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# An Improved Energy Efficient Clustering (IEEC) For Wireless Sensor Networks

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***Abstract:*** ***Wireless Sensor Networks (WSNs) provide a new model for sensing and spreading information from different environments, with the possibility to serve numerous and various applications. WSN is prominent area of research nowadays, because of the potential utilization of sensor networks in different applications. Wireless sensor network is a collection of various small micro-electro-mechanical devices. These small devices have sensors, capability of computation, supply of power and the wireless transmitter and receiver. Clustering is a cross-cut strategy which is utilized as a part of almost all fragments of the protocol stack. The fundamental concept behind scheme of clustering is to make a group of nodes around a cluster head with the obligation of inter-cluster connectivity and up keeping state included in processing of data. This research work aims to propose a new clustering strategy IEEC (Improved energy efficient clustering) based on event occurrence. The proposed strategy can be applied to a wireless sensor network to reduce its energy consumption alongside improve its other performance metrics.***

***Keywords:*** ***WSN, micro-electronics, sensor nodes, clustering, inter-cluster connectivity***

## I. INTRODUCTION

With the growth and advancement in Micro-Electro-Mechanical System (MEMS) technology and wireless communication technology, there is a noticeable advancement in wireless sensor networks (WSNs). WSNs are used in many areas of applications like disaster management, habitat monitoring, military reconnaissance, habitat monitoring etc. WSNs have directed the connection between the world of computing, physical world and human society. WSN incorporates huge number of small sensor nodes that are disseminated in big area consisting of base stations (BSs) or powerful sinks which gather information from these small sensor nodes. Every sensor node has restricted supply of power and also has the ability of processing of data, wireless communication and sensing of information. [7].In WSN, sensor nodes are organized in sensor field. This arrangement of the sensor nodes can be well planned (regular), random or sensor nodes can also be used which are mobile. These sensor nodes synchronized with each other to generate information about the physical environment which is of high quality. Every sensor node gathers the data and forwards the data to the base station. It is not necessary for the nodes to communicate at the similar time and also they can communicate with the nodes which are closer. To handle the messages routing in between the sensor nodes, there is routing protocol in the network. This routing protocol likewise endeavours to get messages to the base station in an energy productive way. The master node is a base station. The base station may correspond with the other sensor nodes. [25]

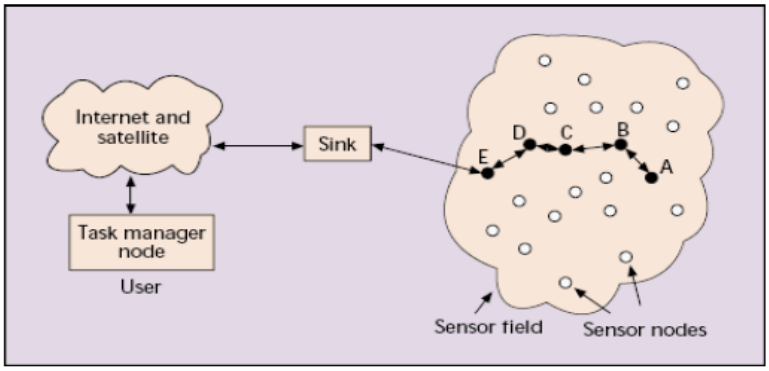


Fig 1 View of a wireless sensor network [19]

## II. CLUSTERING IN WIRELESS SENSOR NETWORKS

The utilization of wireless sensor networks has become massively in the most recent decade, bringing up the critical requirement for energy-efficient and scalable routing and protocols of aggregation in relating large-scale environments. In clustering, sensor nodes are allotted into different groups. Every cluster is directed by a node insinuated as group head (CH) and different nodes are implied as cluster nodes. Group nodes don't talk clearly with the sink nodes. They have to

 

pass the collected information to the cluster head. Group head will add up to the data, picked up from cluster nodes and send it to the base station. In the view of structure of the network, protocols of routing in WSNs can be coarsely partitioned into three categories: flat, hierarchical and location based routing. [25]

Definitely, hierarchical protocols give significant measure of energy in consumption of energy by sensor nodes. In hierarchical protocols, sensor nodes are composed into clusters. Every cluster has a head called cluster head (CH) and others as member nodes (MNs). The nodes which have high level of energy get to be CH and perform processing, aggregation and transmission of data, while nodes with low level of energy get to be MNs sense information and transmit it to the cluster head. Aggregation of data at the cluster head gigantically minimize consumption of energy by diminishing the messages sent to the BS and thusly expanding life time of network. The main routing protocols of clustering in WSNs are Low-Energy Adaptive Clustering Hierarchy (LEACH), Hybrid Energy-Efficient Distributed Clustering (HEED), Power-Efficient Gathering in Sensor Information Systems (PEGASIS), Threshold sensitive Energy Efficient sensor Network protocol (TEEN) and Adaptive Threshold sensitive Energy Efficient sensor Network protocol (APTEEN) [25]. Moderately large number of routing protocols for clustering has been produced for WSNs. The main advantages of clustering are [3]:

- Minimizing the number of nodes which are utilized for transmission.
- Efficient utilization of resources in WSNs.
- Consume useful energy.
- Minimize the communication overhead.

### *2.1 HEED (HYBRID ENERFY EFFICIENT DISTRIBUTED CLUSTERING)*

Hybrid Energy Efficient Distributed Clustering (HEED) is a multi-hop clustering algorithm for WSN which brings clustering routing which is energy efficient with unequivocal energy consideration. HEED does not select nodes as CHs arbitrarily. The way of construction of cluster is performed focused around the hybrid mixture of two parameters. One parameter relies on the residual energy of the node and the other parameter is the cost of intra-cluster communication. In HEED, chosen CHs have moderately high average residual energy contrasted with MNs. Also, one of the fundamental objectives of HEED is to get CHs which are distributed evenly all through the network. Additionally, notwithstanding the phenomena that two nodes, inside one another's range of communication, get to be CHs together, yet the likelihood of this phenomenon is very little in HEED. In HEED, CHs are occasionally chosen focused around two essential parameters: cost of intra-cluster communication and residual energy of the candidate nodes [20]. At first, in HEED, CHs percentage among all nodes, $C_{prob}$, is set to accept an ideal percentage cannot be registered from the earlier. The probability that a node becomes a CH is [1]:

$$CH_{\text{prob}} = C_{\text{prob}} \frac{E_{\text{residual}}}{E_{\text{max}}} \qquad \text{----------(1)}$$

Where $E_{residual}$ is the evaluated current energy of the node and $E_{max}$ is the reference most extreme energy, which is regularly similar for all the nodes in the network. The estimation of $CH_{prob}$, then again is, is not permitted to fall beneath a certain limit that is chosen to be contrarily corresponding to $E_{max}$. A while later, every node experiences a few iterations until it finds the CH. If it gets notification from no CH, the node chooses itself to be a CH and sends a report message to its neighbors. Every node duplicates its $CH_{prob}$ value and goes to the following iteration until its $CH_{prob}$ reaches 1. Accordingly, there are two sorts of status that a sensor node could affirm to its neighbors: final and experimental status. On the off chance that its $CH_{prob}$ is under 1, the node turns into a speculative CH and can change its status to a consistent node at a later cycle if it discovers a CH of lower cost. In the event that if it's $CH_{prob}$ has arrived at 1, the node forever turns into CH. In HEED, each node chooses the CH of minimum communication cost keeping in mind the end goal to go along with it [1]. The advantages of HEED protocol are as follows[25]: (1) It is completely distributed technique of clustering that advantage from the utilization of two vital parameters for election of CH; (2) levels of clusters having low power advance an increment in spatial reuse while levels of clusters having high power are needed for communication which is inter-cluster. This gives distribution of CH which is uniform over the network and balancing of load; (3) communications in a multi-hop design in the middle of CHs and the BS advance more conservation of energy and scalability compared with the single-hop style, i.e., communications of long-range straightforwardly from CHs to the sink, in LEACH protocol. HEED was proposed with four primary goals as given below [4]:

- Enhances the lifetime of the network by distributing consumption of energy.
- Reducing the control overhead.
- Ceasing the process of clustering in even number of iterations.
- Providing well-dispersed cluster heads and compact clusters.

The significant features of this protocol are [4]:

- In HEED, energy distribution enhances the nodes lifetime in the network, hence soothing the neighbouring node.
- Capabilities of Special nodes are not needed, for example, awareness of location.
- The node only needs information about local neighbourhood to make the clusters.
- Nodes regularly update their sets of neighbour in the multi-hop network by irregularly sending and also receiving the messages.

 

## III. PROPOSED STRATEGY

The WSN is geographically organized in clusters with CDMA/ Non CDMA nodes. It is divided such that one specific node is intended to serve as cluster head (CH), while the remaining nodes are permitted to function as its supporters. The methodology commences with the arrangement of various clusters. The information gathered by various sensors requires to be transmitted from a remote source to a known goal through a central node or hub. On the other hand, if the hub node is at large distance, the information might first be transmitted to a relay node and take after a multi-hop routing to send the data to its final goal. It has also been studied that the performance of WSNs can be further enhanced by advancing the consumption of energy. The different applications spin around the feature to find out the most effective method for conserving the power source energy. Serious constraints of energy of sensor nodes which are battery-controlled require clustering methods which are energy-efficient so as to follow the necessities of WSNs. The proposed procedure will be implemented on clustering protocol HEED, utilizing which WSNs performance will be improved. In the existing technique of clustering (HEED), clustering is done everywhere throughout the nodes even where it is not required that prompts unnecessarily consumption of energy. The proposed technique mitigates that disadvantage and efficient clustering is carried out to minimize the consumption of energy alongside uses an efficient routing algorithm to improve the other performance metrics. The research is based on following assumptions:

- Nodes and base station is stationary
- Nodes do not have GPS capable antenna i.e. location awareness capability
- Nodes are homogenous i.e. all have similar communication and processing capacities

## IV. IMPLEMENTATION OF PROPOSED STRATEGY IEEC

The design of proposed scheme based on thorough knowledge and understanding of the factors that influence the performance Wireless Sensor Networks (WSNs), for which the algorithm is intended. To achieve the goals of the proposed algorithm the research implemented using two distinct phases.

- The First phase involve the formation of clusters
- The second phase involved the design and implementation efficient routing algorithm to determine the path from source to the sink

The proposed strategy works as follows:

1. The first is to deploy the nodes.
2. Unlike conventional algorithms, cluster formation is done only in the area where the nodes sense the event.
3. Cluster head selection is done on the basis of residual energy. The node bearing highest residual energy is nominated as the Cluster Head.
4. CH broadcast the advertisement message to all nodes.
5. Whenever nodes send messages to CH, it aggregates the messages.
6. After aggregation is done, CH forms a path to sink to route the sensed data.
7. Now when nodes notice any other event, a cluster is formed in that region too.
8. Data aggregation points are increased on the previously formed path to the sink.
9. For better energy consumption, another path is formed to the sink using nodes which are in the previous path in order to reduce the energy consumption.

Wireless sensor network deployment and cluster formation is shown in fig 2 and fig 3. Node deployment is random and cluster formation is event based and cluster head (CH) is on basis on residual energy i.e. node having maximum remaining energy is selected as the cluster head.

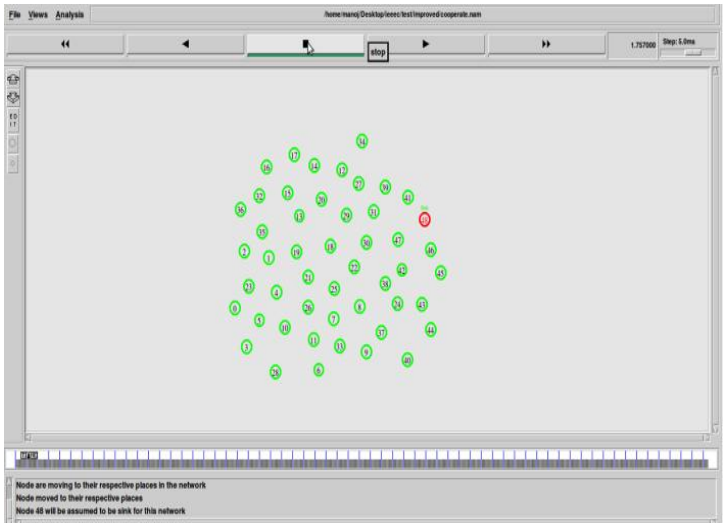


Fig 2 Node deployment

 

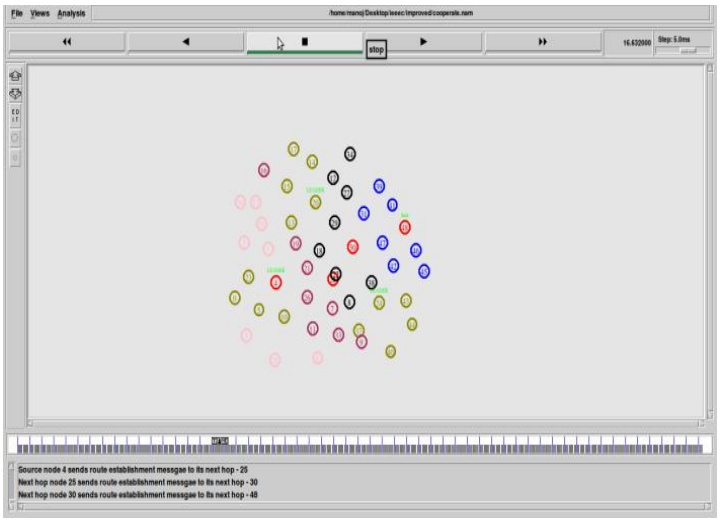


Fig 3 Cluster formation

The proposed method is implemented using TCL in ns-2.35, which is installed using UBUNTU 12.10 as platform. The simulation parameters Used are shown below in table 1:

Table 1 Simulation Parameters

| | |
|---|---|
| Simulator | NS2.35 |
| Channel | Wireless Channel |
| Propagation Model | Two Ray Ground |
| Queue | Drop Tail |
| Antenna | Omni-Directional |
| Routing Protocol | AODV |
| Clustering Protocol | HEED |
| Energy Model | Radio Energy Model |
| Number of nodes | 49 |
| Simulation Area | 1300*1000 |

## V. RESULTS AND DISCUSSIONS

Results obtained by using proposed strategy compared with the existing clustering technique HEED based on following parameters:

- Residual energy
- Throughput
- Delay

Results are presented using Xgraph.

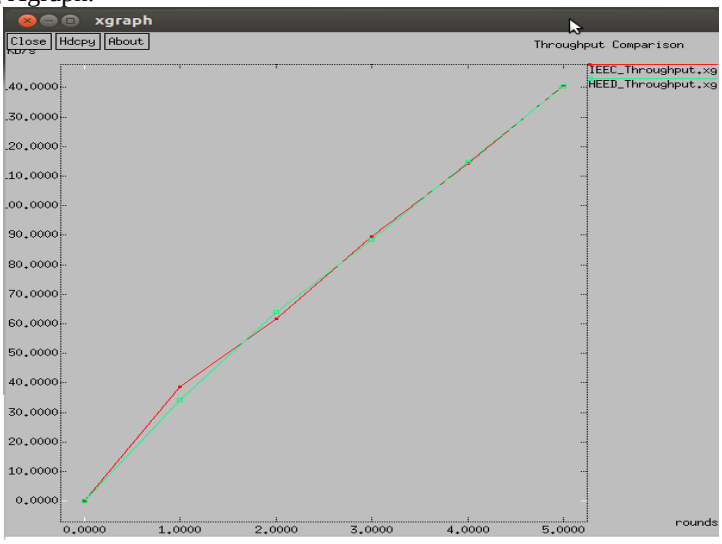


Fig 4 Throughput vs. rounds

 

Throughput is defined as amount of data that is received at the destination node. It is one of the factors that decide the performance of the network. We ran the simulation for 5 rounds and the graph shows the throughput at the destination node after each round. At the end of 5 rounds the throughput variation for the HEED and the proposed method was approximately same as both the methods the value of throughput was about 140kbps.

Table 2 Throughput Comparison

| ROUNDS | HEED THROUGHPUT | IECC THROUGHPUT |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 34 | 39 |
| 2 | 63 | 61.5 |
| 3 | 88 | 89.6 |
| 4 | 114.9 | 114.3 |
| 5 | 140.4 | 140.7 |

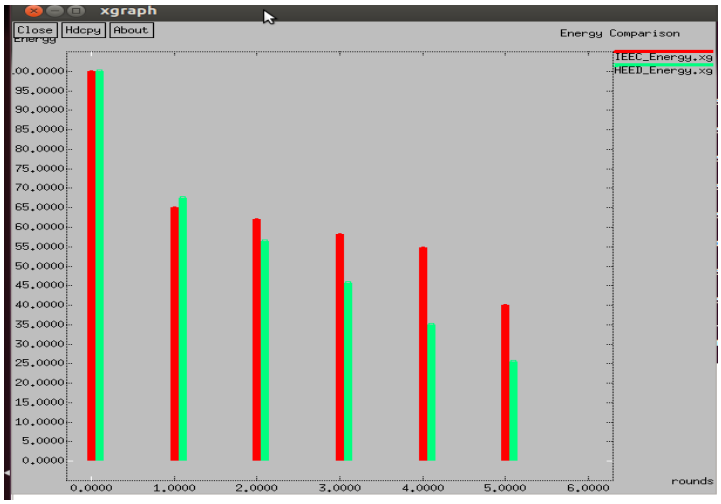


Fig-5 Residual energy vs. rounds

Energy consumption is very important factor which determines the lifetime of network. Lesser the energy consumption, better the performance of the network. In the 5 rounds analyzed for simulation, the proposed scheme performed better as the residual energy of the network was about 40 joules as compared to HEED for which approx 25 joules of energy was left. So the proposed strategy reduces the energy consumption.

Table 3 Energy Comparison

| ROUNDS | HEED ENERGY | IEEC ENERGY |
|---|---|---|
| 0 | 100 | 100 |
| 1 | 67.3 | 65 |
| 2 | 56.2 | 62 |
| 3 | 45.7 | 58 |
| 4 | 34.8 | 54 |
| 5 | 25 | 40 |

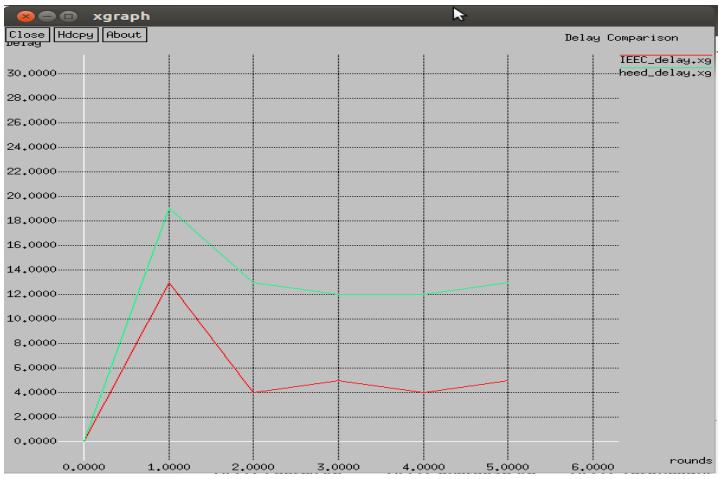


Fig 6 delay vs. rounds

 

For any WSN to have better performance the network must have lesser end to end delay .The proposed strategy proved better as the delay was 5ms which is less than the HEED having 13ms at the end of fifth round.

Table 4 delay Comparison

| ROUNDS | HEED delay | IEEC delay |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 19 | 13 |
| 2 | 13 | 4 |
| 3 | 12 | 5 |
| 4 | 12 | 4 |
| 5 | 13 | 5 |

## VI. CONCLUSION AND FUTURE SCOPE

WSNs are used in many applications of research in these days. In WSN, sensor nodes are organized in sensor fields. In this paper, a method for improving the performance of WSN is proposed which is implemented using HEED. In the existing techniques of clustering, clustering is done all over the nodes even on that places where it is not required which results in unnecessarily consumption of energy. The proposed method lessens this drawback and hence efficient clustering is done to minimize the consumption of energy and minimize the delay. The proposed strategy can be implemented and tested in an environment having mobility of base station to see how the mobility of the base station effect energy consumption in a wireless sensor network and proposed strategy can be implemented on real motes considering their life span.

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