ENERGY OPTIMIZATION IN WSN USING ENERGY EFFICIENT HIERARCHICAL CLUSTERING ALGORITHM

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***Abstract*:**Wireless Sensor Networks (WSN) is the most unpredictable networks which are communicate each other and transfer the data from each node. These are mostly used in any type of environment such as heterogeneous nature. Energy consumption is most widely used for the nodes. Many research has been done on WSN. In the existing techniques, the energy efficiency between the nodes become most complicated and because of their adaptive and mobility nature the energy consumption is more high. In this paper, the proposed system addressed the problem in the existing system such as calculation of cluster head. To overcome this, the proposed EEHCA is introduced to maintain the energy between the nodes and calculating the cluster head more efficiently. Results shows the performance of existing and EEHCA.

***Key words*- Sensor Networks, Clustering, LEACH, EEHCA.**

I. INTRODUCTION

For recent years, Wireless Sensor Networks (WSNs) pulled in heaps of analysts as a result of its potential wide applications and numerous examination challenges. Early investigation on WSNs principally centeredaround advancements in light of the homogeneous WSN in which all hubs have same framework assets. Be that as it may, heterogeneous WSN is ending up increasingly prominent on the grounds that the advantages of utilizing heterogeneous WSNs with various abilities keeping in mind the end goal to meet the requests of different applications have been introduced in late writing [1], [2].

One of the vital difficulties in the association of the WSNs is vitality effectiveness and soundness since battery limits of sensor hubs are constrained and supplanting them are unfeasible. Since, sensor hubs utilize a lot of vitality for information transmission and collection. Consequently, new vitality productive steering conventions are required to spare vitality utilization. In this paper, we propose a novel Energy-Efficient Clustering and Data Aggregation (EECDA) convention for heterogeneous WSN. In this approach, another Cluster Head (CH) race and information correspondence component is introduced to broaden the lifetime and security of the system. After the CHs race, a way with most extreme aggregate of lingering vitality would be chosen for information correspondence rather than the way with least vitality utilization. In this manner, each CH first totals the got information and afterward transmits the amassed information to the Base Station (BS).

The principle commitments of EECDA convention is to give longest steadiness (when the primary hub is dead) and enhances the system lifetime in contrast with Low-Energy Adaptive Clustering Hierarchy (LEACH), Energy-Efficient Hierarchical Clustering Algorithm (EEHCA) and Effective Data Gathering Algorithm (EDGA).

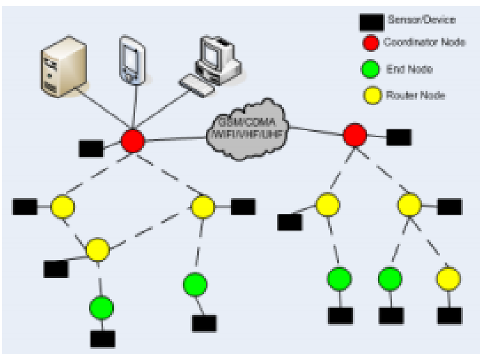

Fig 1: Wireless Sensor Network

II. LITERATURE REVIEW

Wireless sensor networks have gained considerable popularity due to their flexibility in solving problems in different application domains and have the potential to change our lives in many different ways.

1) Lee, S. H., Yoo, J. and Chung, T. C. , "Distance-based energy efficient clustering for wireless sensor networks," Proc.of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), 2004 In this paper Authors modified the Basic Low Energy adaptive clustering hierarchy (LEACH) protocol with their proposed LEACH-MAE(LEACH Mobile Average Energy based) protocol to overcome its shortcomings to support mobility along with the new average energy based Cluster Head selection technique. Author took LEACH-M, which supports mobility of the nodes, as their reference and modified it. They introduced this mobility of nodes on the energy basis. In this protocol the cluster head selection among the mobile nodes is purely based on the received signal strength of the nodes. The Authors simulated LEACH-MAE protocol in NS2 which shows that proposed algorithm improves network life time up to 25 % as well as helps to maintain the equal distribution of energy resource among the sensor nodes.

2) ZiboudaAliouat, MakhloufAliouat , "Effective Energy Management in Routing Protocol for Wireless Sensor Networks", IEEE 2012. In this paper, Authors proposed a multi hop routing protocol: PEGASIS-MH for minimizing energy consumption and extending the network life time. This new protocol is a combination of the more efficient well known protocols hierarchical LEACH and PEGASIS. The results obtained through the simulations carried out in an environment of the simulator NS2 have shown that the performances achieved by our proposal are noteworthy and outperform those of the original protocols.

3) Kumar, M V, and Jacob, "Mobility Metric based LEACH-Mobile Protocol", ADCOM 2008, IEEE 2008. Cluster based protocols like LEACH were found best suited for routing in wireless sensor networks. In mobility centric environments some improvements were suggested in the basic scheme. LEACH-Mobile is one such protocol. The basic LEACH protocol is improved in the mobile scenario by ensuring whether a sensor node is able to communicate with its cluster head. Since all the nodes, including cluster head is moving it will be better to elect a node as cluster head which is having less mobility related to its neighbours. In this paper, LEACH-Mobile protocol has been enhanced based on a mobility metric "remoteness" for cluster head election. This ensures high success rate in data transfer between the cluster head and the collector nodes even though nodes are moving. Authorshave simulated and compared LEACH-mobile-enhanced protocol with LEACH-mobile. Results show that inclusion of neighbouring node information improves the routing protocol.

4) Heinazelman, Chandraksan, and Balakrishna, "Energy- efficient Communication protocol for Wireless Micro sensor Networks", In IEEE 2000 proceeding of the Hawaii International Conference on system Sciences.Jan2000. Wireless distributed micro sensor systems will enable the reliable monitoring of a variety of environments for both civil and military applications. In this paper, Author looked at communication protocols, which can have significant impact on the overall energy dissipation of these networks. Based on their findings that the conventional protocols ofdirect transmission, minimum-transmission-energy, multi-hop routing, and static clustering may not be optimal for sensor networks, so they proposed LEACH (Low-Energy Adaptive Clustering Hierarchy), a clustering-based protocol that utilizes randomized rotation of local cluster based station (clusterheads) to evenly distribute the energy load among the sensors in the network. LEACH uses localized coordination to enable scalability and robustness for dynamic networks, and incorporates data fusion into the routing protocol to reduce the amount of information that must be transmitted to the base station. Simulations and results done by author showed the LEACH can achieve as much as a factor of 8 reduction in energy dissipation compared with conventional routing protocols. In addition, LEACH is able to distribute energy dissipation evenly throughout the sensors, doubling the useful system lifetime for the networks.

5) I.F. Akyildiz, W.SU and E.Cayirci, "Wireless sensor networks: A Survey », Georgia Institute of Technology, " 2001. This paper describes the concept of sensor networks which has been made viable by the convergence of micro electro-mechanical systems technology, wireless communications and digital electronics. First, the sensing tasks and the potential sensor networks applications are explored, and a review of factors influencing the design of sensor networks is provided. Then, the communication architecture for sensor networks is outlined, and the algorithms and protocols developed for each layer in the literature are explored. Open research issues for the realization of sensor networks are also discussed.

6) Indu Shukla, Natarajan Meghanathan, "Impact of leader selection strategies on the PEGASIS data gathering protocol for wireless sensor networks," Jackson State University, Jackson MS, USA, 2010.

The Power Efficient-Gathering in Sensor Information Systems (PEGASIS) protocol is one of the classical data gathering protocols for wireless sensor networks. PEGASIS works by forming a chain of the sensor nodes starting from the node farthest away to the sink. Data from either end of the chain gathers towards the leader node, selected for each round of data gathering, through a hop-by-hop transfer and aggregation process. The leader node transmits the aggregated data to the sink node. In this paper, Author investigated the impact of the following leader node selection strategies for every round: Random (randomly selected node), Shuffle (a node is selected as leader only once in N rounds in a network of N nodes), High-energy (node with the highest energy), 2-block and 4-block (the network is divided into 2 or 4 blocks and the leader node is the highest energy node in the randomly chosen block of a round). Author studied the PEGASIS protocol for both TDMA and CDMA systems. For each combination of network topology (square, circular and rectangular) and sink location (centre, origin and outside the network field), author identified the leader selection strategy that yields the longest network lifetime (up to 5% node failures) and the minimum energy*delay per round.

7) Indu Shukla, "Power Efficient Gathering in Sensor Information System (PEGASIS Protocol)," Jackson State University, Jackson MS, USA, 2010. In this paper, Author proposed PEGASIS (power-efficient gathering in sensor information systems), a near optimal chain-based protocol that is an improvement over LEACH. In PEGASIS, each node communicates only with a close neighbour and takes turns transmitting to the base station, thus reducing the amount of energy spent per round. Here these nodes doesn't form clusters to transmit data instead they communicate with the nearby node. This method is like passing a data packet from one place to another place through intermediate nodes. This method loses so much energy if there are too many intermediate nodes in between.

8) Lee, S. H., Yoo, J. and Chung, T. C. , "Distance-based energy efficient clustering for wireless sensor networks," Proc.of the 29th Annual IEEE International Conference on Local Computer Networks (LCN'04), 2004 In this paper, Author proposed a new distributed clustering and data aggregation algorithm, CODA (cluster-based self-organizing data aggregation), based on the distance from the sink in ad-hoc wireless sensor networks. While cluster-based data gathering is efficient in energy and bandwidth, it is difficult to cluster efficiently. We use the distance vector from the sink, which affects the energy depletion of the network. Author mainly concentrated on energy constraint and efficient clustering of the nodes.

III. RELATED WORK

Routing is a process of selecting best path in the network. So, routing protocols are liable fordiscovering and managing efficient routes in the network. Energy efficiency is an essential issue in WSN routing.Hence, development of energy efficient routing protocol becomes a hot research issue in sensor networks. The energy efficient routingprotocols (EERP) can be broadly classified based on four parameters as follows: network structure, computation model, topology, reliability [17]. Here, we focus on the hierarchical or cluster based routing protocols. Several hierarchical routing protocols for WSNs are given by various researchers. LEACH is an eminent protocol of this category.

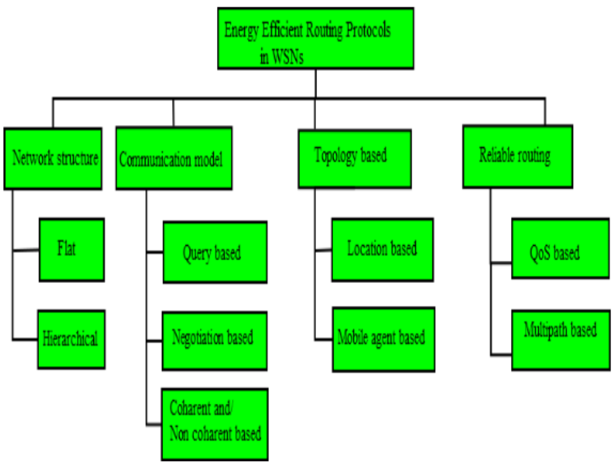

Fig 3: Taxonomy of Energy Efficient Routing Protocolsin WSNs

LEACH is a hierarchical routing protocol that reduces the energy expenditure in the network. LEACH outperforms he classical routing algorithm since it uses adaptive clustering scheme. But when a CH dies in the LEACH that cluster is of no use since data gathered at CH will not reach the BS. LEACH suffers from the problem of CH rotation overhead in every round. LEACH elects the CH depend on the random number in the range (0,1]. If chosen number is fewer than threshold T(n) then node become CH for present round. Energy efficient hierarchicalclustering algorithm (EEHCA) uses a novel process for CH election with the idea of backup CHs to get better efficiency of the network [18]. The distributed energy efficient clustering (DEEC) uses initial and remaining energy level of node for CH selection. It is developed for heterogeneous wireless sensor networks.

IV. EXISTING SYSTEM

LEACH is the most widely used protocol in the wireless sensor networks. The aim of the LEACH is to calculate the energy efficiency and cluster heads between the nodes. Based on their adaptive nature and mobility of the nodes the energy consumption between the nodes is very high and the nodes in the network stops very soon and the nodes becomes the zero state i.e. with no energy. The other name for the LEACH protocol is hierarchical routing protocol. This protocol is combination of nodes and some of the nodes are cluster heads. The formation of cluster heads is done based on the energy maintaining by the nodes. During the first step cluster head sends the advertisement packet to inform the cluster nodes that they have become a cluster head on the basis of the following formula:

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

$$T(n) = 0 \qquad \forall n \in G$$

Where n is a random number between 0 and 1

P is the cluster-head probability and

G is the set of nodes that weren't cluster-heads the previous rounds

Fig 4.1: Cluster head selection

T (n) is the threshold. Node becomes cluster head for the current round if the number is less than threshold T (n). Once node is elected as a cluster head then it cannot become cluster head again until all the nodes of the cluster have become cluster head once. This is useful for balancing the energy consumption. In the second step, non-cluster head nodes receive the cluster head advertisement and then send join request to the cluster head informing that they are members of the cluster under that cluster head. All non-cluster head nodes save a lot of energy by turning off their transmitter all the time and turn it on only when they have something to transmit to the cluster head [2]. In third step, each of the chosen cluster head creates a transmission schedule for the member nodes of their cluster. TDMA schedule is created according to the number of nodes in the cluster. Each node then transmits its data in the allocated time schedule [3]. B. Steady phase In steady phase, cluster nodes send their data to the cluster head. The member sensors in each cluster can communicate only with the cluster head via a single hop transmission. Cluster head aggregates all the collected data and forwards data to the base station either directly or via other cluster head along with the static route defined in the source code. After predefined time, the network again goes back to the set-up phase.

The performance of the LEACH show in the below:

```
107.254 4 received one packet from 10.1.1.15
107.32 5 received one packet from 10.1.1.16
107.339 3 received one packet from 10.1.1.14
107.34 6 received one packet from 10.1.1.17
107.35 4 received one packet from 10.1.1.15
107.392 1 received one packet from 10.1.1.12
107.395 3 received one packet from 10.1.1.14
107.451 4 received one packet from 10.1.1.15
107.469 7 received one packet from 10.1.1.18
107.492 3 received one packet from 10.1.1.14
107.495 3 received one packet from 10.1.1.14
107.498 3 received one packet from 10.1.1.14
107.5 4 received one packet from 10.1.1.15
107.57 5 received one packet from 10.1.1.16
107.588 3 received one packet from 10.1.1.14
107.59 6 received one packet from 10.1.1.17
107.603 3 received one packet from 10.1.1.14
107.611 3 received one packet from 10.1.1.14
107.612 4 received one packet from 10.1.1.15
107.639 3 received one packet from 10.1.1.14
107.641 1 received one packet from 10.1.1.12
107.654 7 received one packet from 10.1.1.18
107.707 4 received one packet from 10.1.1.15
```

Fig 4.2: Shows the communication between the nodes.

```
Logging Event New Cluster Head Selection(Node-19) @ 1
Logging Event New Cluster Head Selection(Node-13) @ 2
Logging Event New Cluster Head Selection(Node-21) @ 3
Logging Event New Cluster Head Selection(Node-19) @ 4
Logging Event New Cluster Head Selection(Node-21) @ 5
Logging Event New Cluster Head Selection(Node-26) @ 6
Logging Event New Cluster Head Selection(Node-3) @ 7
Logging Event New Cluster Head Selection(Node-3) @ 8
Logging Event New Cluster Head Selection(Node-17) @ 9
Logging Event New Cluster Head Selection(Node-28) @ 10
Logging Event New Cluster Head Selection(Node-9) @ 11
Logging Event New Cluster Head Selection(Node-10) @ 12
Logging Event New Cluster Head Selection(Node-17) @ 13
Logging Event New Cluster Head Selection(Node-14) @ 14
Logging Event New Cluster Head Selection(Node-10) @ 15
Logging Event New Cluster Head Selection(Node-23) @ 16
Logging Event New Cluster Head Selection(Node-3) @ 17
Logging Event New Cluster Head Selection(Node-24) @ 18
Logging Event New Cluster Head Selection(Node-21) @ 19
Logging Event New Cluster Head Selection(Node-30) @ 20
Logging Event New Cluster Head Selection(Node-5) @ 21
Logging Event New Cluster Head Selection(Node-15) @ 22
Logging Event New Cluster Head Selection(Node-16) @ 23
Logging Event New Cluster Head Selection(Node-14) @ 24
Logging Event New Cluster Head Selection(Node-25) @ 25
Logging Event New Cluster Head Selection(Node-14) @ 26
Logging Event New Cluster Head Selection(Node-29) @ 27
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Fig 4.3: Shows the Cluster Head formation between the nodes. It is known that for every one second the cluster head is changing due to their mobility. For the 30 Nodes the total time taken to form cluster heads and energy consumption is given in table-1.

LEACH it also has some Disadvantages which are as follows:

There is no idea about the cluster head formation between the nodes within the network. Without any strong reason the cluster head may dies and cluster may not be used by the network.The formation of clusters are done randomly, which may cause the uneven results and some of the clusters have higher nodes and some of the clusters have less nodes. Based on their position the cluster may form at the center and sometimes it may form at the border of the network. This may consume more energy and this may cause loss for the network.

RESEARCH METHODOLOGY

V. ACKNOWLEDGMENT

EEHCA (Energy Efficiency hierarchical clustering algorithm) is the most widely used in WSN. There are many advantages for this protocol such as maintain energy between the nodes and better formation of cluster heads. The information is forwarded to all the sensors that are no more than k hops away from the clusterhead. Any sensor that receives such advertisements and is not itself a clusterhead joins the cluster of the closest clusterhead. Any sensor that is neither a clusterhead nor has joined any cluster itself becomes a clusterhead; we call these clusterheads the forced clusterheads. Because we have limited the advertisement forwarding to k hops, if a sensor does not receive a CH advertisement within time duration t (where t units is the time required for data to reach the clusterhead from any sensor k hops away) it can infer that it is not within k hops of any volunteer clusterhead and hence become a forced clusterhead.

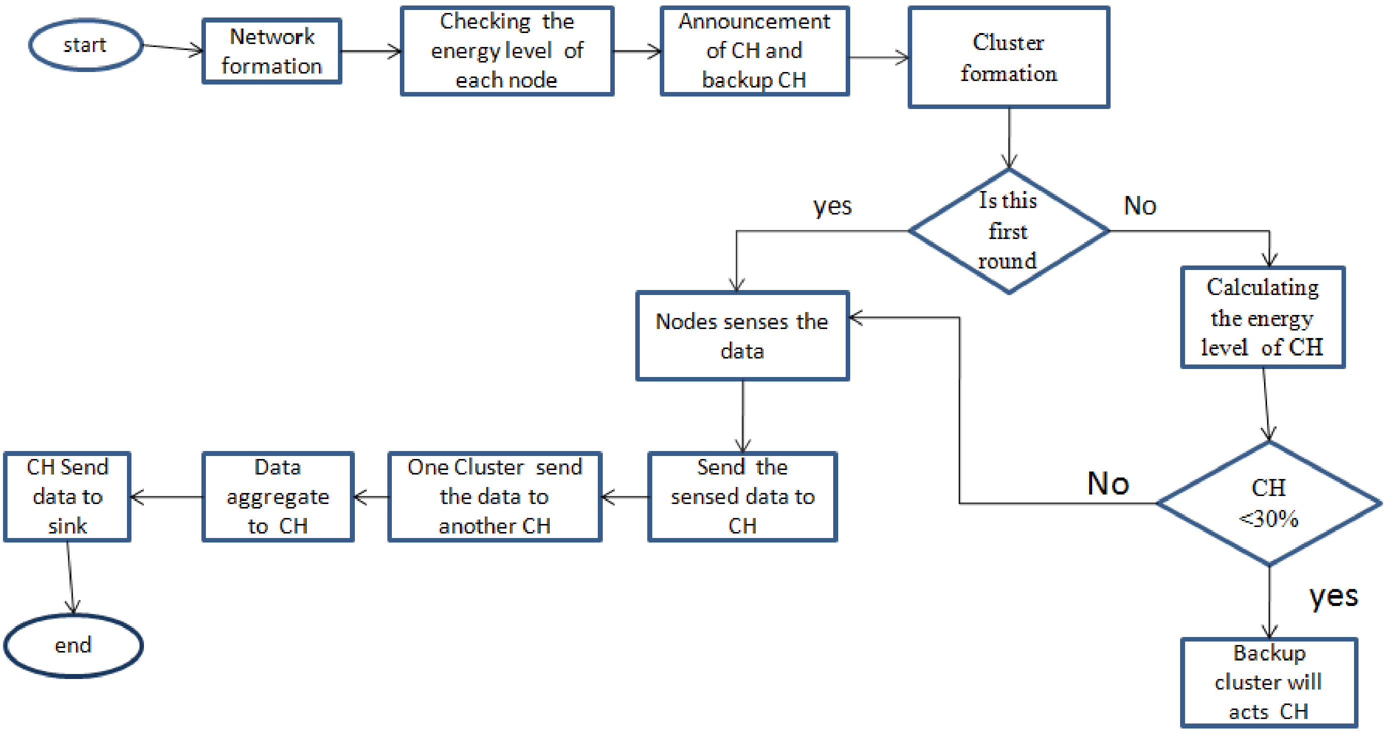


Fig 4.4: Flowchart of EEHCA

Moreover, since all the sensors within a cluster are at most k hops away from the cluster-head, the clusterhead can transmit the aggregated information to the processing center after every t units of time. This limit on the number of hops thus allows the cluster-heads to schedule their transmissions. Note that this is a distributed algorithm and does not demand clock synchronization between the sensors.

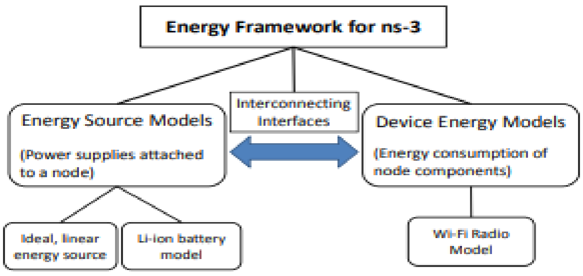


Fig 4.5 Basic Energy Model in NS-3.

The energy used in the network for the informationThe energy used in the network for the information gathered by the sensors to reach the processing center will depend on the parameters p and k of our algorithm. Since the objective of our work is to organize the sensors in clusters to minimize this energy consumption, we need to find the values of the parameters p and k of our algorithm that would ensure minimization of energy consumption. We derive expressions for optimal values of p and k in the next subsection.

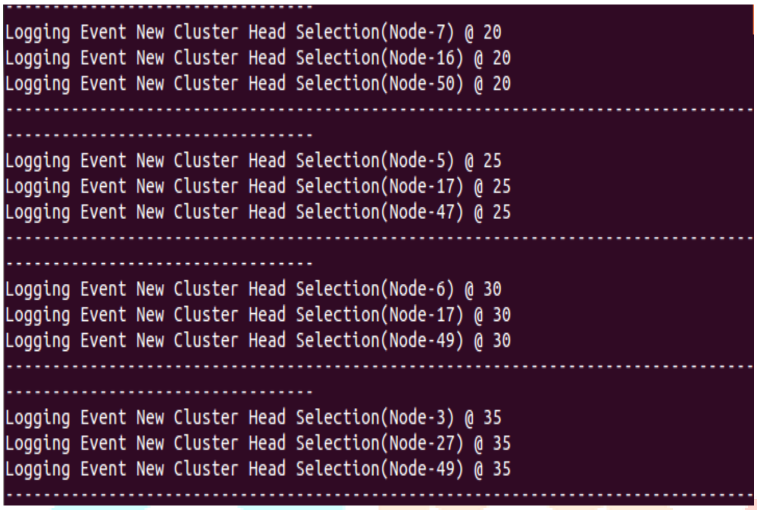


Fig 4.6: Cluster Head Formation & time taking to form Cluster Head between the nodes.

EEHCA Algorithm:

Step-1: Initialize Nodes N.
Step-2: N=30;
Step-3: Energy at each node E=7.5 (initial energy)
Step-4: Start Communication
Step-5: Calculating Cluster Heads 1-3 &1 backup
Step-6: time taken to calculate the cluster heads are t=4-6 sec.
Step-7: Consider 35 Sec total time taken for this cluster head calculation.
Step-8: then the energy at each node is E>7.5.
Step-9: this shows that EEHCA is maintain the energy.
Step-10: Stop.

Optimal parameters for the algorithm. To determine the optimal parameters for the algorithm described above, we make the following assumptions:

a) The sensors in the wireless sensor network are distributed as per a homogeneous spatial Poisson process of intensity λ in 2-dimensional space.

b) All sensors transmit at the same power level and hence have the same radio range r.

c) Data exchanged between two communicating sensors not within each others radio range is forwarded by other sensors.

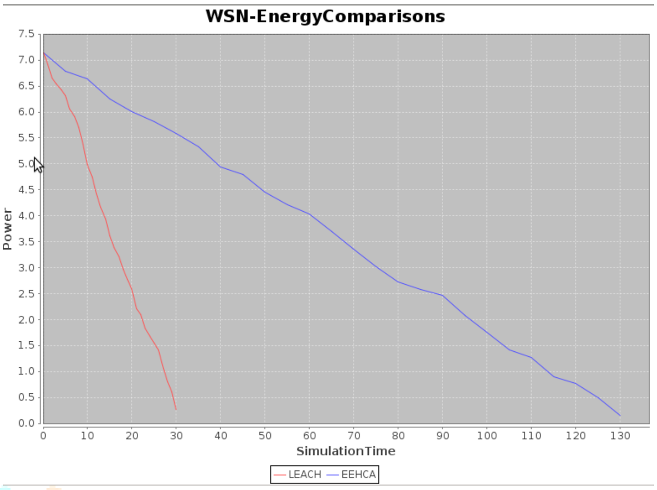
e) Each sensor uses 1 unit of energy to transmit or receive 1 unit of data.

f) A routing infrastructure is in place; hence, when a sensor communicates data to another sensor, only the sensors on the routing path forward the data.

g) The communication environment is contention- and error-free; hence, sensors do not have to retransmit any data. The basic idea of the derivation of the optimal parameter values is to define a function for the energy used in the network to communicate information to the information-processing center and then find the values of parameters that would minimize it.

VI. RESULTS AND DISCUSSION

The simulations are performed using NS-3. Extensive studies are carried out to study the performance of the proposed EEHC against classical and modern clustering algorithms.



Comparison table:

Algorithm	LEACH	EEHCA
No of Nodes	30	30
Total Energy for all nodes	15 Sec	35 Sec
Time for cluster head	1 Sec	4-6 Sec

Table: 1 Shows the Performance of the LEACH & EEHACE.

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