Performance measure of NEAHC Routing Protocol Using k-Means Technique

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Abstract:- A Novel Energy Aware Hierarchical Cluster-Based (NEAHC) Routing Protocol with two goals: minimizing the total energy consumption and ensuring fairness of energy consumption between nodes. Relay node chooses problem as a nonlinear programming problem and use the property of convex function to find the optimal solution. NEAHC is used to extend network lifetime using a combination of a clustering approach and an optimal relay selection algorithm. For instance, first the cluster heads send the advertisement messages to all the nodes asking them to join their cluster. Then, each non-cluster head sends join message to the cluster head and again a third time cluster heads sends the message to the members informing which nodes must be out to the sleep node. So every time, the round changes this process gets repeated leading to so many messages being broadcasted thus leading to higher energy consumption. This method can be replaced by the K-means scheduling where the cluster heads for the subsequent rounds are decided in the initial phase itself. K-NEAHC determines an optimal routing path from the source to the destination by favoring the highest remaining battery power, high network lifetime in multi-hop path, and optimum fairness among sensor nodes

Keywords: NEAHC, Clustering, k-means, Network lifetime.

I. INTRODUCTION

A wireless sensor network (WSN) is a self-configuring network of small sensor nodes communicating among themselves using radio signals and deployed in quantity to sense, monitor and understand the physical world. It is a distributed network and it comprises a large number of distributed, self-directed, tiny, low powered devices called sensor nodes or "motes". Wireless sensor network naturally encompasses a large number of spatially dispersed, petite, battery operated embedded devices that are networked to supportively collect, process and convey data to the users and it has restricted computing and processing capabilities.[1,2]

Motes are small computers which work collectively to form the network. Motes are energy efficient, multifunctional wireless devices. A group of motes collect the information from the environment to accomplish particular application objectives. They make links with each other in different configurations to get the maximum performance. They communicate with each other using transceivers. [3]

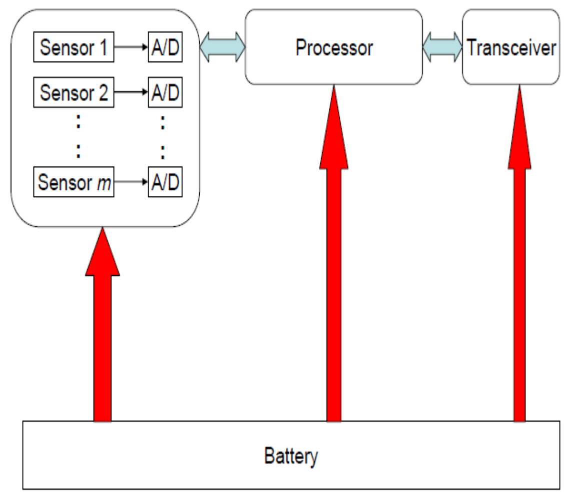


Figure1. Architect of WSN

In wireless sensor network the number of sensor nodes can be in order of hundreds or even thousands. Now a days, wireless network is the most popular service utilized in industrial or commercial applications, because of its technical advancement in processor, communication and usage of low power embedded computing devices. Sensor nodes are used to monitor environmental conditions like temperature, pressure, humidity, sound, vibration, position etc. In many real time applications the sensor nodes are performing different tasks like neighbor node discovery, smart sensing, data storage and processing, data aggregation, target tracking, control and monitoring, node localization, synchronization and efficient routing between nodes and base station.[4] Wireless sensor nodes are equipped with sensing unit, a processing unit, communication unit and power unit. Each and every node is capable to perform data gathering, sensing, processing and communicating with other nodes. The sensing unit senses the environment, the processing unit computes the confined permutations of the sensed data, and the communication unit performs exchange of processed information among 3 neighboring sensor nodes. The basic building block of a sensor node is as shown in the figure 2.

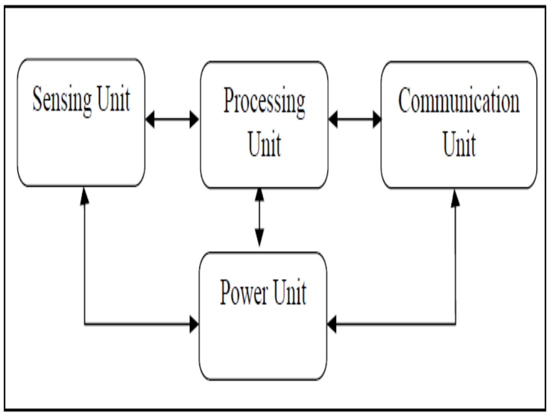


Figure2. Basic building blocks of sensor node

The sensing unit of sensor nodes integrates different types of sensors like thermal sensors, magnetic sensors, vibration sensors, chemical sensors, bio sensors, and light sensors.[5] The measured parameters from the external environment by sensing unit of sensor node are fed into the processing unit. The analog signal generated by the sensors are digitized by using Analog to Digital converter (ADC) and sent to controller for further processing. The processing unit is the important core unit of the sensor node. The processor executes different tasks and controls the functionality of other components. The required services for the processing unit are pre-programmed and loaded into the processor of sensor nodes. The energy utilization rate of the processor varies depending upon the functionality of the nodes. The variation in the performance of the processor is identified by the evaluating factors like processing speed, data rate, memory and peripherals supported by the processors. Mostly ATMEGA 16, ATMEGA 128L, MSP 430 controllers are used in commercial motes. The computations are performed in the processing unit and the acquired result is transmitted to the base station through the communication unit. In communication unit, a common transceiver act as a communication unit and it is mainly used to transmit and receive the information among the nodes and base station and vice versa. There are four states in the communication unit: transmit, receive, idle and sleep.

1.1 CHARACTERISTICS OF WIRELESS SENSOR NETWORK

1. **Fault Tolerance**: Each node in the network is prone to unanticipated failure. Fault tolerance is the capability to maintain sensor network functionalities without any break due to sensor node failures.[8]
2. **Mobility of nodes**: In order to increase the communication efficiency, the nodes can move anywhere within the sensor field based on the type of the applications.
3. **Dynamic network topology**: Connection between sensor nodes follows some standard topology. The WSN should have the capability to work in the dynamic topology.
4. **Communication failures**: If any node in the WSN fails to exchange data with other nodes, it should be informed without delay to the base station or gateway node.[6]
5. **Heterogeneity of nodes**: The sensor node deployed in the WSN may be of various types and need to work in cooperative fashion.
6. **Scalability**: The number of sensor nodes in sensor network can be in the order of hundreds or even thousands. Hence WSN designed for sensor network is supposed to be highly scalable.

II. Related Work

Vishal Gupta et al.[7] displayed H-Leach convention for enhancing the proficiency of remote sensor systems. The progressive conventions are the class of conventions that has the most worry in this field. The normal for these conventions is to bunch the field hubs, in this manner diminishing the overhead for transmissions. In this paper, the creators first segment the total region in the same number of zones as the ideal number of bunches. The convention picks one hub from each zone as the CH of that region based on LEACH criteria in each round. The job of the CH is turned among the hubs of the separate zones in each round to adjust the vitality scattering of the hubs. The part hubs of a specific zone converse with their separate zone bunch head.

Javaid N, Aslam M, Djouani K, et al. [8]proposed an application mindful Threshold-based Centralized Energy Efficient Clustering (ATCEEC) convention for steering in remote sensor systems. The proposed convention expect that every remote sensor hub is equipped for detecting two sorts of ecological elements; temperature and dampness. Task of ATCEEC depends on a propelled focal control calculation, where base station is in charge of determination of bunch heads (CHs). This determination is done based on hubs' leftover vitality, normal vitality of the system and relative separation between the hubs and the base station. ATCEEC accomplishes huge steadiness, broadened arrange lifetime and better power over the system task. The proposed half and half convention is reasonable for both proactive and responsive systems.

Mohammad El-Basioni et al. [9]have perceived the K-implies from the vitality effective bunch based the route venture alluded to as Energy-Aware the route Strategy (EAP) in regards to anticipated life, last, decrease segment, and throughput, and even prompt numerous changes with respect to that to enhance the execution. The explicit created venture presents bigger capacities with respect to bargains decrease, keep going, and furthermore throughput, then again almost no results expected life negatively quality, and utilizing a decent collection procedure diminishes last and even supply misfortunes. Test systems results demonstrated this task impressively outflanks EAP as to supply decrease volume by method for normally 93.4%.

III. K-means CLUSTERING

So as to improve life time of system, clustering approach is embraced. System is partitioned in to different clusters (gathering) containing different sensor hubs as group individuals and a group head. Cluster head transmit accumulated information to the information sink. Bunching sensor hubs is an effective strategy to enhance versatility and life time of a wireless sensor network (WSN).[10] Grouping helps in decreasing the quantity of hubs participating in transmission by presenting cluster head which accordingly lessens correspondence overhead for both single and multi-hop. In WSN arrange is partitioned into clusters, the correspondence between hubs can be intra group. Intra-cluster correspondence includes the message trades between the taking an interest hubs and the CH. Between cluster interchanges incorporates the transmission of messages between the CHs or between the CH and the BS. Bunching plans have focal points, as pursues:[11]

a) Scalability

Since the transmission numbers among the nodes are limited, the number of deployed nodes in the network could be high.

b) Less Overheads

As all cluster individuals just send information to CHs and CHs just send information to base-stations or sinks after information total and combination inside groups, grouping plans can altogether diminish the flooding overheads and diminishing the retransmission of communicate or multicast parcels.

c) Easy Maintenance

After cluster formation, clustering schemes make it easier for network topology control and responding to network changes caused by network dynamics, node mobility, local changes and unpredicted failures. After detecting the changes we need to make the changes only within the individual cluster not in the entire network, so it becomes easy to maintain and manage the entire network.[12]

d) More Robustness

In clustering routing scheme rotation of cluster head makes it increasingly helpful for system topology to control and reacting to arrange changes, containing hub portability and unpredicted disappointments, and so on. A bunching directing plan just needs to deal with these progressions inside individual groups, in this way the whole system is progressively powerful and increasingly helpful for the executives.

e) Load Balancing

Clustering helps in adjusting the heap all through the system by utilizing distinctive grouping topologies stack must be adjusted to expand the system lifetime. To adjust the heap similarly all through the system, cluster estimate is a vital parameter to consider.

f) Less Energy Consumption

Clustering diminishes the energy utilization in the system. Energy utilization is exceedingly diminished by effective choice of group head, in light of the fact that in the clustering not every single hub send their information to the BS rather just CH will transmit the information to the BS.[13]

3.1 K-means Strategy

In the K-means approach, the cluster head selection is based upon three factors. They are node degree, average energy and the minimum path loss factor. The following factors are considered during the cluster head selection. Firstly, calculate the neighbors of each node in the network. The nodes must be in its transmission range. The distance should be calculate using the Euclidean distance formula.

$$\mathbf{distance} = \sqrt{((\mathbf{x_1}-\mathbf{x_2})^2+(\mathbf{y_1}-\mathbf{y_2})^2)}$$

In the node degree, the maximum node degree is having total number of neighbors. For each node, calculate the sum of distances with all of its neighbors. Distance between nodes calculated via Euclidean distance which help in determining the total loss. The average energy of each node can be calculated as

$$\mathbf{EAVG} = \frac{1}{N}\sum_{v \in N_v} E_v$$

Where, E_v is the residual energy of all the neighbor nodes. The position factor POS is calculated using following equation

$$POS_v = \alpha.N_V + \beta.\mathrm{EAVG} + \mu.(1/P_V)$$

Where, α+β+μ=1

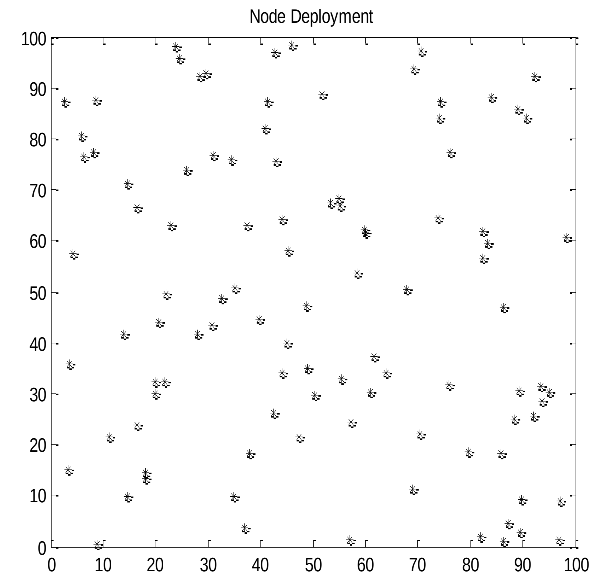
α, β andμ are the weighting factor for the given parameters. Always choose the highest POS as the cluster head.[14]

IV. NEAHC Routing Protocol

A Novel Energy Aware Hierarchical Cluster-Based (NEAHC) Routing Protocol [36] with two goals: minimizing the total energy consumption and ensuring fairness of energy consumption between nodes. Relay node chooses problem as a nonlinear programming problem and use the property of convex function to find the optimal solution. NEAHC is used to extend network lifetime using a combination of a clustering approach and an optimal relay selection algorithm. NEAHC determines an optimal routing path from the source to the destination by favoring the highest remaining battery power, minimum energy consumption in multi-hop path, and optimum fairness among sensor nodes.[15]

V. SIMULATION RESULT

In this simulation environment, the 100 sensor nodes are deployed in the area of (100,100). The MATLAB simulator is used for the given experiment.



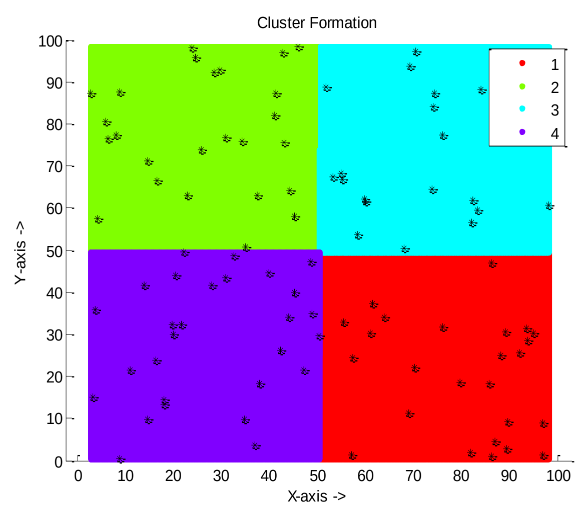


Figure 3: (a) Node Deployment, (b) Cluster formation

The parameters are listed below in the given table. The metrics used for the simulation are:-

- Number of dead nodes
- Number of alive nodes
- Number of packets send to base station
- Number of nodes as a cluster head

Table1:- Simulation Parameters

Parameters	Value
Area(x,y)	100,100
Base Station(x,y)	50,50
Number of nodes	100
Probability	0.1
Initial Energy	0.1J
Transmitter Energy	50 nJ/bit
Receiver Energy	50nJ/bit
Free space Energy(amplifier)	1.0nJ/bit/m^2
Multipath Energy	0.0013nJ/bit/m^2
Number of rounds	3000

Dead Nodes:- This is the graph of dead nodes in NEAHC and K-NEAHC protocol.The network lifetime can be evaluated by using the number of dead nodes. It has been found that the number of nodes die earlier in NEAHC protocol. Here, we can see from the graph that all the nodes are die at the round of 4250 in case of NEAHC nd 5500 in case of K-NEAHC

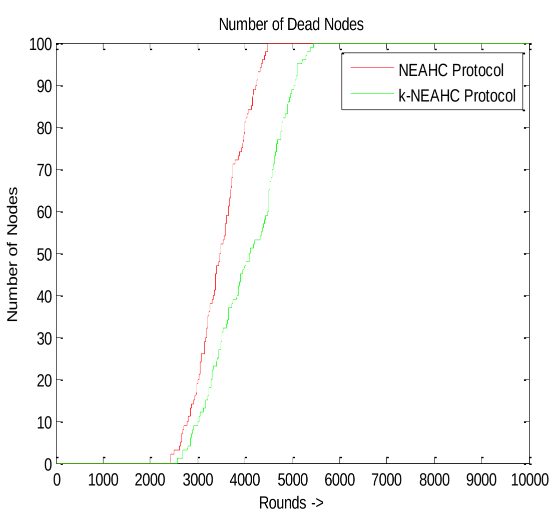


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Figure 4: Dead nodes Vs Rounds

Alive Nodes:- This is the graph of alive nodes in NEAHC and K-NEAHC protocol. It has been found that the number of nodes alive much more in K-NEAHC protocol. Here, we can see from the graph that the nodes are alive at the round of 4250 in case of K-NEAHC and 5500 in case of K-NEAHC.

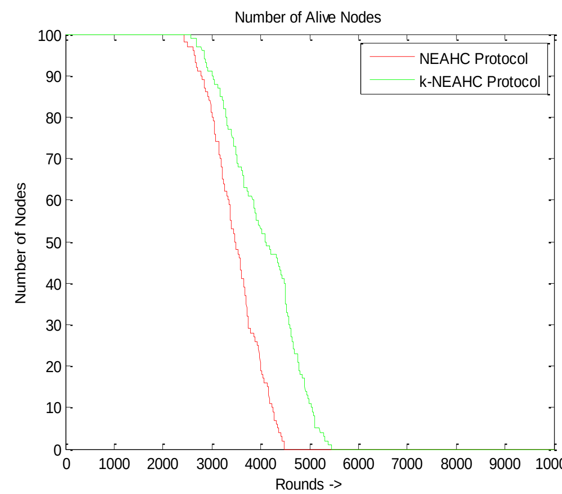

Figure 5: Alive nodes Vs Rounds

Packets Send to base station:-

This is the graph of Packet send to base station after simulation. This graph shows the total number of packets send to the base station by the sensor nodes. Here, from the grapgh we observe that the total number of packets send to base station is 4.5×10^5 in the case of NEAHC protocol and in case of K-NEAHC,the packets send to base station is 9.5×10^5 .

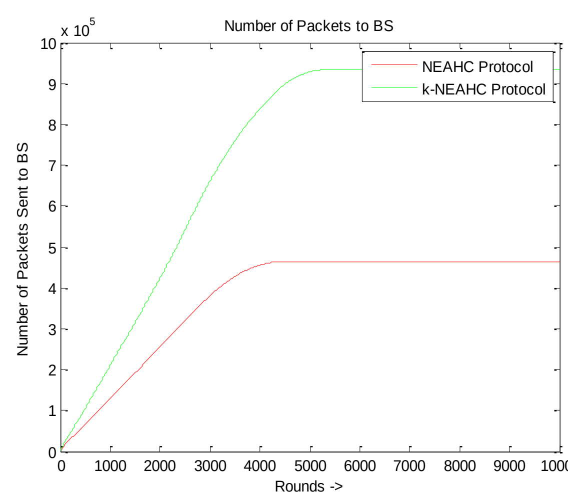

Figure 6: packet send to BS Vs Rounds

Number of nodes as a Cluster Head:-

This is the graph of number of nodes as a cluster head, how much nodes can be select as a cluster head in the network. Here, from the grapgh we observe that more number of cluster heads are selected in the case of K-NEAHC than that of NEAHC.

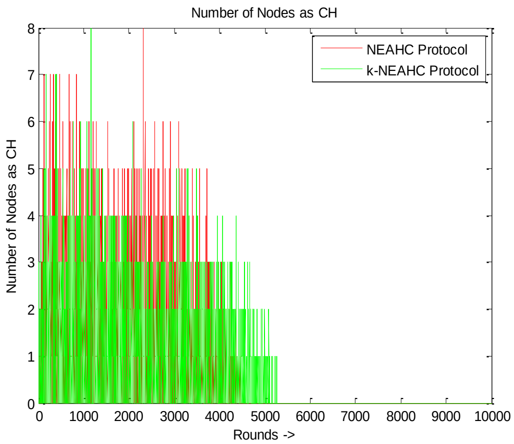

Figure 7: Number of nodes as a cluster head Vs Rounds

VI. Conclusion and future scope

In this paper, we have proposed the K-NEAHC which is an efficient technique. This protocol adopts the selection of path criteria using K-means technique which outperforms NEAHC. In case of dead nodes, all the nodes are die at the round of 4250 in case of NEAHC and 5500 in case of K-NEAHC and the total number of packets send to base station is 4.5×10^5 in the case of NEAHC protocol and in case of K-NEAHC,the packets send to base station is 9.5×10^5 . The proposed protocol shows the better improvement over existing protocol but this work has not taken into account the utilization of 3D WSNs, which are becoming major area of research in these days. Therefore in near future work we will extend the planned technique for 3D WSNs environment.

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