Improved LEACH: A Modified LEACH for Wireless Sensor Network

Conference Paper · October 2016

CITATIONS
0

READS
108

2 authors, including:

A. Krishnakumar
Sree Saraswathi Thyagaraja College
9 PUBLICATIONS **2** CITATIONS

SEE PROFILE

Improved LEACH: A Modified LEACH for Wireless Sensor Network

Krishnakumar Amirthalingam[1],
IEEE Member, Research Scholar,
Department of Computer Science,
Sree Saraswathi Thyagaraja College,
Pollachi, India.
email: krishna2c@gmail.com

Dr. Anuratha.V[2],
Head of the Department,
Department of PG Computer Science,
Sree Saraswathi Thyagaraja College,
Pollachi, India.
email: mailanuvinu@yahoo.co.in

***Abstract*— Wireless Sensor Networks (WSN) are good** field for research **which can be applied almost in any area and in any circumstances. The traditional LEACH protocol is considered for the research and in this work the Improved LEACH is introduced as an energy efficient** Cluster Head **(CH) selection considering the energy and distance as parameters. The probability function is modified with the energy and distance metrics to choose energy efficient CH for data transmission. The simulation result** clearly gives **that the CH elected in Improved LEACH is prominent better scheme than the LEACH protocol. The** sum **of alive nodes is also quite improved and** deliver a **complete the clustering** mechanism in a rapid manner **when compare to the previous** clustering processes **in WSN.**

Keywords*— *Wireless Sensor Network, LEACH Protocol, Cluster Head Selection, Energy, Distance, Alive Nodes.

I. INTRODUCTION

Wireless sensor nodes from Wireless Sensor Network (WSN) are combined and formed as a network to gather a required data from the locations where the humans are not able to get the data at all the time. In common these networks are deployed in military areas where the sensed data play a vital role in changing the total military operations in some circumstances. As this network is wireless which tells, the energy is a main factor to be considered in all kind of data processing to and fourth from this network. There are more common protocols are introduced with the energy conservation metrics.

One of the foremost protocol is LEACH (Low-Energy Adaptive Clustering Hierarchy) introduced by Heinzelman *et al.* [1, 2]. This protocol is designed with two phase. i) Setup phase and ii) Steady phase. In first phase the nodes are elected as cluster-heads according to the default threshold value. The threshold is calculated as in Eq.1,

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

T(n) is the threshold value of n nodes and p denotes probability value. Each nodes of the network chooses a random number from 0 to 1. Afterwards the chosen value is compared with the threshold value obtained. When the chosen value is lesser than the threshold value then the node will be act as a Cluster Head (CH) otherwise the node will be act as member nodes. This process is obviously done in each round of selection of CH. After the election of CH, the TDMA (Time Division Multiple Access) is scheduled in order to send the sensed data from the member nodes including the data from the CH to the BS (Base Station). This process is obviously done in each round of selection of CH. After the election of CH, the TDMA (Time Division Multiple Access) is scheduled in order to send the sensed data from the member nodes including the data from the CH to the BS (Base Station). In steady phase, the nodes first receive TDMA schedule and in that schedule time member nodes transmits the sensed data to the CH and then CH aggregates the received data as well as forward it to the BS.

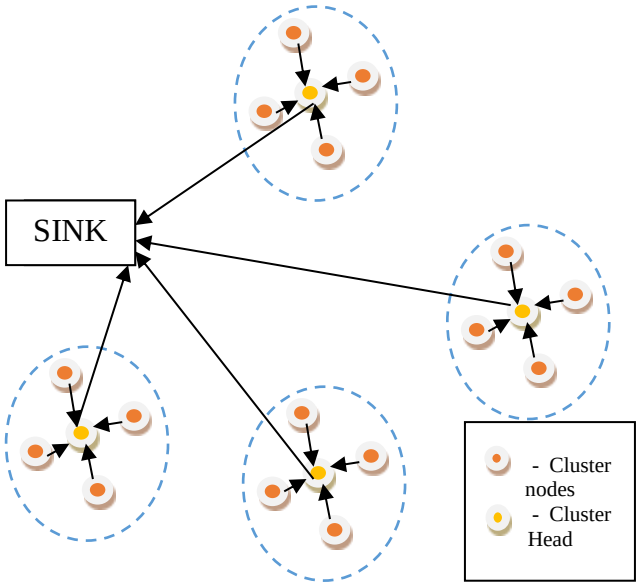

Figure 1. Network Topology of WSN.

This process is continuously done till the scheduled time. After the completion of each TDMA the setup phase is

[1] *[IEEE Member – id: 92131510] [corresponding author]*

functioned in order to elect the CH for next round [3]. The node chosen as CH for previous round will not be chosen as CH for the next round in order to manage the energy level of nodes which extends the lifetime of cluster as well as the network scalability. LEACH Protocol also follows single-hop routing format where every node can communicate CH and do data transmission directly as well as to the sink which makes the application is not suitable for the large regions and the election of CH for each round and advertising the same consumes the energy of the network [4]. Therefore, the developments are needed in resolving energy consumption for the dynamic clustering is the current research trend. Fig.1 shows the normal network topology of the WSNs.

In the proposed model "Improved LEACH" the LEACH Protocol for dynamic clustering is considered and improvement in election of CH according to the node's energy, node's distance to other nodes and as well as distance to BS. These improvements give a better result in balancing the load which shows a better improvement in the lifetime and scalability of the network.

In section II is various works and experiments are discussed under Related work and section III deals with the novel ideas in order to improve the network lifetime is discussed under proposed methodology. Section IV discusses the experimental results through which the outcome of the proposed experiment and finally the conclusion shows the future enhancements of the work and concludes the paper.

II. RELATED WORK

Mahmood *et al.* [5] proposed a methodology to deal with the bulk transmission of sensed information between the nodes and BS. The team mainly deals with the data aggregation and data fusion models where the need for betterment all the time. Proposed a scheme called "efficient cluster head replacement scheme" in which the elected cluster head will remains unchanged when it have a sufficient energy [6]. By this approach this new scheme saves energy which will waste in electing CH in each round and sending the packets between the nodes for the same. As well as by boosting the CH energy to the higher level while transferring the data to BS also increased the lifetime of the node. To do so the power amplification for the inter cluster communication is also introduced in this scheme.

In the LEACH protocol as of the random formation of cluster and random selection of cluster head. CH takes the responsibility of the not only collecting and sending the data to BS but also fusion of the data is also to be done. The energy consume for the data transmission is lower than fusing the data. Reduced energy consumption of CH, the LEACH-TLCH (Two Level CH) is improved by FU *et al*. [7]. The CH election is same as of LEACH protocol and the energy and distance between CH and BS also calculated and compared with the average energy and average distance between the CH and BS. if the energy and distance of CH is higher than the average then the CH takes the responsibility of the data transmission and fusion or else the CH's energy and distance is lower than the average then the secondary CH is elected for data fusion in order to keep the primary CH lifetime for some extent. The flaws in this scheme is the primary CH and secondary CH election and information about the selection has to be informed to all other nodes which leads to energy consumption.

The proposed Ad-LEACH by Qing *et al*. [8] is based on static clustering which reduces power dissipation and complexity of the network. It is achieved by separating the whole area into the small fields to reduce the energy of nodes while transmitting data between the large network. The Ad-LEACH is a combination of LEACH [1] and DEEC [9]. DEEC is used to choose the CH according to its residual energy. The DEEC mechanism which implemented in LEACH proves that it improves the lifetime of the network by choosing the right CH. Meanwhile, the Ad-LEACH is to show improvement in data fusing technique where the energy of a node is highly drains.

Kotobelli *et al.* [10] proposed a modified LEACH algorithm where the preference is given to energy constraint and how to reduce the consuming energy of a node and thus the CH is well formed. The idea is simple by making the CH as static till the energy of the CH is completely ends. This extends the lifetime by reducing the loss of energy in selecting the CH for each rounds and broadcasting election messages between the nodes [11]. As this formula works in static but the major risk of the proposed scheme is that the dynamic nodes will move dynamically and it leads to new cluster formation after some period to reduce the weight of cluster because of adding more nodes to a cluster. The cluster with more nodes will drain the CH's energy when it remains unchanged.

III. PROPOSED METHODOLOGY

According to the proposed scheme the energy and distance are the major constrains for WSNs. Therefore, the need for improvements based on such constraints are always shows importance in the field of research. The CH election is processed using the probability function for each round. Inspite of the probability function the score function (SCRFN) is calculated and updated with the probability function to identify better CH which leads to improvement in terms of network lifetime.

Residual energy for a node is calculated by

$$SCRFN1 = \frac{E_{current}}{E_{max}} \qquad (2)$$

Where, $E_{current}$ denotes the residual energy of a node and E_{max} denotes the maximum energy of a node. The SCRFN1 is calculated for each node of a cluster including the CH to find the node's residual energy.

Likewise, distance between each nodes of the cluster also plays a vital role in energy consumption. When CH is elected which is far away to BS then the energy consumption will be high whenever the CH is communicating to BS. The main task of the CH is to communicate to BS to transfer the collected information. Therefore, distance between the CH and BS also to be taken into account while choosing the CH.

The distance between CH and BS is calculated using

$$SCRFN2 = \frac{d_{bs}}{d_{far}} \qquad (3)$$

Where, d_{bs} is distance between the node and BS and d_{far} is distance to the BS from the farthest node of the cluster.

By combining the score functions SCRFN1 and SCRFN2 and giving the weightage for each and multiplying them with the probability function leads the extension of the network lifetime and scalability.

The combination of score functions with the probability function is calculated by using

$$SCFN = \sum_{i=1}^{2} w_i * SCRFN_i = \left[w_1 \left[\frac{E_{current}}{E_{max}} \right] + w_2 \left[\frac{d_{bs}}{d_{far}} \right] X \left[0, \frac{P}{\left(1 - P\left(r \bmod \left(\frac{1}{P} \right) \right) \right)}, if\ n \in G \right] \right] \quad (4)$$

Where the $w_1 + w_2 = 1$ where the weights are given according to the preference for the energy and distance of the network.

IV. EXPERIMENTAL RESULTS

The score function SCFN is processed in each round and node is chosen based on the value of the SCFN. The simulations are conducted in NS2. The parameters for the simulation is number of nodes taken is 100 (0 – 99 as nodes and 100 as BS). Initial energy of a node is 1J. Number of rounds is 200. The Figure 2 shows improved LEACH residual energy of a node compared with the LEACH.

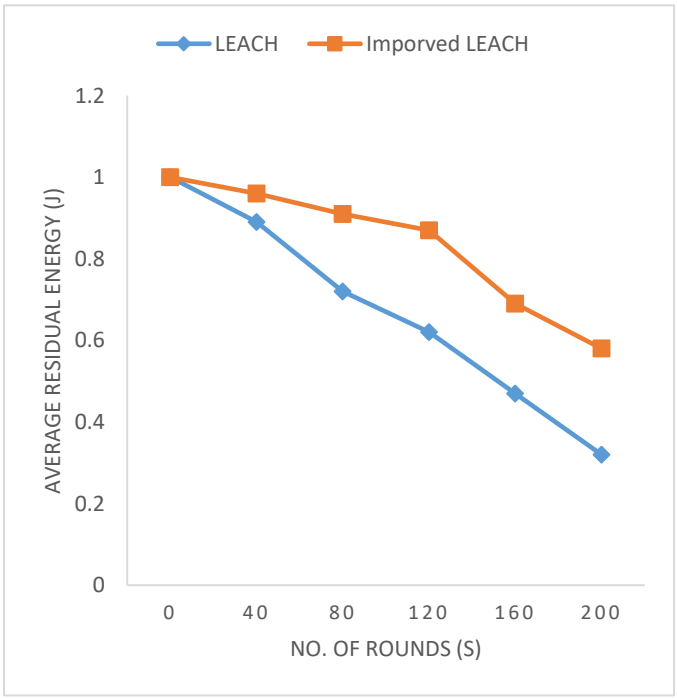

Fig.2 Average Residual Energy of a node

Figure 2 shows the average residual energy of the node after completion of 200 rounds of simulation. The results show the improved LEACH obtain only a half of the energy consumed by LEACH.

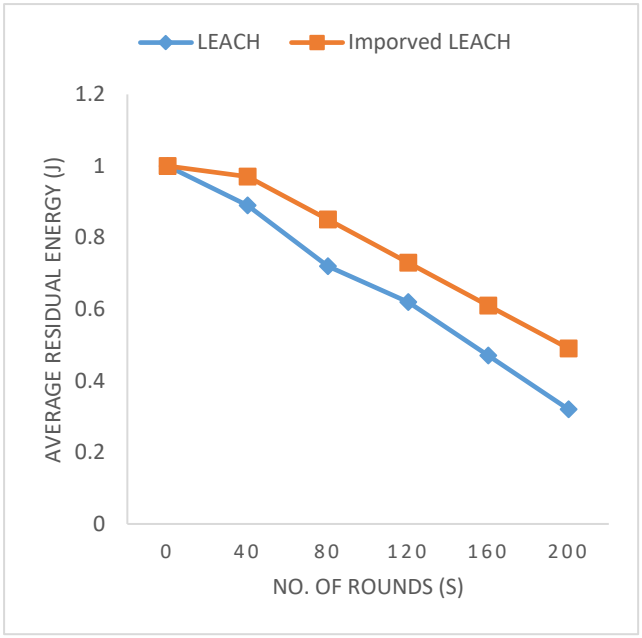

Fig.3 Average Residual Energy of a node based on the distance parameter

Figure 3 shows the results obtained based on the distance as a parameter which is only considered in improved LEACH whereas the distance parameter is not in LEACH. The above result gives a confidence that the improved LEACH provides a better energy scheme than the LEACH protocol. By using the improvised probability function of improved LEACH the number of alive nodes is also quite increased. The Figure 4 shows the number of alive nodes.

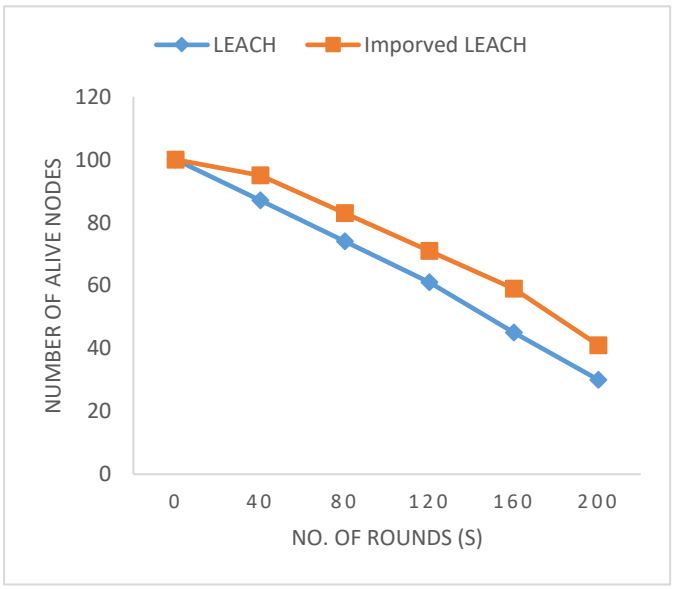

Fig.4 Number of alive nodes

The above figure also shows that Improved LEACH alive nodes are increased 25% than the LEACH protocol. The above results show that the Improved LEACH performs well when comparing to the traditional LEACH protocol in all other ways.

V. CONCLUSION

The Improved LEACH is proposed in this paper which elects the CH with the parameters residual energy and distance between the node and BS. Data transmission from the shortest range maintains the energy of a node. Therefore, these parameters provide a better selection of CH compared to the existing methodologies. Better CH automatically improves the overall performance of the network as well as the network lifetime. The distance and energy are interrelated to achieve the network scalability. Thus the evaluation results show that the Improved LEACH shows a better performance than the LEACH protocol. The further enhancements on parameters such as distance between CH and member nodes and forming the cluster with equal number of nodes may also improves the functionality of the WSN.

REFERENCES

[1] Heinzelman, W. R., Chandrakasan, A., & Balakrishnan, H. (2000, January). Energy-efficient communication protocol for wireless microsensor networks. In *System sciences, 2000. Proceedings of the 33rd annual Hawaii international conference on* (pp. 10-pp). IEEE.

[2] Heinzelman, W. B., Chandrakasan, A. P., & Balakrishnan, H. (2002). An application-specific protocol architecture for wireless microsensor networks.*IEEE Transactions on wireless communications*, *1*(4), 660-670.

[3] Akyildiz, I. F., Su, W., Sankarasubramaniam, Y., & Cayirci, E. (2002). Wireless sensor networks: a survey. *Computer networks*, *38*(4), 393-422.

[4] Wang, C. F., Shih, J. D., Pan, B. H., & Wu, T. Y. (2014). A network lifetime enhancement method for sink relocation and its analysis in wireless sensor networks. *IEEE sensors journal*, *14*(6), 1932-1943.

[5] Mahmood, D., Javaid, N., Mahmood, S., Qureshi, S., Memon, A. M., & Zaman, T. (2013, October). MODLEACH: a variant of LEACH for WSNs. In*Broadband and Wireless Computing, Communication and Applications (BWCCA), 2013 Eighth International Conference on* (pp. 158-163). IEEE.

[6] Barati, H., Movaghar, A., & Rahmani, A. M. (2015). EACHP: Energy Aware Clustering Hierarchy Protocol for Large Scale Wireless Sensor Networks.*Wireless Personal Communications*, *85*(3), 765-789.

[7] Fu, C., Jiang, Z., Wei, W. E. I., & Wei, A. (2013). An Energy Balanced Algorithm of LEACH Protocol in WSN. *International Journal of Computer Science*, *10*(1), 354-359.

[8] Qing, L., Zhu, Q., & Wang, M. (2006). Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks. *Computer communications*, *29*(12), 2230-2237.

[9] Iqbal, A., Akbar, M., Javaid, N., Bouk, S. H., Ilahi, M., & Khan, R. D. (2013). Advanced LEACH: A static clustering-based heteroneous routing protocol for WSNs. *arXiv preprint arXiv:1306.1146*.

[10] Kotobelli, E., Zanaj, E., Alinci, M., Bumçi, E., & Banushi, M. (2015). A Modified Clustering Algorithm in WSN.

[11] Manap, Z., Ali, B. M., Ng, C. K., Noordin, N. K., & Sali, A. (2013). A review on hierarchical routing protocols for wireless sensor networks. *Wireless personal communications*, *72*(2), 1077-1104.