Implication on k-Means Strategy in WSN

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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.

Key words: NEAHC, Clustering, k-Means, Network Lifetime

I. Introduction

Wireless sensor networks are an emerging technology for monitoring physical world .Wireless sensor networks consists of group of sensor nodes to perform distributed sensing task using wireless medium. A wireless network is vast network that links with various physical devices such as server and clients machines along with hardware. Wireless network are broadly categories as wireless local area network (WLAN), wireless personal area network (WPAN), Wireless Metropolitan Area Network (WMAN), Cellular Network, Mobile Adhoc Network and Wireless sensor network etc. Wireless sensor network is one of the part of wireless network, it is also called actuator network. Wireless sensor network (WSN) made up of large number of sensor nodes that interrelated with each other to achieve data aggregation. The wireless sensor networks (WSNs) can be utilized in a wide geographical space to handle physical occurrence with reasonable correctness and consistency. The sensor nodes can observe various entities such as: temperature, pressure, humidity, sunlight, metallic objects, etc.; this monitoring ability can be efficiently used in diverse area such as automation, agriculture, military, and environmental applications. A sensor node is made up of various components like sensors (for sensing something), processor (for processing the data), and transceiver and power units. The sensor nodes are spreaded in a sensor field.[1,2,3] All these dotted sensor nodes has the ability to aggregate information and transmit information to the base station and also the end users. Information is routed back to the end user by multi-hop communications design through the sink. The sink serves as a gateway; it could converse with the task manager node via internet or Satellite.[4,5,6] As we know that while manipulative an efficient routing protocol a sensor node is restricted energy supply, so available energy at that node must be a major constraint. Numerous routing protocols have been planned for WSNs to satisfy energy consumption and efficiency requirement. Efficiency, scalability and lifetime of Wireless Sensor Network can be improved using clustering. In cluster based routing protocols, sensors are separated into different clusters after choosing some nodes as cluster head among them, so that sensor nodes communicate information only to cluster heads and collective information to based station. Clustering is an efficient way to reduce the energy utilization and there expand the life time of the network, doing data aggregation and combination in order to reduce the number of transmitted messages to the Base Station. The Clustering techniques is used in Wireless Sensor Network (WSN) for check the stability, half network time and overall network time.

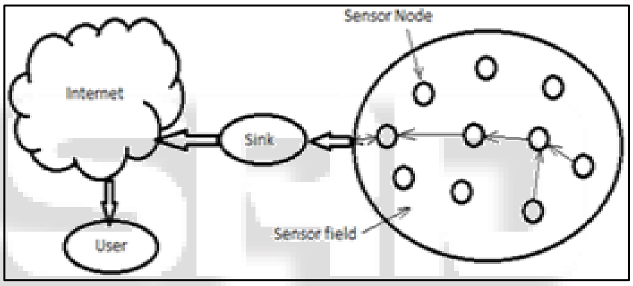

Fig. 1: WSN Environment

II. Features of wireless sensor network

- Dense sensor node deployment Sensor nodes are generally densely established and can be various orders of magnitude higher than that in a mobile adhoc network.[7,8]
- Battery-powered sensor nodes Sensor nodes are generally powered by battery and are placed in a harsh environment where it is very hard to change or give more power to batteries.
- Severe energy, storage constraints and computation Sensors nodes are having very limited storage capabilities, energy, and computation.
- Self-configurable Sensor nodes are usually linearly employed and autonomously design themselves into a communication network.
- Unreliable sensor nodes since sensor nodes are disposed to physical harms or failures due to its placement in harsh or hostile environment.
- Data redundancy in most sensor network application, sensor nodes are closely placed in a region of interest and collaborate to achieve a usual sensing task. Thus, the information sensed by multiple sensor nodes generally has a definite level of correlation or redundancy.
- Application specific a sensor network is generally design and placed for a specific application. The pattern

requirements of a sensor network modified with its application.

- Many-to-one traffic pattern in most sensor network applications, the information sensed by sensor nodes move from multiple source sensor nodes to a particular BS, exhibiting a many-to-one traffic pattern.
- Frequent topology change Network topology modifies usually due to the node damage, failures, addition, energy depletion, or channel fading.
- Heterogeneity of nodes is marked characteristic.

III. K-MEANS CLUSTERING

K-Means algorithm is the easiest algorithm which works on number of iterations. K-means aims to minimize the sum of squared errors. K-means is an unsupervised algorithm in which the number of cluster k are to be fixed before the algorithm starts and likewise the algorithm groups the objects in those predefined clusters. [9,10]

Every cluster has its centroid fixed manually at the initial stage and as per research conducted it should be placed as far as possible from the objects to avoid variations in results. Comparison of all the objects with the cluster centre is carried out and all the objects are made to reside inside the clusters accordingly. When all the data objects are placed in the cluster new centroids for the clusters are calculated. K-means converges faster and the algorithm will converge when no objects changes its cluster position.[11,12]

A. *K-Means Algorithm*

Let dataset D contains various data objects and c=(c1, c2, c3,....,cn) be the group of centres. The algorithm works as:

1) Randomly select the initial centroids 'ci'.
2) Calculate the distance between the clusters centroid and objects using any distance measure.
3) Data object with minimum distance from its centroid is placed in one cluster and accordingly.
4) Repeat the process for all the data points.
5) Recalculate the new cluster centre 'cj' and again calculate the distance of every data point for its centroid.
6) If no further movement among data points terminate the algorithm.[13,14,15]

B. *Pseudo Code for K-Mean Algorithm*

kmeans($X \in \mathbb{R}^{n \times d}, k, C$)

while the any c_j change location do
  for $i \in \{1 \ldots n\}$ do
    $class(x_i) \leftarrow \arg\min_j ||x_i - c_j||$
  end for
  for $j \in \{1 \ldots k\}$ do
    $c_j \leftarrow \sum_i I(class(x_i) = j)x_i / \sum_i I(class(x_i) = j)$
  end for
end while
return C

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.

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.

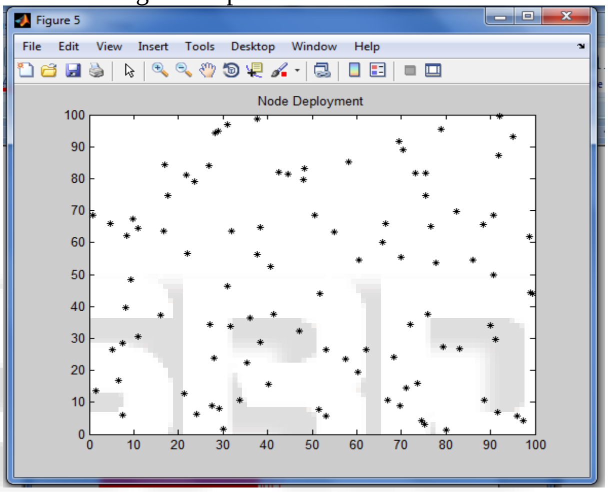

Fig. 2(a): Node Deployment

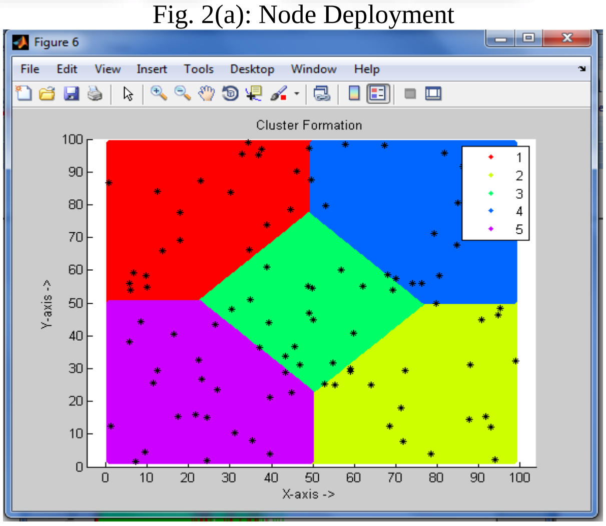

Fig. 2(b): Node Deployment of 5 Clusters

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

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

Table 1: Simulation Parameters

A. 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 4550 in case of NEAHC nd 5580 in case of K-NEAHC .

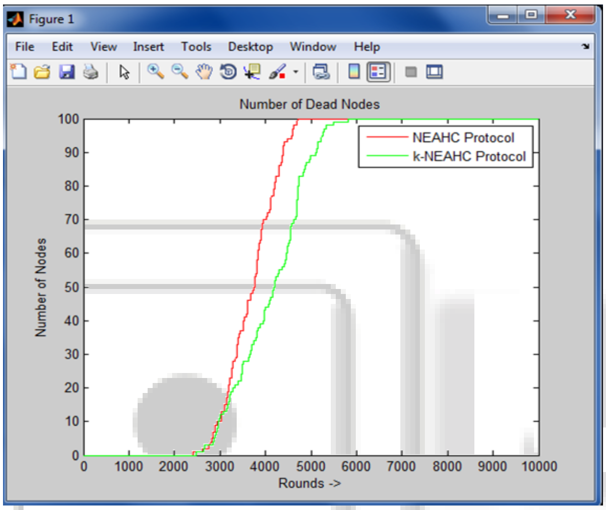

Fig. 3: Dead Nodes Vs Rounds

B. 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 4550 in case of K-NEAHC and 5580 in case of K-NEAHC.

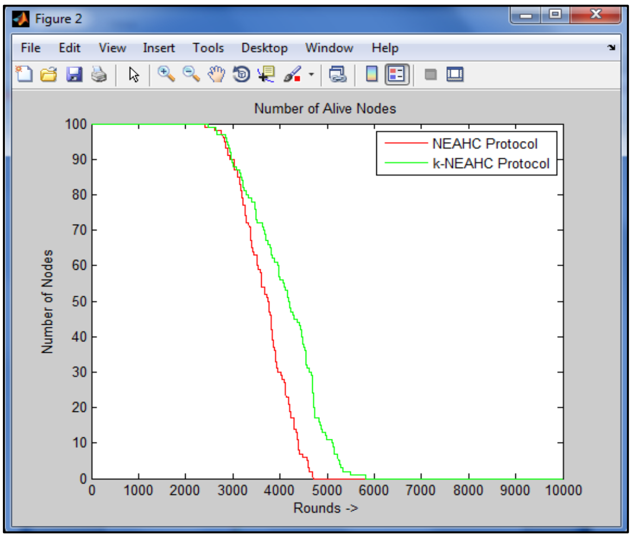

Fig. 4: Alive Nodes Vs Rounds

C. 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 .

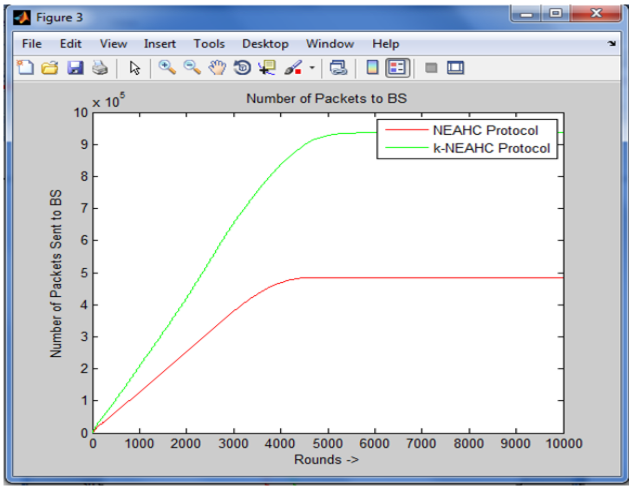

Fig. 5: Packet Send to BS Vs Rounds

1) 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.

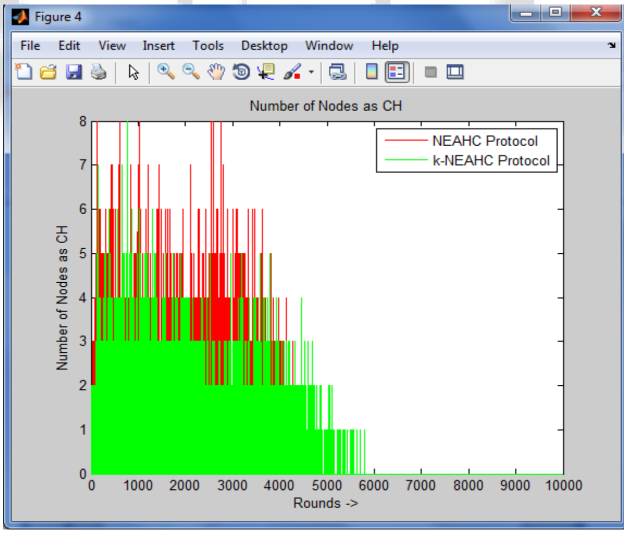

Fig. 6: Number of Nodes as a Cluster Head Vs Rounds

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 large number of variables, K-means computation is very faster. The proposed protocol shows the better improvement over existing protocol in case of dead nodes and throughput 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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