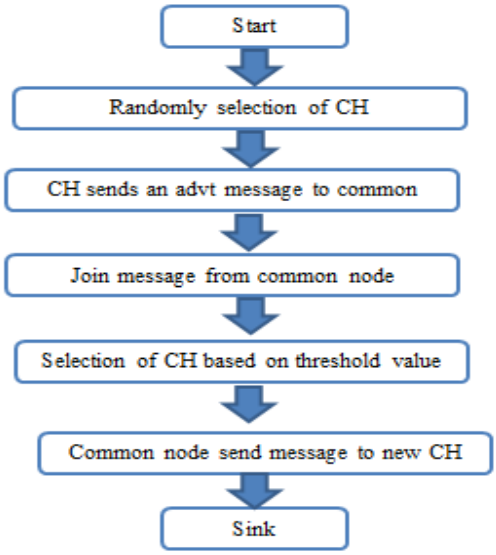

Fig 4. LEACH protocol cluster formation

LEACH operations can be divided into two phases and show in Fig 5:

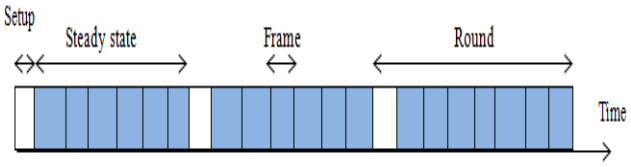

Fig 5.LEACH operation

(1) Setup phase

The clusters are formed and CH is chosen for each round. Threshold values are calculated on this phase [10]. CH broadcast an advertisement message to the common nodes in the network then, to invite them to join their cluster. Cluster formation is done on this phase. CH creates a TDMA schedule and assigns each sensor node a time slot in which it can transmit the sensed data.

(2) Steady phase

Data is sensed and sent to the Base Station. Common nodes starts sensed data and send it to their CH. After receiving data from all the common nodes, aggregates it and then sends it's to BS.

In LEACH, protocol does not considered the residual energy sensor node. However, networks easily drained faster. Then propose the node cooperation method.

E. CH selection

Sensor nodes evenly distributed in network and it will be divided based on topology. LEACH protocol is select CH as random fashion. In the proposed method CH selection done on the soft threshold, which assigned based on initial energy. In this work, consider highest residual energy with the lowest distance as CH.

F. Node Cooperation

Initial CH selection based on random fashion then after, the completion of first round the energy level varies based on data transmission. Sensor nodes categorized as maximum level and minimum level nodes. Node cooperation shown in Fig 6. Follows the different steps:

Step 1: calculate the residual energy of each sensor nodes by remaining power x time

Step 2: compare residual energy of each sensor node with threshold value
Step 3: divide sensor nodes onto maximum level and minimum level of nodes based on residual energy
Step 4: maximum level nodes will sorted
Step 5: find the minimum distance from the previous CH in maximum level node
Step 6: satisfies the minimum distance with maximum residual energy node as CH
Step 7: minimum level nodes goes to sleep mode

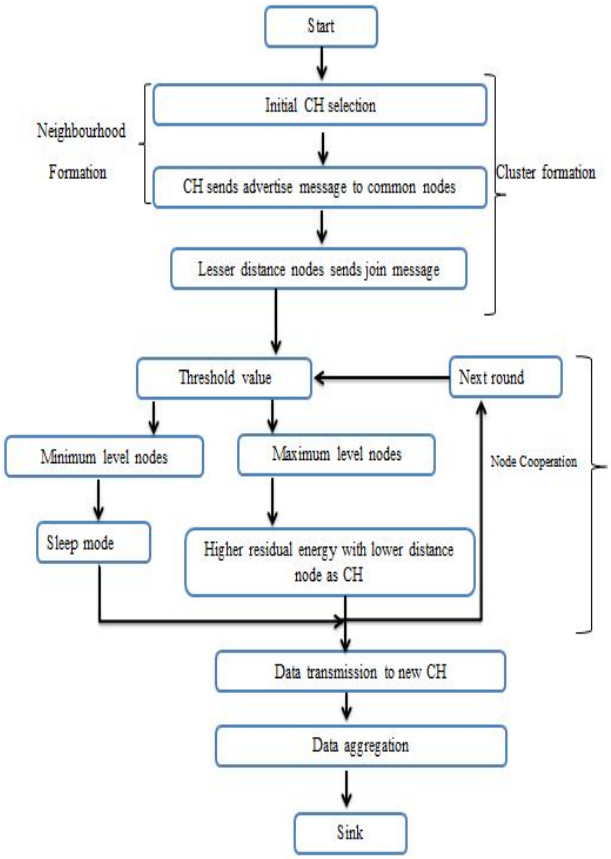

Fig 6: Proposed node cooperation

The maximum level nodes include higher residual value than soft threshold and minimum level has lower residual value than the threshold value. The maximum level nodes participate in the data transmission. Whenever the minimum level data to be needed an awake message is send to the sensor node. Proposed work results in higher number of alive nodes and increase the network lifetime.

IV. SIMULATION RESULTS & ANALYSIS

The simulations are performed for enhancing the LEACH protocol using NS2.34.THE IEEE standard 802.11 for MAC layer were used in the simulation. After the number of simulation, the following results were obtained. Based on these results, a detailed analysis is presented. Alive nodes, residual energy of each node, compare the node energy, different analysis based on different protocol is done. Node cooperation increases the number of alivenodes and reduces the overhead.

1. Alive nodes

Number of alive nodes is higher in proposed system. The maximum level nodes are carries the data transmission. Therefore, highest residual energy nodes as CH that leads to lowest energy dissipation. Fig 7 shows number of alive nodes in the different protocol with time. Number of alive nodes calculated using avoiding the dead node from total number of nodes.

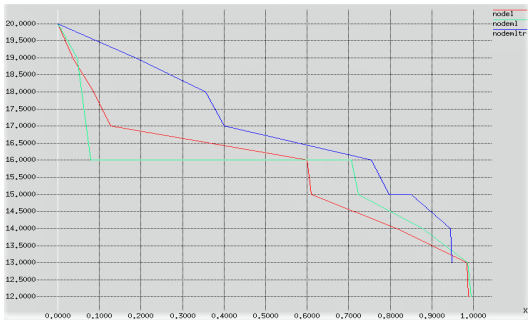

Fig 7. Number of alive nodes

2. Residual energy

In remaining energy is an important performance matrix for analysis. Then analyze individual sensor node energy time by time in the networks show in Fig 8. Residual energy calculated using remaining energy multiplied with time.

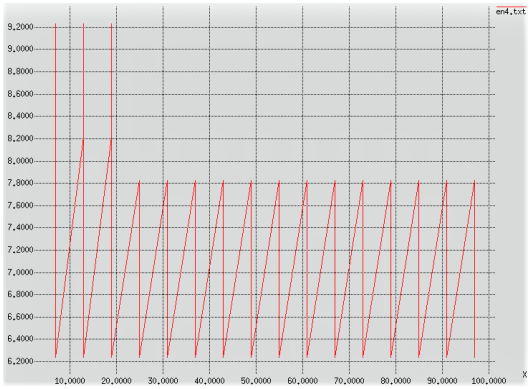

Fig 8. Residual energy of node 4

3. Compare the node energy

Different protocol such as LEACH, proposed LEACH and AODV are compare with their energy. AODV has lesser energy and the proposed system leads to higher energy achieved by the nodes. Fig 9. Shows the energy compare with time. Dynamic clustering does not involve in AODV protocol. Because, the periodically change of CH selection process is not occurred in the AODV protocol.

Fig 9. Energy of different protocol

4. Network lifetime

Network lifetime defined as the time which last node dead in the networks. Proposed system uses to improve the network lifetime by adopting the node cooperation scheme. Fig 10 shows the network lifetime of sensor node 1.

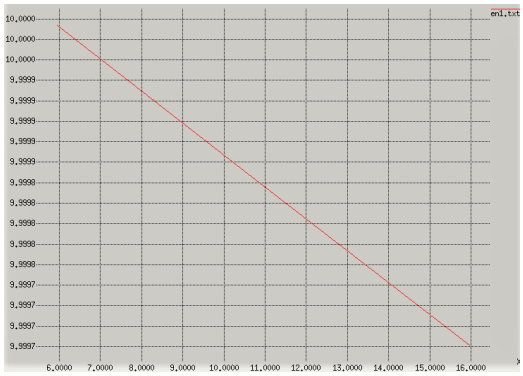

Fig 10. Network lifetime of sensor node1

V. CONCLUSION

Energy consumption among sensor nodes in a WSN can also be balanced using node cooperation. Lifetime maximization and overall energy consumption minimization are two different problems in a WSN. The proposed work incorporates a dynamic clustering scheme that ensures even distribution of energy demand and node cooperation among sensor nodes scheme to optimize the number of sensor nodes involved in the detection and reporting of events. The enhanced work uses a soft threshold parameter for the selection of cluster heads to facilitate the system design engineer to optimize the frequency of re-clustering and improving the lifetime of the network. The dynamic clustering and node cooperation, which reduces the amount of information required to be broadcasted. The maximum level node fully participated on the data transmission and minimum level of nodes moves to sleep mode. Next round considered the all alivenodes on data transmission based on residual energy. Such distributive capability accelerates the decision-making process and enhances the energy conservation process. The proposed work is universal in nature that supports differentrange of applications such as fire detection, temperature sensing, health monitoring. The overall network lifetime of the sensor network is better while using dynamic clustering and node cooperation.

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