Advances in Wireless and Mobile Communications.
ISSN 0973-6972 Volume 10, Number 5 (2017), pp. 949-959

http://www.ripublication.com

Performance Enhancement and Analysis of MODLEACH Routing Protocol in WSNs

Ms. Neha Bhadu
M.Tech, Dept. of CSE, Mody University of Science and Technology, Sikar, Rajasthan, India.

Dr. Uma Kumari
Assistant Professor, Dept. of CSE, Mody University of Science and Technology, Sikar, Rajasthan, India

Abstract

Wireless Sensor Networks (WSNs) have been organized for a scope of aspects that includes information collection, security, armed applications and many more. The biggest challenge amongst the existing difficulties of this system is yet to be dealt i.e., the absence of energy efficiency which degrades the systems lifetime. Several energy efficient protocols have been originated amongst which LEACH is the primary one. MODLEACH (Modified LEACH) is an enhancement over LEACH protocol. It introduced two new techniques namely efficient cluster head replacement scheme and dual transmission power levels to diminish energy utilization. However, this protocol like several others has not taken into consideration the influence of parameters p (probability of becoming a cluster head) on the performance of the network. So, iMODLEACH (Improved MODLEACH) which can be called as the extension to the MODLEACH have been proposed in the paper. Further, mathematical analysis has been done to select nominal value of probability (p) for various sensor network applications. Simulations are performed using MATLAB (R2013a) to verify the mathematical results obtained. Finally, the comparative analysis demonstrates that iMODLEACH outperforms MODLEACH in terms of network lifetime and packets transferred to the base station.

Keywords: Wireless Sensor Networks, Clusters, Cluster Head, LEACH, MODLEACH, iMODLEACH

I INTRODUCTION

Wireless Sensor Networks (WSNs) offers special advantages and flexibility in case of low-power and low-cost fast deployment for applications which don't require human regulation. Nodes in WSNs are normally battery operated detecting tools with constrained energy resources. Accordingly energy effectiveness is a standout amongst the all vital issues and outlining power-efficient protocols is important for delaying the lifetime. WSNs at times are measured for specific conditions with constrained power, consistent data transfer, small range communication, and sensibly less price such detecting applications [1].

Numerous energy-efficient routing protocols are planned in light of clustering structure. The clustering strategy can likewise used to execute information collection, which joins information from source nodes into set of significant data [2].

Several protocols have come into existence with the advancement of this area where TEEN, DEEC [2], LEACH [3], SEP and PEGASIS are few of them. LEACH, among them, turned more encouraging and a bench-mark in the outlining of various protocols where Enhanced LEACH [4], LEACH-CC [5], Ad-LEACH [6] and MODLEACH [7] get counted.

In this study, MODLEACH is considered as a reference protocol and parameter like p is measured to additional boost the performance of the MODLEACH. We varied the estimations of p, and dissected its impact on the executed system numerically and then confirmed those using assistance of simulations. The outcomes plainly reveal that iMODLEACH beats MODLEACH when network lifetime and packets exchanged to base station are considered.

II RELATED WORK

Heinzelman, et.al [8] presented a clustering algorithm, named as Low Energy Adaptive Clustering Hierarchy (LEACH). It divides the system into fixed or variable size clusters by utilizing a disseminated algorithm. The entire processing of LEACH gets executed in various rounds. Clusters are structured for every individual round which gets initiated with a setup phase, followed by a steady-state phase where exchange of data from nodes to cluster heads and base station takes place.

In [9], authors have projected a clustering routing protocol named after Enhanced LEACH, which augmented LEACH protocol by adjusting energy utilization. Their simulation result speaks that Enhanced LEACH do better than LEACH in terms of lifetime and power consumption minimization.

Over again in [10], a low energy-consumption chain-based routing protocol LEACH-CC was proposed. The new protocol is portrayed by each node will send data about its present location and energy level to base station. Base station runs the simulated annealing algorithm to decide the clusters for that round. A chain routing is set up between clusters to decrease the amount of nodes which converse with the base station. The experimental results demonstrate that LEACH-CC outperforms in provisions of network lifetime and energy efficiency.

In [11], they have presented an Ad-LEACH static clustering based heterogeneous routing protocol where a technique of selecting a cluster head is embraced from DEEC. Both the protocols LEACH and DEEC are updated in case of energy effectiveness and throughput.

In [12], D.Mehmood et.al has projected a protocol MODLEACH by initiating two new techniques i.e. efficient cluster head substitution scheme and dual broadcasting power levels. Simulation consequences reveal that MODLEACH is much better than LEACH when lifetime of the network, formation of cluster head and throughput are considered.

In [13], here a Hybrid Energy proficient Reactive protocol is introduced. Mainly, it tries to lengthen lifetime of the network by minimized transmissions in a heterogeneous environment. In [14], here a routing mechanism has been introduced which operates the network in a manner that the lifetime is improved because of their energy hole removal mechanism. Whereas, in [15], tended to the issues identified with throughput capitalization and delay minimization, and recommended a linear programming based solution.

Moreover, in [16] authors directed a thorough study on the assessment of LEACH dependent clustering protocols, while, scalability and traffic constraints are considered for evaluation of routing protocols in [17].

III PROBLEM DEFINATION

Several kinds of LEACH have bounced up since its origin and each individual has demonstrated certain changes in various characteristics and parameters of LEACH.

MODLEACH [12] has not considered the part of p on the protocol performance, essentially the network stability, packets transferred and so forth. It assigned fixed value to parameter p. However, it is found that altering the estimations of p unquestionably demonstrates extensive enhancements in the network performance.

Here, certain numerical investigation was done to discover the role of parameter p and to think of certain ostensible values which needs to be chosen while considering the networks application sphere.

IV PROPOSED iMODLEACH PROTOCOL

In this section, iMODLEACH protocol is discussed in depth. It is largely dependent on MODLEACH which itself turn to be a motivation of LEACH protocol. In this study, the imperative parameter p is considered and its influence on the networks net performance is examined and analyzed, both logically and with the help of simulation.

MODLEACH used fixed standards for probability by assigning it value as p=0.1. After that certain variations are made in the value of parameter p and studied its impact on the network performance and different parameters.

Sensor networks performance is very receptive to p. The value of p is varied from range 0.1 to 0.9, based on which different tests were carried out in MATLAB and readings noted are listed below:

TABLE 1

Variation of p and its effect on Stability and Network Lifetime

P	**Maximum Rounds Traversed**	**Packets sent to Base Station**	**Packets sent to Cluster Head**	**First Dead Node at Round**
0.1	1095	6985	55300	160
0.2	1286	11580	44640	78
0.3	1374	16940	38880	61
0.4	1527	20060	39210	51
0.5	1536	24430	24260	36
0.6	1640	22460	22120	35
0.7	1825	32890	14070	26
0.8	1930	32720	8037	22
0.9	2120	32960	3716	21

With the help of results obtained, we can deduce that on selection of a particular value of p, there is a trade-off between the maximum round traversed and the first dead node of the network. Henceforth we arrive at the following conclusions:

1. Probability of choosing a cluster head is directly proportional to the maximum rounds traversed of a network and packets transmitted to the Base Station.

2. Probability of choosing a cluster head is inversely proportional to the first dead node of the network and packets transmitted to Cluster Heads.

The experiments were conducted by positioning the sink at the origin, at x-axis, at y-axis, in the middle of the network and so on. The results obtained are shown in table 2 below:

TABLE 2

Variation of Sink Position and its effect on Stability and Network Lifetime

Sink Position	**Packets Sent to BS**	**Packets Sent to CH**	**First Dead Node at Round**	**Maximum Rounds Traversed**
[0,0]	4612	17690	15	1316
[0,400]	5586	14820	10	1403
[200,200]	7233	55440	148	1241
[400,0]	5329	14130	11	1452
[400,400]	5272	11440	12	1576

The results clearly signify that the good outcomes are obtained for sink positioned in the middle and worst for sink at the origin. The rest outcomes lie among these two extremes.

Consequently, considering all these results obtained, the value of parameter p can be adjusted appropriately and definitely the performance of the MODLEACH is remarkably improved for various environments of applications.

V SIMULATION

The mathematical analysis was further verified using simulations with 100 nodes, randomly distributed across the sensor field having dimensions 400m X 400m using MATLAB (R2013a) tool.

TABLE 3

Network Parameters

Network Parameters	**Values**
Type of Distribution	Random
Initial Energy of Sensor Nodes	0.5 J
Sink Position	[200,200]

Packet Size	4500 bits
Maximum number of rounds	2500
Transceiver idle state energy computation	50nj/bit
Data Aggregation Energy	5 nJ/bit/report
Amplification energy (Cluster to BS)d>=do	10 pJ/bit/m2
Amplification energy (Cluster to BS)d<=do	0.0013 pJ/bit/m2
Amplification energy (Intra cluster communication),d>=d1	Efs/10=Efs_1
Amplification energy (Intra cluster communication),d<=d1	Emp/10=Emp_1

A. Influence of varying Probability p on different Network Parameters

1. Cluster Head Formation

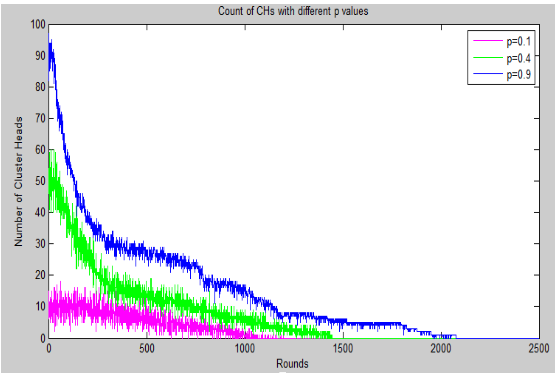

Fig. 1 Count of Cluster Heads formed for different values of p

The plot in fig.1 visibly signify that for p=0.1, the cluster heads formed are too less while it is too large for p=0.9 (approx reaching 90 during the first 200 rounds); a number too large which can put in a lot to the utilization of energy; for this reason a nominal value for the determination of p for a practical generation of cluster heads is p=0.4.

2. Alive Nodes

Stability period of a network is defined as the death of the first node once the network starts its functionality.

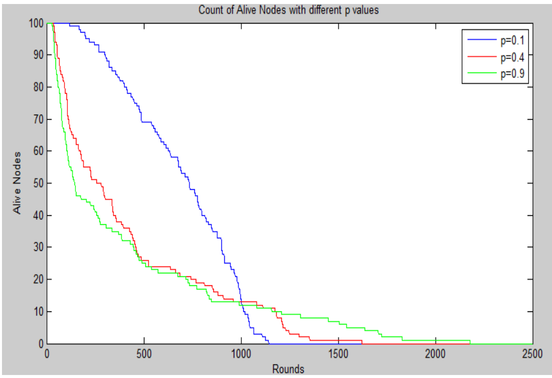

Fig.2 Count of Alive Nodes for different values of p

The graph in fig.2 is plotted by changing the values of p. For p=0.1, the stability period is reasonably better however, the network dies quite early at about 1095 rounds. For p= 0.9, the stability is relatively less but the final rounds are going equal to 2120 rounds, while for p=0.4, we get intermediary, adequate and good enough values in terms of maximum rounds traversed and stability period of the network.

3. Packets to Base Station

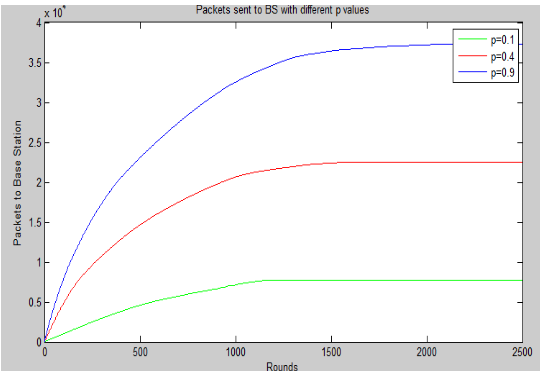

Fig.3 Packets Transmitted to Base Station for different values of p

The plots in fig.3 visibly reveal that with the increasing value of p from 0.1 till 0.9, the number of packets sent to base station is progressively rising.

4. Packets to Cluster Heads

The plot in fig.4 signifies that with increase in the value of p from 0.1 to 0.9 the packets sent to cluster heads goes on decreasing sharply.

There are trade-offs between different parameters involved with the variations in the value of p. Therefore such value of p should be chosen which can balance other parameters as well.

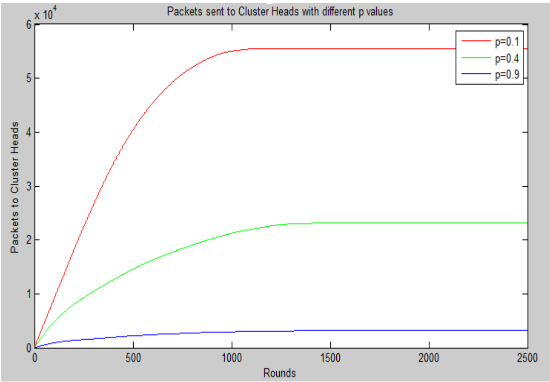

Fig.4 Packets Transmitted to Cluster Heads for different values of p

C. Comparative Study

Comparison among the variants of LEACH routing protocol i.e. MODLEACH and iMODLEACH are done by taking into account the following two performance metrics:

1) Network Lifetime

The time for the first node or a certain percentage of sensor nodes to run out of power is called lifetime of the network. Considering network lifetime of MODLEACH and iMODLEACH we observe that in case of iMODLEACH the first node dies early in comparison to MODLEACH however, the network keeps alive for greater number of rounds in iMODLEACH.

TABLE 4

Comparison of MODLEACH and iMODLEACH on the basis of network lifetime

Routing Protocol	**Round**	
	First Dead Node	**Last Dead Node**
MODLEACH	160	1095
iMODLEACH	100	1497

2) Throughput

It can be defined as average rate of successful packet delivery. Sometimes throughput is based on the network lifetime but this is not the case always.

TABLE 5

Comparison of MODLEACH and iMODLEACH on the basis of Packets Transmitted to Base Station

Routing Protocol	Packets Transmitted to Base Station
MODLEACH	6985
iMODLEACH	20060

It can be clearly observed that the number of packets transmitted to base station is significantly greater in iMODLEACH as compared to MODLEACH. So, we can say that iMODLEACH gives better throughput in terms of packet delivery.

So, the above assessment shows that iMODLEACH performs much better then MODLEACH in terms of network lifetime, and throughput performance metrics.

CONCLUSION

In this paper, we have introduced iMODLEACH protocol which is an enhancement to the MODLEACH protocol. Simulation results signify that iMODLEACH beats MODLEACH in terms of network lifetime and packets transferred to base station. Therefore, taking into consideration all these facts and figures, we can appropriately adjust the value of parameters p and undoubtedly the performance of the iMODLEACH is significantly enhanced for different environments of applications. In future, we are interested to implement iMODLEACH for heterogeneous environment.

REFERENCES

[1] Ouadoudi Zytoune, Youssef Fakhri and Driss Aboutajdine,” A Balanced Cost Cluster-Heads Selection Algorithm for Wireless Sensor Networks”, World Academy of Science, Engineering and Technology 28 2009.

[2] Qing, Li; Zhu, Qingxin; etc. “Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks”, Computer Communications, August, vol. 29, no.12, pp.2230-2237, 2006.

[3] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan.“Energy-Efficient Communication Protocols for Wireless Microsensor Networks”. In Proceedings of Hawaiian International Conference on Systems Science, January 2000.

[4] A.Koucheryavy, Ahmed Salim, and Walid Osamy, “Enhanced LEACH Protocol for Wireless Sensor Networks”, St. Petersburg University of Telecommunication, 2009.

[5] Baiping Li1, a, Xiaoqin Zhang, “Research and Improvement of LEACH Protocol for Wireless Sensor Network, International Conference on Information Engineering, 2012.

[6] A. Iqbal, M. Akbar, N. Javaid, S.H. Bouk, M. Ilahi, R. D. Khan, "Advanced LEACH: A Static Clustering-based Heteroneous Routing Protocol for WSNs", J. Basic. Appl. Sci. Res., 3(5)864-872, 2013.

[7] D. Mahmood, N. Javaid, S. Mehmood, S. Qureshi, A.M. Memon, T. Zaman, “MODLEACH: a variant of LEACH for WSNs 26th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE2013), Regina, Saskatchewan, Canada, 2013.

[8] W. Heinzelman, A. Chandrakasan, and H. Balakrishnan.“Energy-Efficient Communication Protocols for Wireless Microsensor Networks”. In Proceedings of Hawaiian International Conference on Systems Science, January 2000.

[9] A.Koucheryavy, Ahmed Salim, and Walid Osamy, “Enhanced LEACH Protocol for Wireless Sensor Networks”, St. Petersburg University of Telecommunication, 2009.

[10] Baiping Li1, a, Xiaoqin Zhang, “Research and Improvement of LEACH Protocol for Wireless Sensor Network, International Conference on Information Engineering, 2012.

[11] A. Iqbal, M. Akbar, N. Javaid, S.H. Bouk, M. Ilahi, R. D. Khan, "Advanced LEACH: A Static Clustering-based Heteroneous Routing Protocol for WSNs", J. Basic. Appl. Sci. Res., 3(5)864-872, 2013.

[12] D. Mahmood, N. Javaid, S. Mehmood, S. Qureshi, A.M. Memon, T. Zaman, “MODLEACH: a variant of LEACH for WSNs 26th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE2013), Regina, Saskatchewan, Canada, 2013.

[13] N. Javaid, S. N. Mohammad, K. Latif, U. Qasim and Z. A. Khan, M. A. Khan, “HEER: Hybrid Energy Efficient Reactive Protocol for Wireless Sensor Networks”, 2nd IEEE Saudi International Electronics, Communications and Photonics Conference (SIECPC ’13), 2013, Riyadh, Saudi Arabia.

[14] M. B. Rasheed, N. Javaid, Z. A. Khan, U. Qasim and M. Ishfaq, "E-Horm: An Energyefficient Hole Removing Mechanism In Wireless Sensor Networks", 26th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE2013), Regina, Saskatchewan, Canada, 2013.

[15] N. Javaid, Z. A. Khan, U. Qasim, M. A. Khan, K. Latif, A. Javaid, “Towards LP Modeling for Maximizing Throughput and Minimizing Routing Delay in Proactive Protocols in Wireless Multi-hop Networks”, 2nd IEEE Saudi International Electronics, Communications and Photonics Conference (SIECPC ’13), 2013, Riyadh, Saudi Arabia.

[16] Aslam. M, Javaid. N, Rahim. A, Nazir. U, Bibi. A, Khan. Z. A, “Survey of Extended LEACH-Based Clustering Routing Protocols for Wireless Sensor Networks”, 5th International Symposium on Advances of High Performance Computing and Networking (AHPCN-2012)in conjunction with 14th IEEE International Conference on High Performance Computing and Communications (HPCC-2012), 25-27 June, Liverpool, UK, 2012.

[17] Javaid. N, Bibi. A, Khan, Z. A, Khan. U, Djouani. K, “Evaluating Wireless Proactive Routing Protocols under Scalability and Traffic Constraints”, 48th IEEE International Conference on Communications (ICC2012), Ottawa, Canada, 2012.

[18] Fareed, M.S.; Javaid, N.; Ahmed, S.; Rehman, S.; Qasim, U.; Khan, Z.A., "Analyzing Energy- Efficiency and Route-Selection of Multi-level Hierarchal Routing Protocols in WSNs," Broadband, Wireless Computing, Communication and Applications (BWCCA), 2012 Seventh International Conference on , vol., no., pp.626,631, 12-14 Nov. 2012. doi: 10.1109/BWCCA.2012.109.