IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET)
ISSN(E): 2321-8843; ISSN(P): 2347-4599
Vol. 2, Issue 5, May 2014, 169-178

IMPROVED POWER CONSERVATION THROUGH ENERGY EFFICIENT LEACH PROTOCOL IN WIRELESS SENSOR NETWORKS (IPCEELP)

ABDO SAIF MOHAMMED & M. N. SHANMUKHASWAMY

Department of Electronics and Communication, Sri Jayachamarajendra Colleges of Engineering, Mysore, Karnataka, India

ABSTRACT

In this paper, the LEACH protocol for the WSN have been reported. The main requirements of WSN are to improve the lifetime and energy efficiency of network. Here, our proposed protocol has been improving the lifetime and energy efficiency of WSN network. In this work we focus in the residual energy of sensor nodes to elect the cluster head of any cluster formation. This proposed has given comparative study of three cluster heads called improve to LEACH protocol and HEED on the basis energy efficiency and lifetime.

KEYWORDS: Wireless Sensor Networks (WSN), Cluster Head Election, LEACH and HEED Protocol

I. INTRODUCTION

The wireless sensor network has many sensor nodes; these nodes can forward the information and cooperate with each other to accomplish some specific tasks through the application of communication for wireless self-organization [1]. The application of sensor nodes can be used in many areas, such as the military monitoring, environmental, industry, medical, industry and agriculture [2]. Because the sensor nodes have small size, cost and other factors. Sensor node has a battery with limited bandwidth and the capacity. Usually the sensors are arranged in very bad condition. So we consider about the limited energy of sensors, if we went to design any wireless sensor network protocol. A cluster head is the main issue in WSN, so the many strategies and experiments treys to introduce the optimal cluster head.

Many of clustering algorithms [3], [4], [5] and LEACH [3] is one these algorithms dependent on the Clustering in WSN. LEACH algorithm use randomly strategy to selected cluster-heads (CH), to enhance the lifetime and energy consumption of sensors network. LEACH has many improvement protocols [3] [4] which considering the residual energy of the nodes, to select the cluster head. HEED [6] protocol considers the residual energy and communication cost to select cluster heads. In this work, we compare our proposed, LEACH and HEED Protocols. The remainder of this paper is organized as follows. Section 2 introduces a related work, describes the LEACH and HEEDS protocol in Section 3 and Section 4. Section 5 proposed improvement and extension to LEACH protocol. Section 6 contains performance evaluation of our scheme throughout simulations results and section 7 shows the conclusion.

II. RELATED WORK

In [7], authors discussed advantages of maintenance, scalability and less overheads of wireless sensor network clustering. This proposed depend on eight clustering attributes to classification of wireless sensor network clustering, and then analyzed six clustering algorithms of wireless sensor network clustering, such as LEACH, HEED, PEGASIS, and etc., the authors depend on various attributes to compare clustering algorithms of wireless sensor network.

In [8], discussed some clustering protocols operations and analyzed clustering algorithms advantages and limitations. The authors The studded seven algorithms of WSNs clustering, such as LEACH, TEEN, APTEEN, TL-LEACH, and etc. proposed compared the clustering algorithms of In addition, the survey compared to assemble these protocols in terms lifetime of network and energy consumption.

The authors [9], presented the WSNs clustering algorithms, they discussed the major challenges of clustering algorithms, such as HEED, LEACH and EECS. This proposed considered the residual energy, cluster size, cluster distance and delay as a main metrics to compared clustering algorithms for wireless sensor networks.

LEACH [10] is uses a stochastic model for cluster head selection in WSNs. So the many protocols issue according to leach protocol [11] [12], which is trying to improve cluster head selection based on the residual energy of sensors. Authors in [13], suggest two levels of CHs to optimize its cluster challenging, this proposed called TL-LEACH. HEED [6] uses two parameters residual energy and communication cost to select cluster heads. Also in [14], considered the communication between adjacent nodes to select its two level of CH. Others studied to improve energy by responding to events in the network [15, 16].

In [17], try to reduce the energy consumption in WSN, by uses hierarchical structure to any intra-cluster communication up to 5-levels. They calculate cluster heads and hops optimal number.

III. LEACH PROTOCOL

LEACH is a kind of adaptive algorithm to organize the nodes into cluster, every cluster have one node as cluster head. [18][19][20][21][22][24]. The process is executed in periodical manner; every round consists of two phases: First phase building a cluster head and second phase data communication. In the first phase, close nodes make a cluster dynamically, and one node will be selected as cluster head randomly; in the second phase, every node send their data to cluster head, then cluster head collect the data and sends it to the sink node. The cluster heads consume more energy than ordinary nodes, because heads need to fuse the data and communicate with sink node. LEACH algorithm can ensure that each node in one cluster would be selected as cluster head in equal capability, which makes each node consume energy relatively equally. The requirement of selecting cluster head in LEACH is follows:

Each node produces a random number between 0 and 1, and checks it with the threshold value T (n) if this number is less than T (n), and then this node represents the number chooses as cluster head. When node has been cluster head, then T (n) is set to 0, to let the possibility of other nodes to select is T (n). As the number of nodes which have been cluster head increases, T (n) will increase, so the possibility for the rest of nodes to be selected will increase. When there is only one node left, T (n) =1, which means this node will be selected for sure. T (n) could be defined as follows [23]:

$$T(n) = \begin{cases} \frac{p}{1-p*(r \bmod (\frac{1}{p}))} & ,n \in G \\ 0 & otherwise \end{cases} \quad (1)$$

Where p represents the desired percentage of cluster heads, r represents the current round, and G represents the set of nodes that have not been cluster-head in the last l/p rounds. When the cluster head is selected, it will announce other nodes. Non cluster-head nodes will select a cluster to join with it, according to the distance between them and the cluster heads. When the cluster heads received all messages to share with it, they will produce a message at the time to inform all the nodes in their clusters.

IV. HEED PROTOCOL

Hybrid Energy Efficient Distributed clustering (HEED) [6, 24], is a multi-hop wireless sensor network clustering algorithm that brings an energy-efficient clustering routing with explicit consideration of energy. Different from Leach in the way of elections the cluster head, HEED does not select in the cluster head in randomly manner. Is performed the cluster method based on the hybrid combination of the two parameters. The first parameter depends on the residual energy of the node, and the second parameter is considering the cost of communications within the intra-cluster. Elected cluster head in HEED, depending high average of residual energy compared to MNs. In addition, one of the main objectives for HEED is to get networks with an even distributed cluster heads as follows probability.

$$CH_{prob} = C_{prob} * \frac{E_{residual}}{E_{\max}},$$

Where E residual is represent the node with current residual energy. Emax is representing the maximum energy of battery. The clustering process requires a number of iterations called Niter. Cprob represent the initial percentage of cluster heads among all nodes in the network.

CH prob represent probability of node to become a cluster head. Any iteration i, i < Niter, every uncovered node elects to become a cluster head with probability CHprob. After step i, the set of tentative cluster heads, SCH, is updated and a node vi selects its cluster head to be the node with the lowest cost in SCH. Every node then doubles its CHprob and goes to the next step. If a node elects to become a cluster head, it sends an announcement message where the selection status is set to tentative_CH, if its CHprob is less than 1, or final_CH, if it's CHprob has reached 1.

A node considers itself covered if it has heard from either a tentative_CH or a final_CH. If a node completes HEED execution without selecting a cluster head that is final_CH, it considers itself uncovered, and announces itself to be a cluster head with state final_CH. A tentative_CH node can become a regular node at a later iteration if it finds a lower cost cluster head. HEED protocol depend on residual energy, and communication cost to select cluster head. The communication cost is the minimum power levels required by all nodes within the cluster range to reach the cluster head. The communication cost uses to allow a node that belong to several CHS choose the best one. In HEED protocol each node can join only to one cluster head with one hop only. After a cluster formation, each node can be either elected to become a CH due to a probability or join a cluster according to CH messages.

V. PROPOSED WORK

We proposed improvement and extension to LEACH protocol and compare our proposed with LEACH and HEED. The proposed work is as follows:

Cluster Formation

In this work we divide the network area into three equal regions according to the three optimal cluster numbers. These three Cluster heads use to manage the data aggregated from the sensor nodes in each region and then send it to base station. After the formation of the cluster, the cluster head will consume more energy than others nodes, so to achieve a balance in the levels of energy consumption, we suggest each ordinary nodes and sub cluster transmits a packet and advertises its ID and residual energy level. The cluster head monitors advertisements from its ordinary nodes in its regions

and only one node with highest residual energy level will become as a cluster head in this regions. The others nodes it will become directly ordinary nodes.

Cluster Setup

We proposed the sensor network consist three regions and one node as spire node to the all network. Each region include 32 sensor nodes, so each region has one node as cluster heads and others work as sub cluster heads and ordinary nodes. In this work we build the multi-hops in each region depend on the position of sensors to select it to which region affiliated and sort the sensor nodes in each region as descending depending on residual energy, after sorted the nodes, we divided it to two groups nodes with highest residual energy and lowest residual energy. In each region there two groups one is highest and other is lowest, we select the highest node with residual energy from the highest group as a cluster head and others working as sub cluster according to our sorted before. We select the lowest node with residual energy from the lowest group as a first ordinary node join to the cluster head and others working as ordinary nodes to sub clusters according to our sorted before as lowest residual energy. The spire node in the sensor network has permission to solve the congestion problem in each region.

VI. SYSTEM MODEL

In this paper our proposed protocol was simulated and compared with HEED and LEACH protocol. First Dead shows in Figure 1, Tenth Dead shows in Figure 2, All Dead shows in Figure 3, Packet to CH shows in Figure 4 and Packet to BS shows in Figure 5. All these figures are shown below.

The results can be summarized as follows:

- The first death in our proposed occurs at round 2053 and HEED at round 1495, whereas in case of LEACH the first node dies at round 1075.
- Also the last node death in our proposed occurs much later than the last node death in case of HEED and LEACH.
- The packet delivery ratio in our proposed is more than HEED and LEACH.

Table 1: Statistics Comparison Results of First Dead

Cluster Based Protocols	First Dead
HEED	1495
LEACH	1075
Proposed	2053

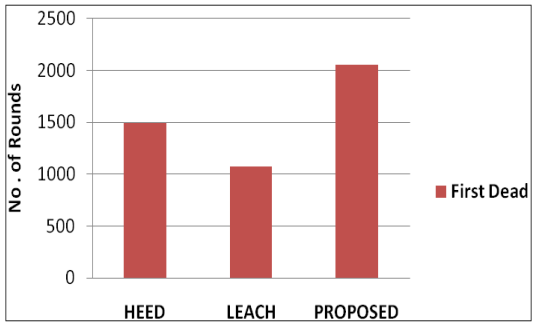

Figure 1: Comparison of LEACH, HEED and our Proposed Protocols with Respect to First Dead

Table 2: Statistics Comparison Results of Tenth Dead

Cluster Based Protocols	Tenth Dead
HEED	1593
LEACH	1337
Proposed	2315

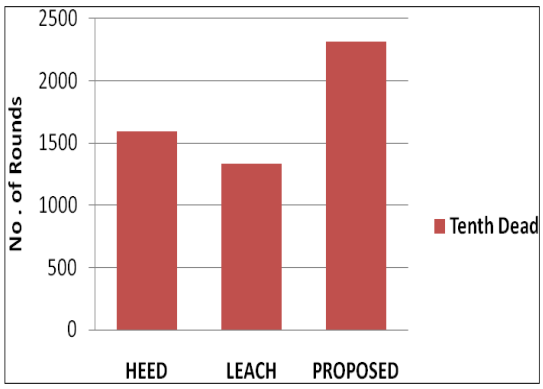

Figure 2: Comparison of LEACH, HEED and our Proposed Protocols with Respect to Tenth Dead

Table 3: Statistics Comparison Results of All Dead

Cluster Based Protocols	All Dead
HEED	3008
LEACH	2496
Proposed	7358

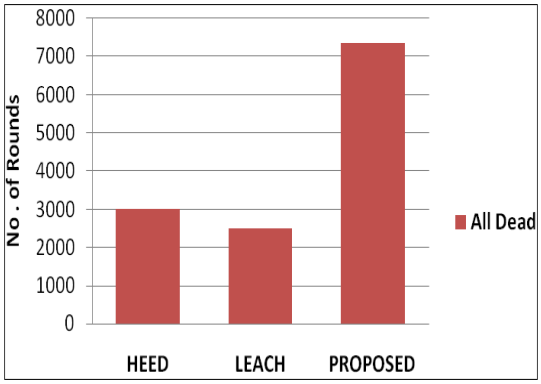

Figure 3: Comparison of LEACH, HEED and our Proposed Protocols with Respect to All Dead

Table 4: Statistics Comparison Results of Packet to CH

Cluster Based Protocols	Packet to CH
HEED	130784
LEACH	158891
Proposed	303458

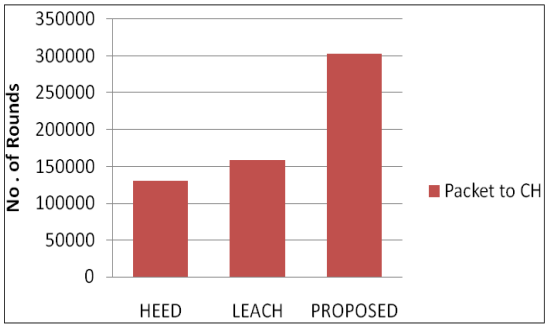

Figure 4: Comparison of LEACH, HEED and our Proposed Protocols with Respect to Packet to CH

Table 5: Statistics Comparison Results of Packet to BS

Cluster Based Protocols	Packet to BS
HEED	73741
LEACH	19361
Proposed	158891

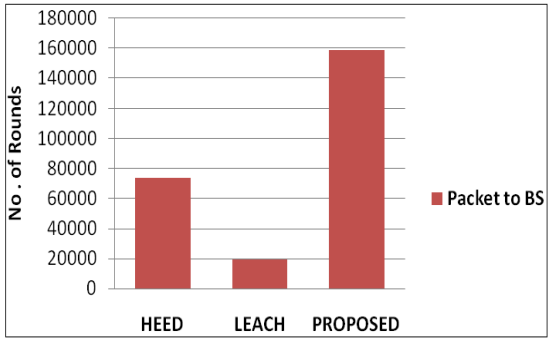

Figure 5: Comparison of LEACH, HEED and our Proposed Protocols with Respect to Packet to BS

VII. CONCLUSIONS

In this work, our proposed which improve LEACH protocol in field of lifetime of sensor network and energy efficient. We observed that our proposed protocol is more energy efficient and lifetime as comparisons to HEED protocol. And the HEED protocol is more energy efficient and lifetime as comparisons to LEACH protocol. While justifying our proposed through simulation results, we have increased the lifetime, energy and number of packet in the wireless sensor network.

ACKNOWLEDGEMENTS

The authors wish to acknowledge J.S.S Research Foundation, S.J.C.E Technical institutions campus, Mysore, Karnataka, India for all the facilities provided for this research work.

REFERENCES

1. Li Xunbo, Li Na, Chen Liang, Shen Yan, Wang Zhenlin, and Zhu Zhibin"An Improved LEACH for Clustering Protocols In Wireless Sensor Networks". 2010 International Conference on Measuring Technology and Mechatronics Automation.

2. Edgar H. Callaway Jr. “Wireless Sensor Networks Architectures and Protocols”. BeiJing: Electronic Industry Press, 2007, pp.2-12.
3. W. Heinzelman, A. Chandrakasan, H. Balakrishnan. "Energy-Efficient communication protocol for wireless microsensor network", Proc. of the Hawaii International Conference on System Sciences, IEEE Computer Society, Washington. DC USA, Jan 2000, pp.3005-3014.
4. S. Lindsey, C. S. Raghavendra, "PEGASIS: Power-Efficient gathering in sensor information systems". In: Proc. of the IEEE Aerospace Conference, Big, Sky, Montana, July 2002, vol.3, pp.1125-1130.
5. A. Manjeshwar and D. P. Agarwal, "TEEN: a routing protocol for enhanced efficiency in wireless sensor networks", In proceedings of the 1st International Workshop on Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, IEEE Computer Society, San Francisco, April 2001, pp.2009-2015.
6. Ossama Younis, Sonia Fahmy, "HEED: A Hybrid, Energy-Efficient, Distributed Clustering Approach for Ad Hoc Sensor Networks," IEEE Transactions on Mobile Computing, vol. 03, no. 4, pp. 366-379, Oct., 2004.
7. Jiang, C.; Yuan, D.; Zhao, Y. Towards Clustering Algorithms in Wireless Sensor Networks— A Survey. In Proceedings of IEEE Wireless Communications and Networking Conference, Budapest, Hungary, 5–8 April 2009; pp. 1–6.
8. Lotf, J.J.; Hosseinzadeh, M.; Alguliev, R.M. Hierarchical Routing in Wireless Sensor Networks: A Survey. In Proceedings of 2010 2nd International Conference on Computer Engineering and Technology, Chengdu, China, 16–18 April 2010; pp. 650–654.
9. Boyinbode, O.; Le, H.; Mbogho, A.; Takizawa, M; Poliah, R. A Survey on Clustering Algorithms for Wireless Sensor Networks. In Proceedings of 2010 13th International Conference on Network-Based Information Systems, Takayama, Japan, 14–16 September, 2010; pp. 358–364.
10. W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, “An Application-Specific Protocol Architecture for Wireless Microsensor Networks,” IEEE Transactions on Wireless Communications, vol. 1, no. 4, pp. 660–670, October 2002.
11. M. J. Handy, M. Haase, and D. Timmermann, "Low energy adaptive clustering hierarchy with deterministic cluster-head selection," in Proc. 4th IEEE International Workshop on Mobile and Wireless Communications Network (MWCN '02), pp. 368-372, Stockholm, Sweden, September 2002.
12. I. Saha Misra, S. Dolui and A. Das, “Enhanced-Efficient Adaptive Clustering Protocol for distributed sensor networks”, ICON 2005.
13. Loscri' V., Marano S., Morabito G., "A Two-Levels Hierarchy for Low-Energy Adaptative Clustering Hierarchy (TL-LEACH).". Proceedings "VTC2005", Dallas (USA), pp. 1809-1813, Sept, 2005.
14. Junpei Kamimura and Naoki Wakamiya and Masayuki Murata, “Energy-efficient clustering method for data gathering in sensor networks,” in Proceedings of First Workshop ON Broad-band Advanced Sensor Networks and October 2004.

15. A. Manjeshwar and D. P. Agrawal, “An Efficient Sensor Network Routing Protocol (APTEEN) with Comprehensive Information Retrieval,” Proc. Second Int'l Workshop Parallel and Distributed Computing Issues in Wireless Networks and Mobile Computing, Apr. 2002.
16. Zengwei Zheng, Zhaohui Wu, and Huaizhong Lin. An Event-Driven Clustering Routing Algorithm for Wireless Sensor Networks. Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems. Sendai, Japan, Sep. 28 - Oct. 2, 2004.
17. S. Bandyopadhyay and E. Coyle, “An Energy-Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks”, in Proceedings of IEEE INFOCOM, April. 2003.
18. M. J. Handy, M. haase, D. Timmermann. Low energy adaptive clustering hierarchy with deterministic cluster-head selection[C]. Proc. of the 4th IEEE Conf. on Mobile and Wireless Communication Network, Stockholm, 2002: 368~372.
19. P. Tillapart, T. Thumthawatwon, P. Pakedeepinit, T. Yeophantong, S. Charoenvikrom, J. Daengdej. Method for cluster heads selection in wireless sensor networks[C]. Proc. Of the 2004 IEEE Aerospace Conference, Chiang Mai, 2004:3615~3623.
20. W. Heinzelman, A. Chandrakasan and H. Balakrishnan, "Energy-Efficient Communication Protocol for Wireless Micro-sensor Networks," Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS '00), January. 2000.
21. Abdo Saif Mohammed, M.N. Shanmukhaswamy "A Novel Algorithm to Select Cluster Heads with Highest and Balanced Energy in Wireless Sensor Networks” International Journal of Computer Applications (0975–8887) Volume 54– No.4, September 2012.
22. Abdo Saif Mohammed, M.N. Shanmukhaswamy “New Algorithm for Optimized Cluster Heads with Failure Detection and Failure Recovery to Extend Coverage of Wireless Sensor Network” International Journal of Scientific and Research Publications, Volume 2, Issue 21, Oct 2012, ISSN 2250-3153.
23. Udit Sajjanhar and Pabitra Mitra. Distributive energy efficient adaptive clustering protocol for wireless sensor networks. In: Proceedings of IEEE International Conference on Advanced Information Networking and Application, 2006.
24. Pawan Kocher, Simarpreet Kaur, Niranjan Yadav “CLUSTER BASED ENERGY EFFICIENT PROTOCOL FOR WIRELESS SENSOR NETWORK” International Journal of Research in Engineering & Applied Sciences, http://www.euroasiapub.org

AUTHOR'S DETAILS

Mr. Abdo Saif Mohammed. Completed his B.Sc. degree in Computer Science & Information System from University of Technology-IRAQ in the year 2001, M.Sc. in Computer Communication from Bharathiar University-India in the year 2009. And He is presently working as Assistant Professor in the Department of Computer Science, Thamar University Yemen, Dhamar, Yemen. He is doing his Ph. D in the area of Wireless sensor networks under the guidance of Dr. M.N Shanmukhaswamy. His field of interest includes Wireless sensor networks, Analog and mixed mode VLSI circuits, Control systems, Digital signal processing.

Dr. M. N. Shanmukha Swamy. Completed his B.E. degree in Electronics and Communication from Mysore University in the year 1978, M.Tech in Industrial Electronics from the same university in the year 1987 and obtained his Ph.D in the field of Composite materials from Indian Institute of Science, Bangalore in 1997. He is presently working as Professor in the Department of Electronics and communication, Sri Jayachamarajendra college of Engineering, Mysore, Karnataka, India. He is guiding several research scholars and has published many books & papers both in National & International conferences & journals. His research area includes Wireless Sensor Networks, Biometrics, VLSI and composite materials for application in electronics.