An Energy Efficient Load Distribution Clustering Algorithm for Wireless Sensor Network

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Abstract
The Wireless Sensor Networks (WSNs) contain self-organizing nodes which collect the information from the environment to monitoring the area. The important design issue of wireless sensor network is to prolong the lifetime of network, energy consumption and balance the node load. Each sensor node emerged only by batteries in important condition. In this paper, propose the algorithm Energy Efficient Load Distribution Clustering (EELDC) for wireless sensor clustering network. In this EELDC algorithm, decide the sensor network into different kind of clustering and elect the Cluster Head by using Residual energy. Energy Efficient Load Distribution Clustering algorithm performs the following operation such as fined Node Energy, find the Node Load. Then distribute the Node Load, Node Energy and the Processor to the Idle Node and Low Energy Node. Then compare the proposed EELDC algorithm with other existing algorithm such as LEACH, LEACH-C, EPRB, and EELBC. Finally, conclude our proposed algorithm with the increase network lifetime and highly distribute load balance to other node in the wireless sensor clustering network.

***Keywords*: WSN, EELDC, network lifetime, load balance.**

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1. Introduction

Wireless Sensor Network (WSN) is a self organizing network which consists of many numbers of low powers, tiny, cheap, heterogeneous sensor nodes which deployed the environment for monitoring. The important features of sensor node have low battery power with uncharged facility and maximum energy consumption during data packet transmission [1]. Sensor nodes are mainly used to collect the environment data and then the data are route in to the sink node for processing. It also store the data for further usage of environment control and ground data monitoring. In WSN, has a lot of application in environment monitoring, smart space, disaster management, habitat monitoring, smart parking system and health monitoring system. Multi-hop WSN has continuous traffic and the entire node act as an originator that sends or forwards the data packet into the WSN at a regular time interval and to forward its data packet to the sink node.

Data collection is an important task for many applications in WSN. The major problem is how to save the sensor node energy during the communication. There are three types of WSN data gathering such as centralized data gathering, many to one traffic pattern and multi-hop communication. These characteristic can lead to packet loss, packet collision and network congestion. The high energy utilization cause premature

death of entire network and sensor nodes. Here, Load balance data gathering algorithm are used to save the sensor node energy. Routing trees are constructed between sink and sensor node based on communication cost and energy metrics [2].MAC protocol algorithms are used to reduce the energy consumption of sensor node and increase the network life time. This technique is used to utilize the wasted energy of idle sensor node energy [3-5].

In this WSN, each sensor node acts as a router to send or forward the data to the sink node by multi-hop path. But each sensor node has battery power without the facility of recharging [6]. Here the sensor node energy is reduced for the process of communication. Due to energy shortage of sensor node lead to fail the node or that sensor node are died. So the operation of forward the data packet is loss that reduces the life time of network [7]. At the same time died node are not able to forward the other sensor data to the network. So the network life time is reduced and end to end delay occurs. Another one main reason for sensor node energy is reduced because of the distance between and two sensor nodes during routing. During data packet transmission one node is sending the more number of data packet to another node. Some of the sensor nodes are idle. Here, only the active nodes need more energy for forward the data [8]. Further, the active nodes are died earlier because of low energy. Here the network life time also reduced. These issues create another problem like network partition and changing the network topology.

In WSN, clustering is one of the important techniques used for energy saving of sensor node. Clustering is minimizing the energy consumption of sensor node [9]. Major challenge of WSN is balance the load of sensor network. Here, we distribute the load to the entire node in the clustering for maximize the network life time. Many of the authors proposed clustering algorithm for load balanced. In cluster based WSN, nodes are categorized into different group called cluster. Each cluster has a base station or sink node and Cluster Head (CH), which collect the sensed data from another sensor nodes and processing the data then send data packet to sink node or base station by other cluster head [10].

In this cluster based WSN, CH have high overload compare to the sensor nodes. Clustering is also called Gateway. CH is performed in additional activities like data collection from nearby sensor node, aggregate and processing. Cluster Head is used to find and remove duplicate data and unwanted data sent by sensor nodes in the clustering network. This CH performs the operation by battery power. Here, many authors proposed the technique to maximize the CH power, maximize the network life time and minimize the power consumption of the CH of clustering. Network life time of clustering is based on node lifetime, connectivity, coverage and transmission [11].Some authors are proposed algorithm, to solve the load balancing problem in WSN. Genetic algorithm is used to increase the life time of network in large scale surveillance application [12].Here, proposed the technique called Reconfiguration algorithm is used to maximize the life time of network by fairly distributing CH. In wireless Sensor Network, fairly distribution of CH, the current CHs are able to select the next CH by the two metric such as General Node (GN) and General Node transmission range [13]. The idle nodes in the clustering are always active node for data transmission with the help of primitive scheme switching a sensor node between off and on duty cycles.

At the same time during transmission some of sensor nodes are performed redundant operation of data. So the nodes energy is used by unwanted. Due to redundant operation some sensor nodes are considered as active node. At the same time active nodes are selected based on connectivity and coverage. In WSN Connected Dominating Set is used as a virtual backbone based clustering. Load Balance connected Dominating Set (LBCDS) constructs the LBCDS and allocate equal load to the dominators. Due to heavy load dominator are quickly deplete their energy. Here, Proposed LBCDS- GA is also used to distribute the load to dominator. This technique is used to increase the network life time [14].

Author proposed Neuro fuzzy energy aware clustering scheme, have the parameter energy aware cluster and optimum. In this algorithm contains two parts neural network system and fuzzy sub system that better performance of energy efficiency in forming CH and clustering. In this NFEACS based neural network that

give better training set to energy and received signal strength of entire sensor node to evaluate, find higher energy are trained with center location of BS. In WSN, NFEACS is handling mobility of node to increase the life time of network [15].Here proposed energy aware clustering using Neuro- Fuzzy Approach (EACNF) to form energy aware and finest cluster. The proposed approach consists of neural network and fuzzy sub system that achieved energy efficiency in forming Cluster Head and cluster in WSN. EACNF used neuro network that provide effective training set related to density and energy of all nodes. Accordingly to select energy aware cluster head, find highest energy is trained with different location of BS [16].

The Major Contribution of this paper

- First perform the cluster formation.
- Cluster Head selection based on residual energy.
- CH is used to find the active node and idle node, based on the node load and enery CH is distribute the load from one node to another node.
- Then perform the route operation.

The organization of this paper is as follows. Section 2 contains the related work. Section3 illustrates the procedure of the network model and proposed work. The experiment results are discussed in Section 4. Finally, conclusions and remarks are given in Section 5.

2. Related Works

WSN have major problem of maximization of network life time. An Energy Efficient Clustering Algorithm are used to balance the load for solve the problem. Author proposed Density based Dynamic Clustering (DDC) protocol is used for select the CH by Independent Set. Here author designed Distributed Independent Set Discovery (DISD) for CH selection in O(1) complexity. Next is forming IDs by dynamic rotation. Then dynamically find the optimal sensors in clustering. At the same time establishing load balance allows the IDs member to balance allows only the IDs member to participate in CH selection. Network energy model is based on low-traffic session and high traffic session [17]. Described one severe problem of monitoring WSN is funneling effect. The sink load are not balanced can lead to funneling effect. Author introduces multiple sink nodes for overcome the imbalance load in the network. Multiple sink is to balance the load for a sensor network as to increase the network life. Next load balancing routing approach is used to balancing the loads of critical nodes. Algorithm describes the first compare critical node load with non-critical node load then the node occur in the same layer easily identify the load. Next, using a probability lists children node for generating or receiving packet. Critical node and non critical node are identified by algorithm. Critical nodes have heavy load and also the packet generated by the other node. Then balance the load of critical nodes [18]. Low efficiency Adaptive Clustering Hierarchical (LEACH) algorithm is used for effectively balance network load. But it is not applicable in heterogeneous energy network environment. To solve this issue, the Energy–Coverage Ratio Clustering Protocol (E-CRCP) is introduced. Then cluster is determined by minimum energy consumption principle. CH selection is determined by regional coverage maximization problem. ECRCP algorithm is to balance the system energy load and CH selection [19]. In WSN, sensor nodes are distributed among region for the gathering and transmit data to the final destination. Here, proposed novel approach for maximization network life time by combining load balancing and energy aware in heterogeneous WSN. Also introduce a Stable Election Protocol (SEP) combined with a LEACH (load balance) protocol to support even distribute of load balance of each sensor node. This technique is used to transmit more number of packets to the BS of the network and distribute energy load to entire sensor node and increase network life time [20].

Important resource of WSN is energy. Sensor node send data packet from cluster to BS, need energy. Repetitive use of same sensor node introduce the problem like service unavailability and void hole problem. Load balance is important technique for balancing the load between service availability and energy efficiency. Here author proposed a real time energy efficient load balancing technique have two tier of operation. In tier1

using the concept of space time block coding over M-ary quartered amplified modulation and binary shift keying modulation which is used to reduce energy consumption between clusters to BS. In tier2 is applying the technique Feedback Control System, which is used to reduce the energy consumption between sensor node and CH [21].

In WSN, random deployment strategy is used to distribute equally the load balance to entire sensor node for better use of energy and network life time. Here author introduce the concept of an efficient load balancing algorithm with grid-based clustering where splitting and merging of cluster is divided for dense and space clusters. Then apply average dense clustering for cross clustering. Next to reduce the CH energy consumption have to use multi-hop communication. Here the proposed algorithm is a centralized algorithm, cluster member in CH are reduce the communication. So the energy is reduced and same amount of packet is distributed. This technique can perform load balancing and better performance of energy consumption [22].The aim of sensor node' load balancing in WSN, network operation are split into fixed time intervals. It is based on the concept of rounds. Firstly, CHs are configured then CH selection is rotated which is based on the concept of Round – Based Policy (RBPP). Here CH selection rotated which is the waste node energy resource is utilized by another node. Next the author proposed Dynamic Hyper Round Policy (DHRP), is a distributed energy efficient scheme, which scheduling cluster load to maximize the network life time and minimize the energy consumption. Simple Energy Efficient Data collecting (SEDC) algorithm is to evaluate DHRP and find the end to end energy consumption. This approach balances the load and potentially the network life time [23].

Due to remote communication of sensor node requires a gateway or level of hop to forward the data packet from sensor to BS. Here, sensors are group into cluster which have less energy constrained and CH are gateway which is used to balance the cluster head. Next propose Load Balance among the cluster. CH is act as a centralized manager to handle the sensor load and also acts as a hop. So nodes are uniformly distribute the load that will extend the network life time and reduce energy consumption [24]. The major challenge of WSN is balance the load and prolongs network life time. Author proposed EP algorithm divide the sensor node into different cluster by Kmean++ algorithm. And also select CH by FLS-Fuzzy logical system. Here Genetic Algorithm proposed (GA) for implement fuzzy rule. Based on GA, rule as a chromosomes and lifetime as a fit function. The best offspring can be code as the best fuzzy rule [1].

In WSN clustering is an effective method to minimize energy consumption of the sensor node for extend prolong the life time of network. Although WSN, NP hard problem is known as load balanced clustering. Genetic Algorithm (GA) is an effective approach to solve the load balancing problem as well as equal loads of the clustering [25].Clustering is an effective method to improve network life time and scalability. Author proposed Energy Efficient Load Balanced Clustering (EELBC) is a min-heap based clustering algorithm, which address energy efficiency and load balancing. In this approach, CH is built then algorithm runs in O(n log m) time for n sensor nodes and m CHs [26].Describe load balancing protocol is an important issues, can be avoid the tradeoff between the service capacity and energy efficiency. Author introduce a user –oriented load balancing is an energy efficient load balancing algorithm which is based on distribute load on sensor nodes proportionally to user oriented approach and the agent's capacity. In this approach is combined user oriented load balancing and dynamic provisioning algorithm based on greedy graph for maintained the scalability and performance [27].

At the same time propose an effective approach reconfiguration algorithm by fairly distributing CH to maximize the network life time. Sensor nodes are grouped into Cluster Head and General Node. Then distribute the load to CH, so GNs in the cluster can be balanced. It is used to reduce energy consumption [13].Clustering based routing protocol to extend lifetime of WSN. Here author proposed two algorithms CALB and IGP-G.In CALB is a clustering algorithm with load balancing is a fully distributed clustering algorithm which is only communicates with immediate neighbors. Improved Gossiping Protocol (IGP) is a load balancing algorithm which is based on data routing. In IGP algorithm is to allow a better distribution of

load and processing capacity of CH and reduce the number of sensor node. It is used to improve the load balancing of cluster size and CH loads [28].

All application in WSN is to have sensor nodes unattended, deployed for several days, month and years. In WSN the network lifetime maximization problem is mostly-off and many to one type. The sensor nodes are collect and send data packet to a sink node by multi-hop transmission. Then the sensors are collected and send data packet to a sink node by multi-hop transmission. Then the sensor nodes forward the data packet to the BS by multi routing, a high burden of node and the traffic is highly non uniform. Here, author proposes solution that balances the energy consumption of node and prolongs the networks life time by balancing the traffic load. Firstly, proposed optimal load balancing solution. Secondly, proposed a heuristic to approximate the optimal solution [29]. In WSN, a CDS is used as a virtual backbone, here author introduce LBCDS is construct an LBCDS and load balanced allocate to dominator are simultaneously. Here author proposed LBCDS-GA to construct an LBCDS. Al the same time to build the LBCDS and load balance allocate to the dominator can prolong network life time by balance the load of entire dominator [14].

Author describes load balancing is an important method for improving resources like channel bandwidth. Here for performed load balanced in network proposed Distributed Energy Efficient Adaptive Clustering Protocol (DEACP) with load balancing and data gathering. DEACP technique achieved to decrease the network energy consumption, balancing the energy consumption and prolong the network life time. Accordingly node ratios are turned with fixed time duration according to sleeping control rule optimization. Here, find the appropriate CH and member node to reached and distribute appropriate load balancing [2].Sensor nodes are organized as clustering, to use for prolonging the network life time and load balancing. Here the problem arises such as global clustering approach in Global Round Based Policy (GRBP). Author proposed the algorithm' HCSP – Hierarchal Clustering-task Scheduling Policy is a node-driven clustering which overcome GRBP operation. The aim of HCSP provides scalable clustering task scheduling energy-efficient and more flexible. HCSP technique is used to reduce the cluster head. In this HCSP each local super round, cluster is reconfigured only once. So the cluster reconfiguration is varying from one cluster to another [30].

3. Proposed method

In this section, we explained the network model, then we proposed two main phases in our proposed method.

Network Model

We consider a Clustering WSN, where sensor nodes are uniformly distributed throughout the network area. The sensor nodes in the WSN are distributes within an identity square area, assume the side's length is represented by M. We understand that the entire sensor node can communicate and transmission with sink with needed node energy Ne and also sensor node can use different power for communication. We assume the sink and sensor node are stationary.

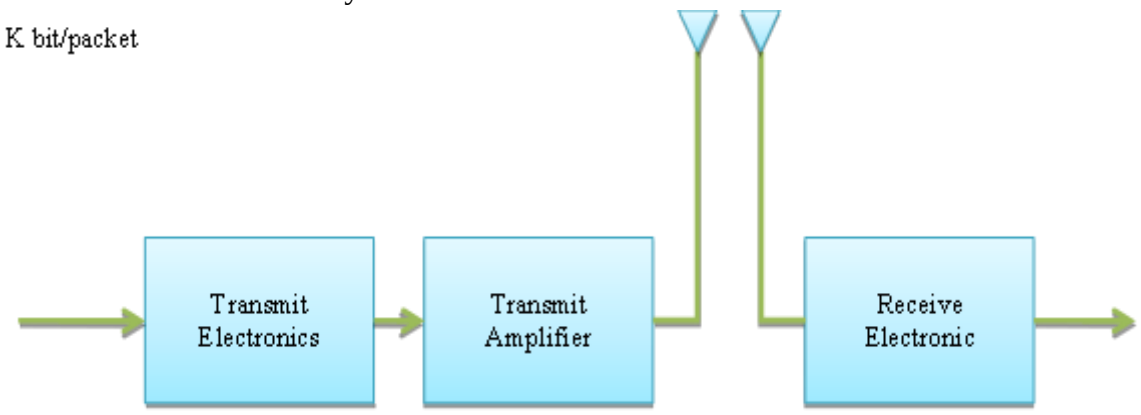


Fig 1. Network Model

Our proposed method is having the following assumption, the location of the sink is configured to be variable based on the evaluation of the clustering algorithm

1. The sensor nodes are fixed in the WSN network.
2. The sink is aware of its position but the sensor nodes are not aware its position.
3. The WSN is homogeneous. All sensor nodes are possible to send and receive data.
4. The sensor nodes may be able to send the data to the BS with a multi-hop transmission.
5. Active sensor nodes are sending and receiving the data.
6. Initially all sensor nodes have the equal level of energy (E_0)
7. In all sensor nodes, considered number of CH (k) is to be 5%.
8. Then the sensor nodes are transmitting their data on the concept of TDMA. TMAC-Timeout MAC protocol is used to support the sleep schedule in WSN and support the energy efficiency.
9. In WSN the responsible of sink is routing and clustering. The proposed algorithm is centralized.
10. The node energy consumption is based on their distance from CH or sink.

In WSN evaluate the energy consumption of sensor node based on the distance between the source and destination (D). In this proposed method, the energy needed to sending message is based on the length of message (L).

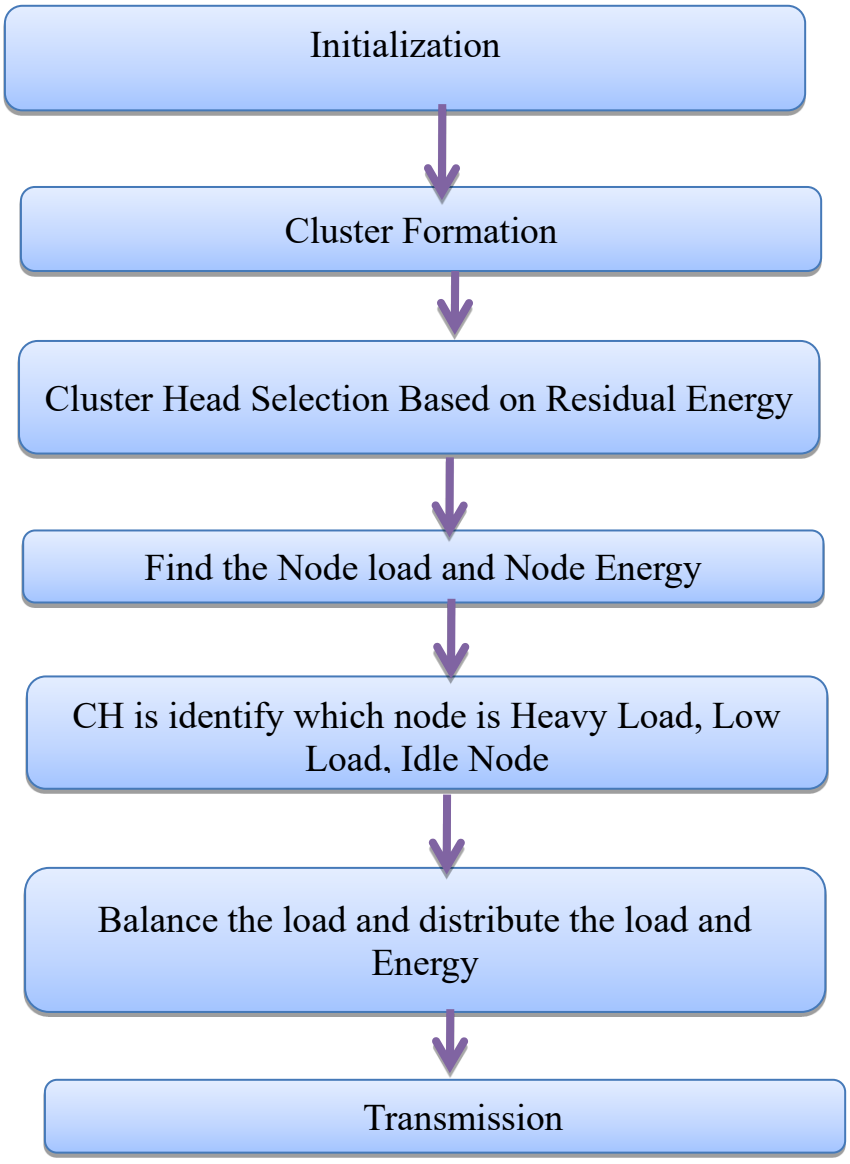


Fig 2. Flowchart of proposed method

In this section, illustrate the proposed EELDC algorithm. The proposed algorithm has two phases, first one is set-up phases and second one is steady state phases. Considered the first phase is divided into Advertisement, Schedule creation and Cluster set-up phase. Second phase is support data transmission using TDMA-Time Division Multiple Access. Firstly, use Kmean++ clustering algorithm to the CH selection. Then the proposed EELDC algorithm is find the load of the each and every node, Find the node load and node energy and distribute the energy and load to the to the low load node. We assume the CH is work like a distributed node.

CH Selection

After the cluster formation, in this section we proposed aCH selection based on Residual energy. The CH election is based on the Threshold energy (E_{CH}), optimum number of the cluster (K_{opt}), the Residual energy E_{Res} and probability dependent Threshold (T(n)) of the sensor nodes. After every round all the above parameter are updated. In this proposed Residual energy CH selection method, we have calculated the threshold energy for CH selection.

$$E_{CH} + l(E_{ele} + E_{da}) \left[\frac{Na}{Kopt}\right] \quad (1)$$

E_{da} – Energy parameter. During data aggregation operation, E_{da} is used for finding energy consumption. Then we have calculate the probability-dependant Threshold T(n).

$$T(n) = \frac{P}{1-P*r(mod(\frac{1}{P})} \quad (2)$$

p=0.05

r = current round of the simulation

P is the percentage of the node that is used for optimal energy consumption. We assume CH selection, which select new CH.

$E_{Res} \geq E_{CH}$ (3)

In Residual energy CH selection, entire active node send its information to BS in every second, here BS precede the CH selection process. Every active node have own random number ranging from 0-1. BS analyze the T(n)values of all the active node and such that entire active node satisfy

Random number< T(n)(4)

which is called G-node. NG-node is represented as the total number of G-nodes. These algorithms calculate the K_{opt} number of G-node based on the higher value of the E_{Res}. Here we considered as sensor nodes as CH otherwise G-node assumed as the total number of CH of WSN. After selecting the CH, BS broadcast the data in the WSN, here all the active node, idle node and Route nodes are get the CH's ID.Now all other active node chooses the neighboring CH depending upon the received signal strength from current CH.

Residual Energy based CH selection Algorithm

S – Total number of sensor node in the WSN

Sa – Total number of active node in the WSN

Steps:

Initialize

Find the value of the K_{opt}

Find the value of E_{CH}

Find the value of T(n)

If(random number < T(n))

The sensor node in the G-node

End

Find the value of the $N_{G\text{-}nodes}$

If($_{NG\text{-}node}$> K_{opt})
Select K_{opt} number of nodes from G-nodes using higher E_{Res} and select as CH ofthe Network.
Else
All G-nodes are elect as CH of the network
End.

This algorithm is used to select the CH among the all nodes in the network. If the node have highest energy then the node select as a Cluster Head.

Algorithm for identifying active node

Initialize
Assume all sensor nodes are alive S = { s_1,s_2,s_3……..s_n}
Select a node (s) from a set S
Calculate the energy level value E(s) for a node (s)
If produce random number >E(s)
Then
Find node (s) as a Active node (AN)
End

The above algorithm is used to find the active node. Based on the algorithm calculate the threshold value of the node energy. If the node reaches the threshold value that a node finds as active node.

Algorithm for identifying ideal node

Initialize
Assume all sensor nodes are alive S = { s_1,s_2,s_3……..s_n}
Select a node (s) from a set S
Calculate the Energy value E(s) for a node (s)
If produce random number< E(s)
Then
Find node (s) as an Ideal Node (IN)
End

The above algorithm is used to find the idle node. The same node is participates in the transaction process then the node energy is drop. That node is act as an idle node. Based on the algorithm, if the node energy is less than the random number then the nodes are idle node.
Then the CH is continuously monitoring the node load based on the active node and idle node.

Algorithm for Transmission

Input D = set of n data items
{ CH1, CH2,……CH_{Kopt} } = A set of K_{opt} cluster
d_{TH} = Threshold distance = $\frac{\sqrt{fs}}{mp} = 87.7\ meter$
node send data to the CH. Find the distance between each BS and selected CH (d_{BS})
if (d_{BS}< d $_{TH}$)
then
CH directlycommunicate to the BS

Route Phase

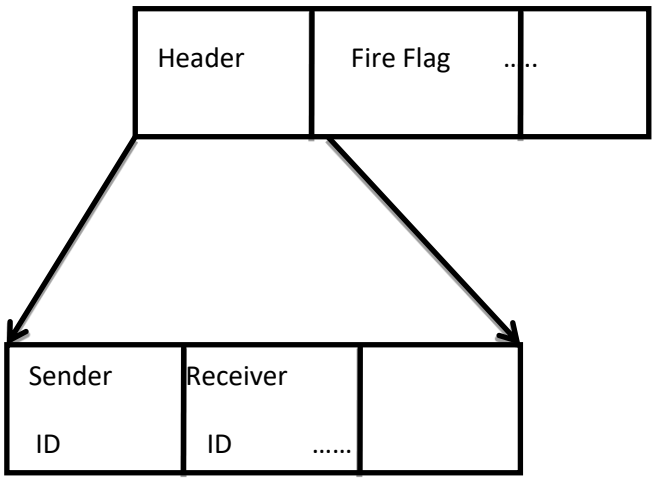
In this phase Route phases are illustrated, when the clustering phases is completed and a total number of Cluster Head(k) is determine then the algorithm called the routing phases to send the collected packet data. In route phases, the proposed algorithm is multi-hop routing, so it is identify the RN in the sink path. The cluster members transmit the information to their Cluster Head (CH) based on TDMA schedule. Assume, CH sends the routing information to the sink based on the RN. PSO is implemented to active route the data, and then construct the routing tree by fitness function. The route nodes are leads to the routing tree formation.

Algorithm for Route Node (RN)

Initialize random position and velocity
For each CH as the source route do
Build a path from priority vector
If a valid path then
Return fitness value calculated
Elsereturn penalty value as it fitness;
End
End
Calculate p and g for each particles based on neighborhood topology
While target fitness of routing=0 do
Update position and velocity of each particle
Evaluate fitness for each particle
Update p for each particle
Update g for each particle
End

Enhanced Tree Encoding

In this section, the fitness function (minF-routing) is used to determine the route node (RN). Then the algorithm updates the velocities in PSO and the particle location. The responsibility of route node is transmitting the collected data to the sink. POS is quickly building the routing tree via BS. We note that, updating the velocity and location, the number of invalid path is increase. At the same time the number of invalid path is reduced by the application and quickly detects the valid path. The proposed algorithm develops the tree encoding method.



To achieve this method, In PSO the priority decoding and encoding has been tested successfully. Then the new fire flag format is presented. We assume that, setup a fire flag because the node is aware of the other node status. Then send the data to each other based on event. In this network, the fire flag have two Boolean

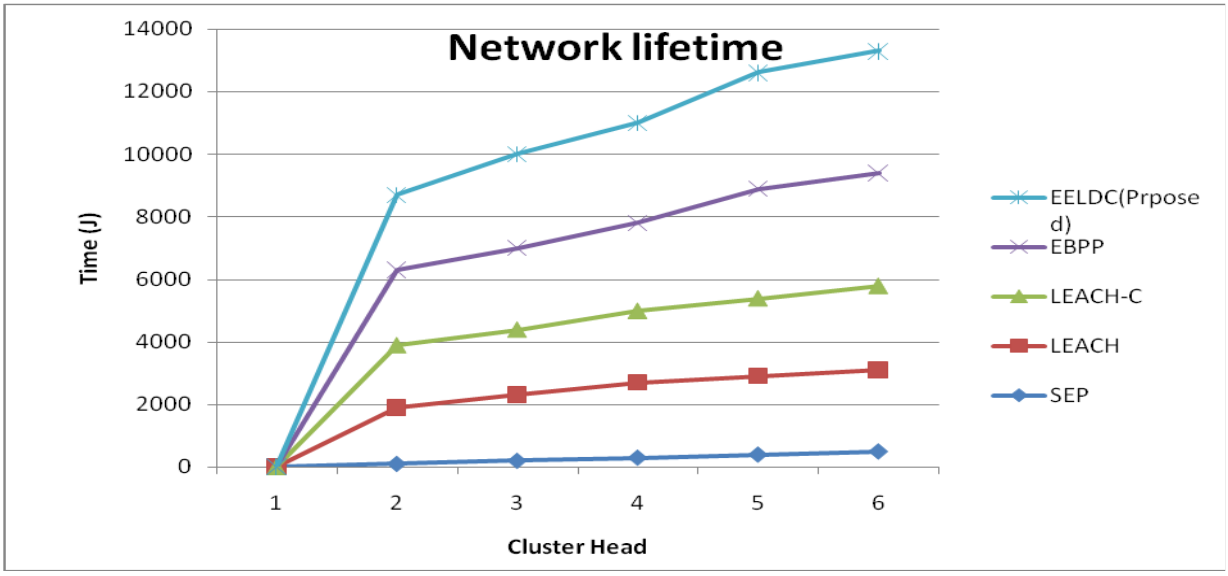
values of F as a uniformly event and T as a non-uniform event. Sensor nodes are mapped on to a random priority number between [-1,1], validate path from Cluster Head to the sink.

4. Performance Evaluation

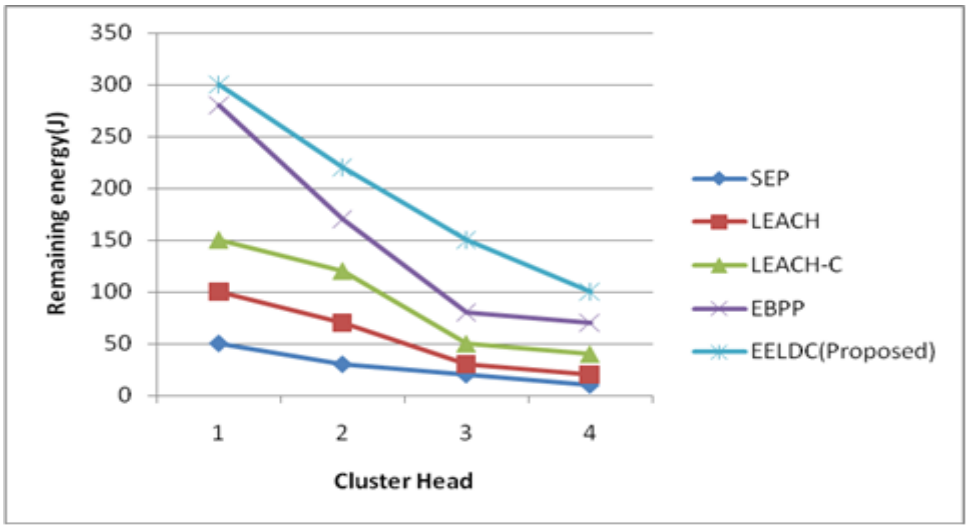
Table1.Simulation Parameters

N - Number of nodes	100
m × m - Sensor field region	100 m × 200 m
E0 -Initial energy of a nodes	0.5 (j)
K- Number of CHs	5
DP- Data packet length	4096 (bits)
DA- Energy data aggregation	5 (nJ)
[Xmin, Xmax]- Particle position	[0, 200]
[Vmin, Vmax] -Particle velocity	[0, 200] (m/s)
[c1min, c1max] and [c2min, c2max] Acceleration constants	2
Eamp- Multipath fading transmitter amplifier energy	130 (pJ/bit/m2)
Eelec -Transmission and receiving energy	50 (nJ/bit)
Efs- Free space transmitter amplifier energy	10 (pJ/bit/m2)
Max Round- Maximum number of rounds	40 rounds
Sw -Swarm size	15
Iter Number of iterations	5
HMCRmin and HMCRmax – Harmonic memory considering rate	0.8 and 0.9
and PARmax Pitch adjustment rate	0.1 and 0.9
ωmax Maximum values of inertia weight	0.9
ωmin Minimum values of inertia weight	0.4
Base Station (BS) Various sink locations	(0, 100), (100, 100), (50, 150), (50, 200)

Network lifetime



Compare with proposed EELDC with existing clustering algorithm our proposed algorithm is used to increase the network lifetime.



5. Conclusion

In this section, conclude the proposed EELDC algorithm. Many clustering algorithm is concentrated only the network lifetime. The proposed algorithm is used to increase the network lifetime and also distribute the load. CH selection is based on node residual energy. The algorithm is used to find the active node and idle node. Then easily distribute the load from one node to another node.

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