ISSN 2347 - 3983
Volume 8. No. 6, June 2020
International Journal of Emerging Trends in Engineering Research
Available Online at http://www.warse.org/IJETER/static/pdf/file/ijeter89862020.pdf
https://doi.org/10.30534/ijeter/2020/89862020

An Enhancement Process for Reducing Energy Consumption in Wireless Sensor Network

Samar Awad Mohammed[1], Khaled abd Elsalam Aly[2], Atef Mohammed Ghuniem[3]
[1]Electrical Engineering Department, Faculty of Engineering, Suez Canal University, Ismailia, Egypt, Samar_Awad@eng.suez.edu.eg
[2]Electrical Engineering Department, Faculty of Engineering, Suez Canal University, Ismailia, Egypt
[3]Electrical Engineering Department, Faculty of Engineering, Suez Canal University, Ismailia, Egypt

ABSTRACT

Wireless Sensor Network (WSN) is considered one of the utmost common techniques in various applications such as monitoring, military, health, and fire track. WSN composed of a huge of number sensor nodes which have restriction on memory resources, computation, and energy. The lifetime of WSN is affected by confined energy resources. In this proposed paper, we suggest a new method to obtain better enhancement of WSN in terms of energy-efficient and network lifetime. Then the simulated result of the suggested method was compared with the basic Low Energy Adaptive Clustering Hierarchy (LEACH) protocol with fixing parameters. The suggested method achieved a 200% improvement compared with the basic LEACH in the concept of energy-efficient.

Key words: Energy-efficient, LEACH protocol, Network lifetime, WSN.

1. INTRODUCTION

Wireless Sensor Network (WSN) consists of a very huge number of very tiny sensors diffused in a specified area based on the desired application [1], [2]. Each sensor is capable of sensing, data processing and communicate with other sensors. These sensors called nodes that form WSN and transmit the sensing data to the sink or Base Station (BS) where the data is computed and processed for obtaining understandable results. Various protocols arrange communication between BS and wireless nodes. LEACH routing protocol is one of the energy-efficient protocols. In this protocol, the network is split into various clusters and each one has elected Cluster Head (CH) that connected with the BS and cluster member nodes, gathering data from the nodes and then sending the collected data to the BS [3][4]. A cluster head has additional functions over the other nodes, so it loses its energy faster than the other nodes Which makes it die early [5][6]. In this paper, we propose a modification of the LEACH algorithm by making CH not send collected data from its member to BS every round and still CH in the next round which reduces energy consumption in Wireless Sensor Network and increases the network lifetime. Time Division Multiple Access (TDMA) or Code Division Multiple Access (CDMA) routing protocols [7], [8], [9], [10] is used in the LEACH.

First, LEACH operation begins with the setup phase then the steady-state phase. This paper is organized as follows: Sections 2 present the related work, respectively. LEACH protocol is presented in Section 3. In Section 4, the proposed method. Section 5 presents the experiment method is shown and the result is talked related to the performance evaluation of our method. At last, the conclusion is showed in Section 6.

2. RELATED WORK

Wireless sensor field is growing quickly, particularly with many new applications about the Internet of Things (IoT) field. On another hand, there are many types of research are coming out with a variety of techniques and protocols to improve and enhance this technology trying to cover the requirements of this period. The obstacle to sensor Technologies is the low battery. So, most of the following researches considering these shortcomings and suggest techniques and algorithms overcome it.

Sharma [6] suggested improvement of LEACH protocol in the heterogeneous system and contrasted the emulation results with LEACH Homogeneous network; To simulate the protocol they chose an area of 100 * 100 meters. Sharma found an improvement in network lifetime and performance caused because that 10 nodes have more energy than the rest of 90 nodes.

Naveen [7] proposed fifteen various types of clustering wireless sensor protocols that deemed more in energy-efficient and network lifetime. They also compared them with various parameters as energy-efficient, load balance, scalability, and stability.

Prasad [9] reported that a Cluster head selection algorithm is considered the base for obtaining performance in clustering wireless sensor network better than other, and proposed an

improved energy-efficient leach protocol (IEE-LEACH) for MANET aiming to get minimization of energy consumption and rising network lifetime by chosen CH that nearest distance to the BS and exhausted high remaining energy. Prasad used TDMA routing protocol to simulate LEACH.

One of the reasons for shortening the network lifetime is the increasing number of dead nodes. Nandi [11] proposed a new protocol for picking the best place for the BS, which beats the problems of delivering data, and them the simulated result was compared with the basic LEACH protocol using TDMA technique. usually when the BS situated far away from the node, then will cost more energy in the node for transmitting data from a node to BS, which leads to a decrease in the network lifetime.

Sharma [12] compared three various WSN protocols in terms of throughput data and communication time, direct transmission protocol, LEACH, and EEE LEACH. EEE LEACH has better data transmission time and direct transmission protocol has minimum throughput [12]. In [13], Sharma proposed an algorithm known as Distance Based Cluster Head (DBCH).

3. LOW ENERGY ADAPTIVE CLUSTERING HIERARCHY (LEACH)

LEACH protocol proposed for wireless sensor networks by MIT's Chandrakasan [14]. LEACH is a self-adaptive cluster forming protocol. The nodes are diffused randomly then one node is chosen to be a cluster head which will Performa a function as a portal for all nodes in the same cluster to the BS. Same probability for all nodes in the cluster to be a cluster head. The cluster head selection happens in the setup phase of every round in the LEACH protocol. Each node produces a random number between 0 and 1, when this number is less than the threshold T(n) Refer to "(1)," then the node would be elected as a cluster head. After that, the cluster head estimates all member nodes in the same radio range (each node links the CH based on Received Signal Strength Indicator RSSI [14], [15] that it's the cluster head for the existing round and the cluster compose. The threshold is defined as follows [16]:

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

here p is the prospect of a node to be a cluster head, r represents the number of rounds, G represents the set nodes that have not been selected in the previous 1/p rounds.

As each member node know the cluster head in its cluster and TDMA slots for each node are formed by cluster head (to prevent interference). Next, the steady-state stage of the LEACH protocol process starts. Then, the data packet from all nodes send to the cluster head then the cluster head merges the data packets and sends the combined data to the BS. We have noticed that the cluster head functions are more than the member nodes, so the cluster head losses more energy than the others which one of the obstacles of the LEACH algorithm. LEACH ignored the BS and cluster head location, instability, and energy dissipation in the case of cluster head death.

Figure 1 shows the LEACH infrastructure. The LEACH protocol is attacked by the following kinds of attacks which decline the performance of LEACH by altering, dropping, spoofing, or replying to the packets.

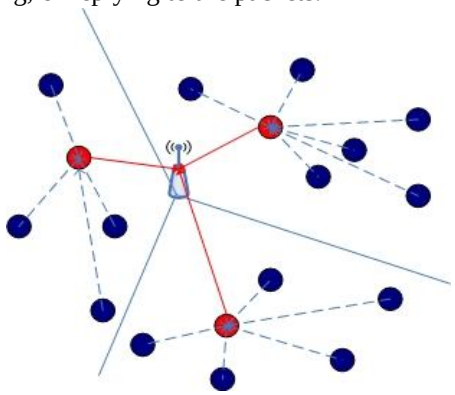

Figure 1: LEACH Infrastructure

The flow chart of the LEACH protocol is shown in Figure 2.

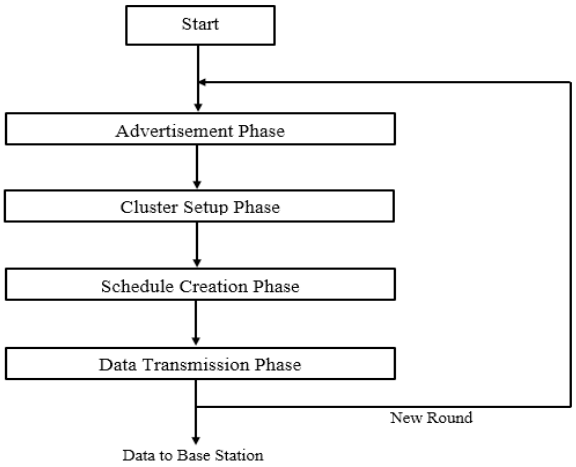

Figure 2: Flowchart of LEACH Protocol

4. PROPOSED METHOD

On breakage down the peculiarities of LEACH protocol, cluster head chosen plays the base role in enhancing and improving the network lifetime, data transmission, and energy-efficient We noticed that in LEACH each round cluster head transmits collected data (from cluster members) to the sink that consumes energy every round, and cluster head is changed every round which makes extra overhead needed for cluster head advertisement. There are protocols [17],[18],[19] trying to solve the problem caused by changing the cluster head every round by check if residual energy of CH still the applicable range, the CH in the current round will be CH in the next round. But these protocols don't solve

periodically transmission from CH to sink every round despite the greatest amount of the power consumption to do the communication between the base station and cluster head. So we built our method on this idea.CH will not transmit the collected data to the base station every round .it can aggregate the collected data from its cluster members and hold it to next round and merge it to the newly collected data .by this way we decrease energy dissipation [16], [17] formed by CH transmission to sink and decrease overhead due to CH advertisement.

Our method steps:

1. Start round r = 0, c=0.
2.If (mod(r,2)! =0) GOTO step 9
3. All the SN has a probability of becoming CH.
4. For round r, after the node is elected as CH, it will start broadcasting 'Hello' message to nodes in a cluster.
5. Energy used to broadcast messages is equal for all the cluster heads.
6. Initially, all the nodes those are not CH are supposed to keep their receiver ON to receive broadcasted message.
7. For round r, non-cluster head nodes will choose the cluster based on minimum energy criteria required to transmit/receive messages/data.
8. Random selection of CH will be done if a greater number of nodes declare themselves as CH.
9. Non-CH node informs CH about its presence in that cluster.
10. CH will have a list of members in the cluster due to Step -1
11. CH schedules communication of non-CH nodes with itself based on TDMA.
12. The scheme is used to minimize power consumption in non- CH nodes. The transmitter is switched off.
13. Data aggregation is done by CH after collecting data from non-CH nodes.
14.Set c equal r
15.If (mod(c,2)! =0) GOTO step 1
16. CH finally transmits the same to BS.

The flow chart of the proposed method is shown in Figure 3.

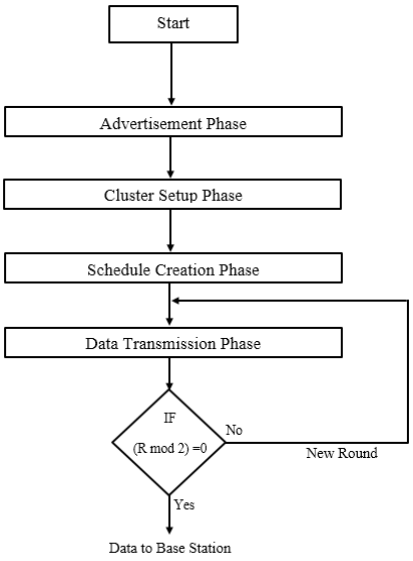

Figure 3: Flowchart of the Proposed Method

5. EXPERIMENT METHOD AND RESULTS

To confirm the better performance of the presented method, we designed an experiment where the numbers of nodes are set as 100. We used a MATLAB platform to simulate this algorithm.

Yet a major issue in wireless sensor networks [20] is the network lifetime prolong. So, we tend to increase the lifetime of the network and present the proposed algorithm with the same parameter used for the LEACH protocol. Parameters values are picked depending on previous researches who analyzes the WSN parameter to pick the optimal resulted values for simulation and experiments and as explained in [20], [21], [22], [23], [24].

Table 1 below presents the proposed method simulation parameters.

Table 1: Simulation Parameters

Parameter	Value
Sensor deployment area	100 × 100 m
Sensor deployment area	(50,50) m
Number of nodes	100
Data packet size	4000 bits
Control packet size	100 bits
The initial energy of the sensor	0.5 J
Probability of node to become CH	0.1
Maximum round (rmax)	4000

Network lifetime is a measurement operator that used to monitor the network life cycle, in this paper, we concentrate on the last dead node in the full network at the same time with data packet transmission through the network. The alive nodes of the LEACH algorithm in contrast with the number of rounds and our method are clarified in Figure 4. It turns out that the proposed method increased network lifetime by compared with basic LEACH.

Figure 5 shows the number of dissipated energies while using LEACH and our method. It turns out that the proposed method decreased energy consumption by comparison with the basic LEACH protocol.

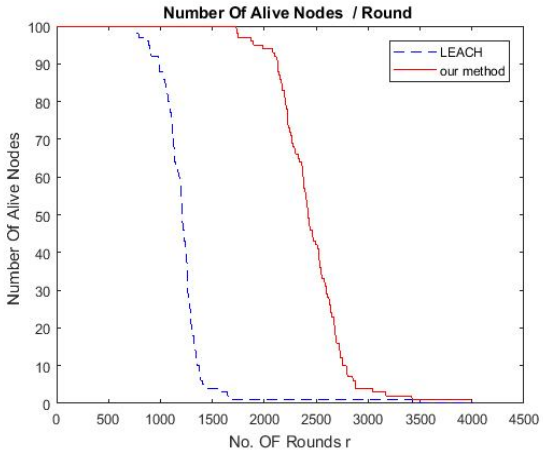

Figure 4: Network Lifetime Result

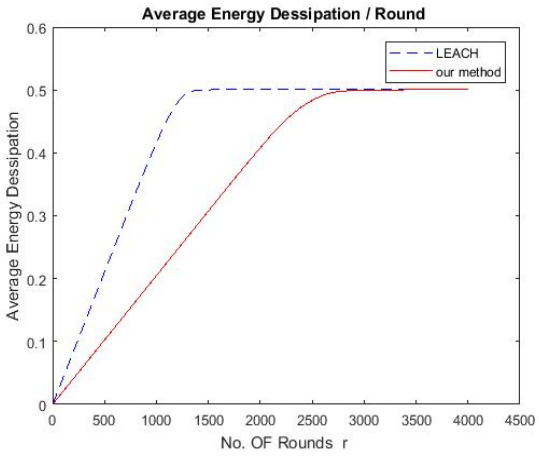

Figure 5: Energy Consumption

6. CONCLUSION

The wireless sensor networks are vastly used in various areas. LEACH protocol is one of the most familiar techniques in WSN. In this paper, we presented a new algorithm that decreases energy dissipation and the overhead caused by the cluster head election an advertisement. the proposed method increased network lifetime by compared with basic LEACH. In the future, our work will apply to application scenarios with strict coverage requirements and integrates our method with cloud computing.

REFERENCES

1. Akyiliz, Ian F. **A survey on sensor networks**. IEEE Commun. Mag., 2002, 40.8: 102-114. https://doi.org/10.1109/MCOM.2002.1024422
2. Chintala, Radhika Rani, et al. **Wireless Sensor Network for m-Healthcare Monitoring of Human Being**. International Journal, 2020, 8.5. https://doi.org/10.30534/ijeter/2020/31852020
3. M. Quwaider and S. Biswas, **Modeling energy harvesting sensors using accelerometer in body sensor networks**, in Proc. 8th International Conf. Body Area Networks, 2013, pp. 148–152.
4. Mhatre, Vivek, and Catherine Rosenberg. **Homogeneous vs heterogeneous clustered sensor networks: a comparative study.** 2004 IEEE international conference on communications (IEEE Cat. No. 04CH37577). IEEE, Vol. 6, pp. 3646-3651, 2004.
5. M. Quwaider and S. Biswas, **DTN routing in body sensor networks with dynamic postural partitioning.** Ad Hoc Networks**,** 2010, 8.8: 824-841. https://doi.org/10.1016/j.adhoc.2010.03.002
6. Sharma, Nishi, and Vandna Verma**. Energy efficient LEACH protocol for wireless sensor network.** ***International Journal of Information and Network Security***, 2013, 2.4: 333.
7. Naveen, Sharma , and Anand Nayyar. **A comprehensive review of cluster based energy-efficient routing protocols for wireless sensor networks**. International Journal of Application or Innovation in Engineering & Management (IJAIEM), 2014, 3.1: 441-453M.
8. Quwaider, **Real-time intruder surveillance using low-cost remote wireless sensors**. In: 2017 8th International Conference on Information and Communication Systems (ICICS). IEEE, 2017. pp. 194-199.
9. Prasad, A. Y., and R. Balakrishna **Implementation of optimal solution for network lifetime and energy consumption metrics using improved energy efficient LEACH protocol in MANET**. Teklanika, 2019, 17.4: 1758-1766.
10. Samara, Ghassan; ALJAIDI, Mohammad. **Efficient energy, cost reduction, and QoS based routing protocol for wireless sensor networks**. International Journal of Electrical & Computer Engineering (2088-8708), 9(1). https://doi.org/10.11591/ijece.v9i1.pp497-504
11. Nandi, Arnab, et al. **Centered Sink LEACH Protocol for Enhanced Performance of Wireless Sensor Network**. In: 2019 International Conference on Automation, Computational and Technology Management (ICACTM). IEEE, 2019. pp. 436-440.
12. Sharma, Meenakshi, and Anil Kumar Shaw. **Transmission time and throughput analysis of EEE LEACH, LEACH and direct transmission protocol: a simulation based approach.** ***Advanced Computing*****, 2012, 3.6: 75**. https://doi.org/10.5121/acij.2012.3609
13. Sharma, Rohini, Narendra Mishra, and Sumit Srivastava. **A proposed energy efficient distance based cluster head (DBCH) Algorithm: An Improvement over LEACH**. Procedia Computer Science, 2015, 57.807-814: 28.
14. Alippi, Cesare, and Giovanni Vanini. **Wireless sensor networks and radio localization: a metrological analysis of the MICA2 received signal strength indicator**. In: 29th Annual IEEE International Conference on Local Computer Networks. IEEE, 2004. pp. 579-580.
15. Y. Shatnawi and M. Quwaider, **Congestion Control in ATM networks using PID Controller with Immune Algorithm.** In: 2019 10th International Conference on Information and Communication Systems (ICICS). IEEE, 2019. pp. 19-24. https://doi.org/10.1109/IACS.2019.8809150
16. Long-long, Xu, and Zhang Jian-jun. **Improved LEACH cluster head multi-hops algorithm in wireless sensor networks**. In: 2010 Ninth International Symposium on Distributed Computing and Applications to Business, Engineering and Science. IEEE, 2010. pp. 263-267.
17. Kemal Akkaya and Mohamed Younis, **A survey on routing protocols for wireless sensor networks.** Ad hoc networks, 2005, 3.3: 325-349.
18. Mr. Santosh N. Shelke, Mr. Sandip R. Shinde, **Energy Saving Techniques in Wireless Sensor Networks**,

International Journal of Scientific & Engineering Research, Vol. 4, Issue. 4, April-2013.

19. Vasaki Ponnusamy, **Energy Analysis in Wireless Sensor Network: A Comparison,** International Journal of Computer Networks and Communications Security, VOL. 2, NO. 9, pp. 328–338, SEPTEMBER 2014.
20. Liang, Haibo, et al**. Research on routing optimization of WSNs based on improved LEACH protocol.** EURASIP Journal on Wireless Communications and Networking 2019.1 (2019): 194.
21. Comeau, Frank, and Nauman Aslam. **Analysis of LEACH energy parameters.** Procedia Computer Science 5 (2011): 933-938. https://doi.org/10.1016/j.procs.2011.07.131
22. Chit, Tin Aye, and Khine Thin Zar. **Lifetime Improvement of Wireless Sensor Network using Residual Energy and Distance Parameters on LEACH Protocol.** 2018 18th International Symposium on Communications and Information Technologies (ISCIT). IEEE, 2018.
23. M. Quwaider and Y. Shatnawi**, Neural network model as Internet of Things congestion control using PID controller and immune-hillclimbing algorithm,** Simul. Model. Pract. Theory, vol. 101, p. 102022, May 2020, doi: 10.1016/j.simpat.2019.102022. https://doi.org/10.1016/j.simpat.2019.102022
24. Oudani, Hassan, et al. **Energy efficient in wireless sensor networks using cluster-based approach routing.** International Journal of Sensors and Sensor Networks 5.5-1 (2017): 6-12.