A Protocol for Energy Efficient Mechanism for Wireless Sensor Network with Symmetric Cluster Formation

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***Abstract*—The network scalability may be achieved by grouping sensor nodes into a cluster hierarchy. Cluster head is referred as the leader of every cluster. In order to achieve stable clustering for mobile environment many clustering schemes are used for Wireless Sensor Network. This paper, proposeds an extension to Low Energy Adaptive Cluster Head protocol namely a protocol for energy efficient mechanism for wireless sensor network with symmetric cluster formation which is known as Highest Energy Clustering Hierarchy (HECH) protocol. Mathematical simulation studies show the correctness and effectiveness of the protocol.**

***Index Terms*— Cluster, Routing Protocol, Symmetric Cluster Formation, Wireless Sensor Network**

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are network systems containing sensor nodes. The sensor nodes can sense certain physical characteristic and can be used to capture environmental information such as temperature, motion, sound etc[1]. The Sensor was used to send collected data usually via radio transmitted to a command center (sink) either directly or through a data concentration center(gateway).From the technological advances ,the size and cost of sensor has decreased and stimulate our interest to use large set of not reusable unattended sensors[2] .Such interest motivated intensive research in the past few years addressing the potential of collaborations among sensors in data gathering, processing, coordination , managements of the sensitivity activity and data flow to the sink. In adhoc manner a mutual distributed wireless sensor is designed in a network.

II.TYPES OF ROUTING PROTOCOLS

Many routing protocols such as [3, 4, 5, 6] are planned for wireless sensor networks for the problem of routing. The routing mechanism consists of sensor nodes characteristics along with the application and architecture requirements. Almost all of the routing protocols classified as hierarchical, location-based or Data-centric. In subsequent we consider two popular protocols namely Leach and Pegasis.

A. LEACH

A cluster based protocol is Low Energy Adaptive Clustering Hierarchy (LEACH) [4] protocol. The mechanism of LEACH is rotation of cluster Head in a random way and to evenly distribute the energy load among the sensors in a network. The Cluster heads broadcasts once the clusters are constructed. Time Division Multiple Accessing (TDMA) schedules provide the order of transmission for members in the cluster. Time slot is assigned to each node. Within the exclusive timeslot, data is transmitted to the cluster head by the node. The Cluster head will be elected in the next round randomly once the last node in the schedule has transmitted its data. To improve the scalability, it employs localized coordination and balance the energy usage of the network among all the nodes.

B. PEGASIS

The chin-based power efficient protocol called Power-Efficient Gathering in Sensor information System (PEGASIS) [7] protocol was based on LEACH. The assumption has made that each node must know location information about all other nodes at first. From the base station the farthest node is considered first by PEGASIS. By using a greedy algorithm the chain can be constructed easily. The data is aggregated by chain leader and forwards it to base station. Each node in the chain takes turn to be the leader in order to balance the over head involved in communication between the chain leader and the base station. A self-organizing, adaptive cluster protocol that uses randomization to distribute the energy load evenly among the sensors in the network is the routing algorithm. According to the Algorithm the nodes organize themselves in local clusters. Among them one node is organized itself as local base station or cluster head. The cluster head nodes are not fixed rather this position is self elected at different time intervals in order

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to spread the energy usage over multiple nodes. No extra negotiation is required to determine the cluster heads because each node makes its decision about whether to be a cluster-head independently of the nodes in the network.

III. MOTIVATIONS

Based on receiving signal strength in LEACH clusters will be formed and use local cluster heads to routers and to sink but its disadvantages are that there is no uniformity in the battery levels of the nodes due to random election of the cluster head. Particular part of network may die quickly. We propose HECH protocol by the following papers [8,9,10,11,12,13,14,15,16,17,18]. Our proposed protocol provides a cluster constructing method which avoids the uneven member distribution for clusters and also provides a hierarchical routing scheme between cluster heads and base station.

IV. HECH PROTOCOL:

Our approach is given below.
1. Formation of Cluster (For the first round only)
2. Election of Cluster Head.
3. Communication inside the cluster.
4. Cluster Heads and Base station communications.

The features of the proposed protocol are given below.

- **Formation of Cluster:**
  Uniform Cluster formation taking the position information of nodes into consideration is the main key feature of this protocol and the number of nodes in a cluster is limited to cluster number.

- **Election of Cluster Head:**
  Based on the remaining battery level of the nodes cluster heads will be elected for all cluster and this is not happened in LEACH (There is a random election of cluster heads in LEACH).

- **Communication inside the cluster:**
  Initially all cluster members has same energy levels inside the cluster, after one iteration between nodes there will be a difference in the energy levels. The node with maximum battery level is elected as cluster head. With cluster head as root a rooted tree is constructed. The cost of data transmission is depending on the distance of transmission. Except Cluster head inside a cluster a node sends data to its predecessor and the aggregated data will reach to cluster head finally.

- **Cluster Heads and Base station communications:**

In hierarchical tree manner all cluster Heads communicate each other and the data is forwarded to the base station. Two parameters will be taken into consideration here that is hop-count and energy cost of the path (energy cost is given by the total amount of energy consumed if a particular path is followed.)

Description of Algorithm:

STEP-1 The position of the remaining nodes in the network has in the knowledge of every node and the max number nodes inside a cluster are limited to cluster number.

STEP-2: After completion of the previous step the entire network is divided into number of clusters and each node belongs to one cluster exactly.

STEP-3: The node which has highest battery level is elected as cluster head for that round in each cluster.

STEP-4: With cluster head as root trees are constructed inside the cluster and among the cluster heads with base station as root.

STEP-5: By assuming that each node has data to transmit, they will transfer the data by transmitting to their neighbors towards the root (cluster head) and all the cluster heads sends the aggregated data to their neighboring Cluster Head's towards base station. After this each node has different battery levels then we have to go to STEP-3 for next round.

Pseudo Code for Proposed Clustering Algorithm:

```
main ( )
{
formnodes();
// form 100 random sensor nodes in the xy plane.
formclusters();
 //it will construct the clusters as in STEP-1 of the above algorithm.
electclusterheads();
// Clusters heads will be elected based on the battery levels of the nodes.
formtrees();
// Trees will be constructed with cluster head as root.
processtheschedule();
// Data Transfer Phase.
avgclusterenergy():
 // Analysis of the network.
electclusterheads():
 // Elect cluster heads for the next round.
}
```

V EVALUATION OF HECH

The main features of HECH are
1. Reduction of Energy dissipation.
2. Localized coordination along with Self configuration.
3. Maximum energy is with Cluster Head.
4. Load balanced.

However drawbacks in HECH is given. First, our control messages are more than those in LEACH. Because we want to get more information to construct more evenly distributed topology and the hierarchical

routing tree. The cluster-head in LEACH transmits data to base station directly. Our cluster-heads use hierarchical routing to forward the data to the base station.

VI. Simulation Results and Performance Analysis

Our algorithm is implemented in Glomosim Simulator. Every node in the network belongs to some cluster. Our assumptions regarding simulation are as follows:

- For message passing between any two nodes one unit cost is taken.
- For sending request to joining into a cluster one unit of cost is taken.
- For communication between any two nodes two units of cost is taken.

With these assumptions we simulated our algorithm using Glomosim.

Simulation Parameters:

The various parameters considered for simulation were:

- Network size: The network size is considered as 100X100 m^2.
- Area: The radius of the network is a measure of its area. Nodes are randomly deployed in a given area.
- Hop Count: The maximum hop count between cluster head and any node belonging to the cluster.
- Cluster Number: Maximum number of nodes inside a Cluster.

Performance Metrics:

Our aim is to minimize the energy consumption in clustering a network and uniform cluster distribution for uniform load distribution.

- Energy: The most considerable parameter in cluster formation is energy. We calculated the initial energy of whole network and the energy of the network after processing the schedule, which reflects the energy consumed during communication.
- Cluster Number: The Maximum number of nodes inside a cluster.

First, we will discuss the cluster topology distribution

Fig. 1 shows the cluster distribution of LEACH. We can say that the cluster distribution is not balanced from the figure. For making it balanced we will make our clustering approaches. And Figure-2, Figure-3 show that our clustering approaches. All the Figures show that the cluster topology is more balanced. The clustering becomes more balanced as the number of clusters increases but there is an upper limit for number of clusters, otherwise more energy have to be spend for cluster formation itself. So we consider this and find the optimum value for both number of numbers and cluster number.

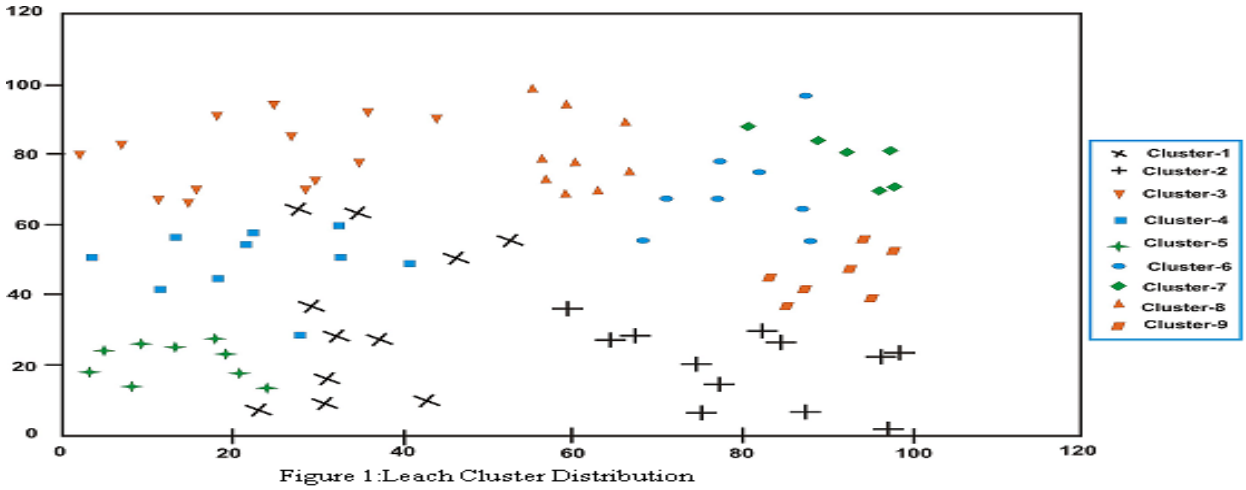

Figure 1 :Leach Cluster Distribution

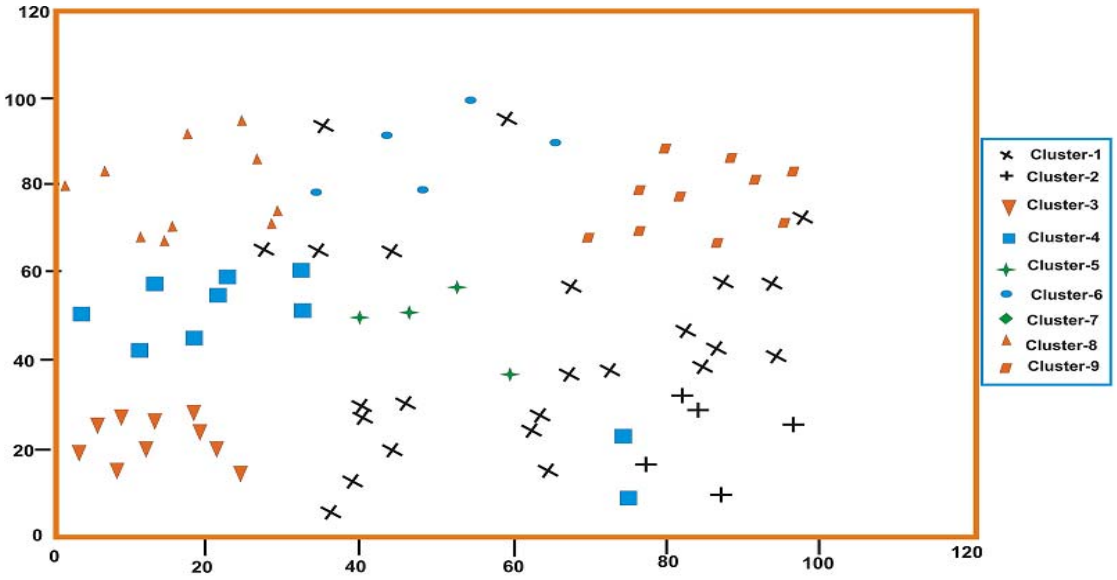

Figure 2:HECH with Cluster Number=12

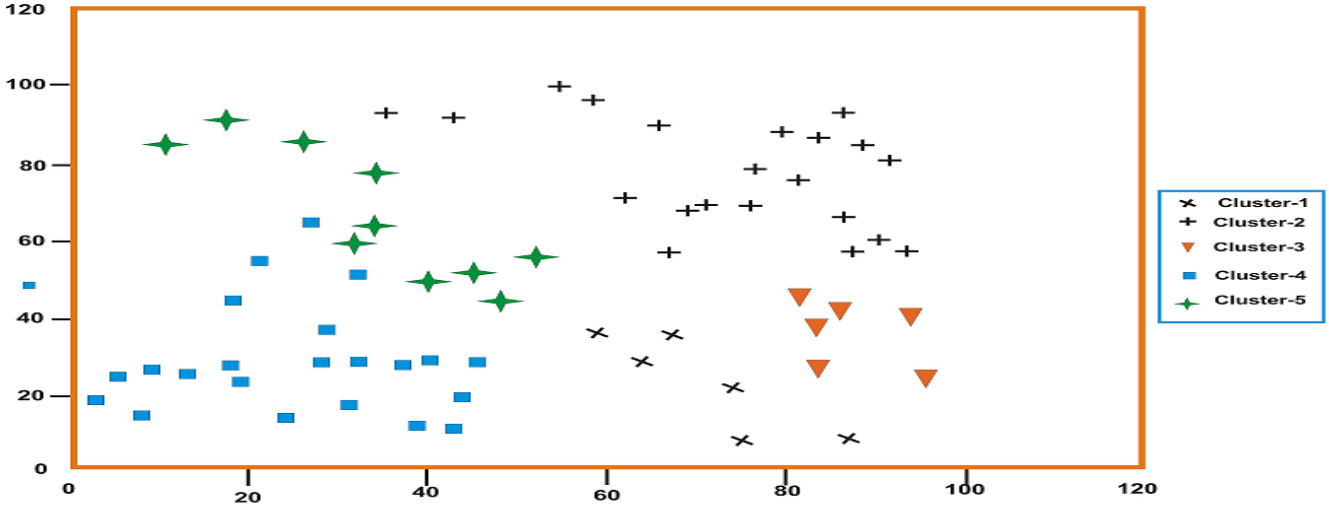

Figure 3:HECH with Cluster Number=15

The following simulation results show that a network containing 9 clusters and the energy levels of each cluster in shown below for both random clustering and HECH. From Fig-4 the average remaining energy per cluster is shown which is more in symmetric clustering than random clustering and at the same time the energy consumed per cluster is more in random clustering.

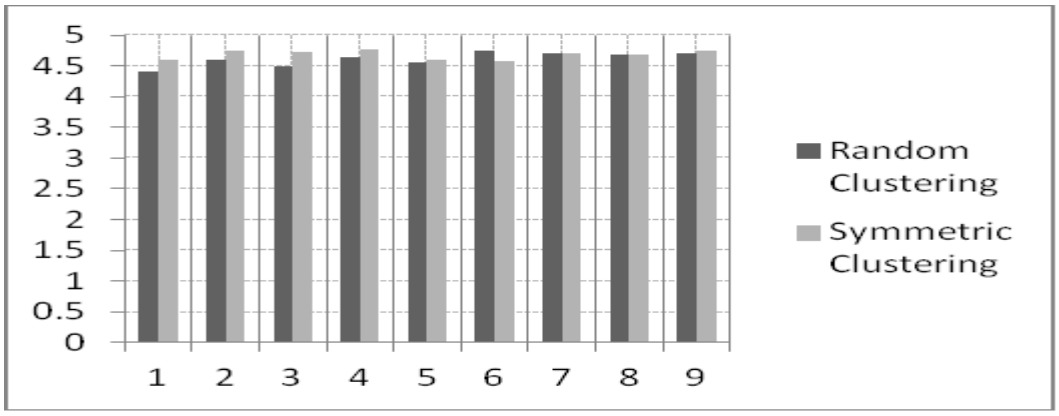

Figure 4:Remaining Energy Levels per Cluster

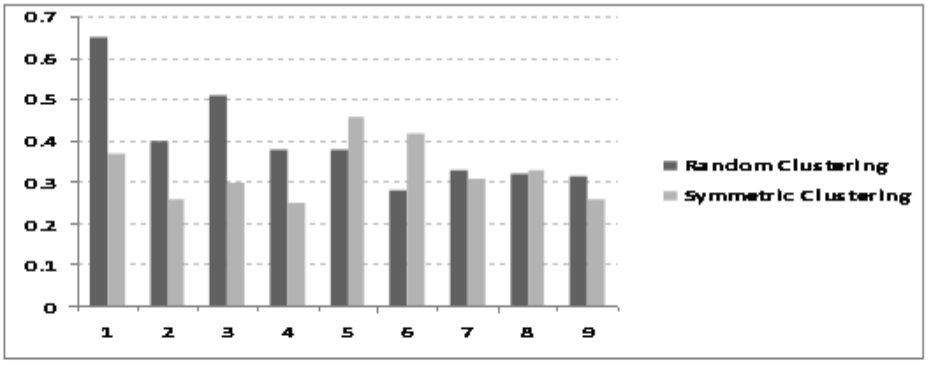

Figure 5:Energy Dissipated per Cluster

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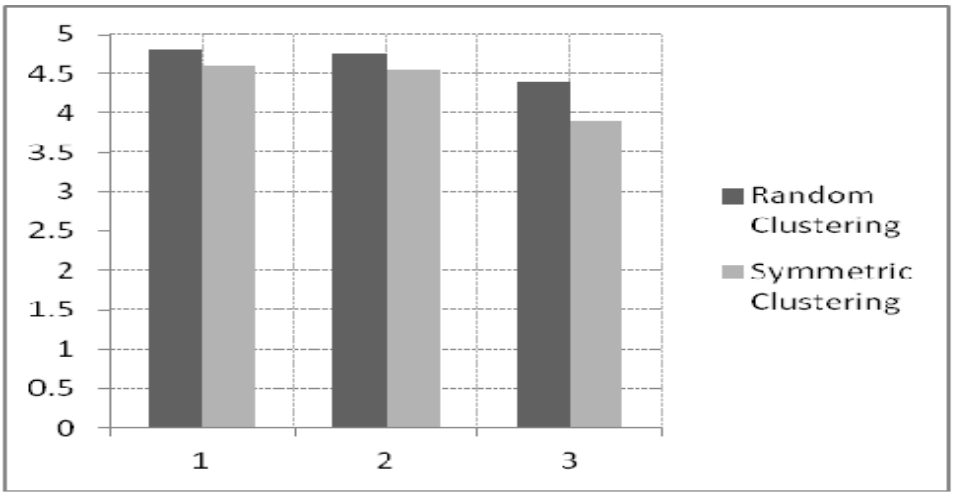

Figure 6:Average Network Energy for Cluster Number=15,12 and LEACH

So our protocol is more efficient in remaining energy than other protocol which we are getting by this simulation results. From figure-5 we will get the energy dissipated per cluster is more in random clustering than symmetric clustering which is shown by the simulation results given below. And the average network energy is compared in the following figure-6 shows average network energy for HECH with 1.CN=15, 2.CN=12 and LEACH .Here we can also see that the number of members in a cluster is an important factor.

VII. Conclusion

Here we proposed a new load balanced and energy-efficient routing protocol HECH outperforms LEACH by a more balanced cluster distribution and by reducing the non uniform cluster topology. It uses the number of cluster members to construct clusters in a certain area. The cluster head for the next round will be elected on the basis of max remaining energy levels of the nodes, so with this cluster topology the network is more energy balanced and net life time of the network increases which shows in the simulation results.

References

[1] Prasant kumar Pattnaik and Rajibmall ,"Fundamentals of Mobile Computing"PHI publication 2012 ,pages 149-169.

[2] Ruay-Shiung Chang and Chia-Jou Kuo. An Energy Efficient Routing Mechanism for Wireless Sensor networks.AINA'06,2006IEEE

[3] Kemel Akhaya and Mohammed younis,"A Survey on energy aware routing protocols in Wireless Sensor Networks".

[4] W.R.Heinzelman, A.Chandrakasan and H.Balkrisnan, "Energy Efficient Communication Protocol for Wireless Micro sensor Networks," Proceedings of the Hawaii International Conference on System Sciences (HICSS), January 2000.

[5] S.K.Padhi, P.K.Pattnaik, B.Puthal,"Review Of Routing Protocols in Sensor and Adhoc Networks", International Journal Of Reviews in Computing, Volume3-2010, page(s)11-17

[6] K. Akkaya, M. Younis, A survey on routing protocols for wireless sensor networks, Elsevier Journal of Ad Hoc Networks 3 (3) (2005),Page(s) 325-349.

[7] Lindesy and C.Raghavendra,"PEGASIS:Power Efficient Gathering in Sensor Information System",Prodeedings of

IEEE Aerospace Conference,Bigsky,Montana,page no.1-6,March 2002.
[8] E.L. Lloyd, Xue Guoliang,"Relay node placement in wireless sensor networks", IEEE Transactions on Computers, Volume 56,Issue 1,2007,Pages:134-138.
[9] Chang Jae-Hwan, L.Tassiulas,"Maximum Lifetime Routing in Wireless Sensor Networks", IEEE/ACM Transactions on Networking, Volume 12,Issue 4,2004,Pages:609-619.
[10] E.L. Lloyd, Xue Guoliang,"Relay node placement in wireless sensor networks", IEEE Transactions on Computers, Volume 56, Issue 1, 2007, Pages: 134-138.
[11] Lusheng-Miao,-karim-Djouani,anish Kurien,G.Noel,"A competing algorithm for gradient based routing protocol in wireless sensor networks",Proceedings of the 2010 Wireless Information networks and Systems(WINSYS),2010,Pages 1-8.
[12] Zheng Rong,"Asymptotic Bounds of Information Dissemination in Power constrained Wireless Networks", IEEE Transactions on Wireless Communications ,Volume 7,Issue 1,2008,Pages 251-259.
[13] Raminder P.Mann,Kamesh R. Namuduri, and Ravi Pendse,"Energy-aware routing protocol for Ad-hoc wireless sensor networks,EURASIP Journal on Wireless Communications and Networking,Vol.5 page(s)635-644,2005.
[14] L.Lin,N.B.Shroff and R.Srikant,"Energy- Aware Routing in Sensor Networks:A Large System Approach,"to appear in Ad Hoc Networks Journal(Elseviar),special issue on Recent Advances in Wireless Sensor Networks 2007.
[15] S.K.Padhi, P.K.Pattnaik,"A novel Distributed protocol For Randomly Deployed Clustered Based Wireless Sensor Network", Journal of Theoretical and Applied Information Technology, Volume15.No.1-2010, pages.39-47
[16] Otgonchimeg Buyanjargal and Youngmi kwon ,"Adaptive and Energy efficient Clustering algorithm for event- driven application in Wireless Sensor Networks(AEEC),"Journal of Networks",Vol.5,No.8,August 2010.
[17] Y.Srinivas,J.Vijayasekhar,Prasad, .R.Satya,Krishna N.Vamsi," Cluster-Id Routing Scheme in wireless SensorNetworks",pageNo.48,volume1,Issue1,IEEE,2011.
[18] Jalil jabari latf,Mehdi Nozad Banab,siavash khorsandi,"A novel Clustered based Routing protocol with extended Life time for Wireless Sensor Networks".IEEE.2008.