Volume 5, Issue 7, July 2015 ISSN: 2277 128X
International Journal of Advanced Research in Computer Science and Software Engineering
Research Paper
Available online at: www.ijarcsse.com

Deploying an Optimized LEACH-C Protocol for Wireless Sensor Network

Er. Sarbjeet Kaur
CSE Department
Chandigarh University
Gharuan, Mohali, Punjab, India

Er. Ravi Gupta
Assistant Professor in CSE
Chandigarh University
Gharuan, Mohali, Punjab, India

Abstract-: ***Wireless sensor network is built of several nodes (from a few to several hundreds or even thousands), where each node is connected to one sensors. The main challenging task in this network is lifetime and energy consumption. The cluster based routing protocols are most accepted to improve the network lifetime and to reduce the energy consumption of wireless sensor network. This paper presents the pollination based optimization algorithm also called OLEACH-C to improve the performance of LEACH-C protocol. The PBO algorithm is used for clustering in WSN. The node that has maximum remaining energy will be selected as a cluster head. If the two nodes having the same energy then cluster head will be selected on the basis of distance. The node that has minimum distance from the base station will be selected as CH. The Simulations results show that the OLEACH-C protocol selects the best CHs that guarantee a routing optimization with the minimum energy consumption and minimum communication links` cost between nodes within each cluster and other energy efficient communication protocols for WSN routing protocol improve the energy consumption and network lifetimes***.

Keywords— Wireless Sensor Network, ILEACH-C, Efficient Energy, Network Lifetime

I. INTRODUCTION

Wireless Sensor Network (WSN) is consists of hundreds or thousands of sensor nodes which have limited memory, computational and communicational resources and at least one base station. The sensor nodes are deployed in a large region with very low powered sensor nodes. The sensor nodes may be heterogeneous or homogeneous [1].The wireless sensor networks can be utilized in a various information, home, military and telecommunications applications [2]. The sensor nodes are very small devices with wireless communication capability, which can collect information about sound, light, motion, temperature etc and processed different sensed information and transfers it to the other nodes. The sensor nodes in a wireless sensor network are randomly deployed so the positions of the sensor nodes need not to be prearranged. The energy consumption is the main concern in wireless sensor network. There are number of protocols in wireless sensor network to reduce the energy consumption and to increase the network lifetime. But the hierarchical based routing protocol is the best protocol to reduce the useful energy consumption. The hierarchical routing protocol is the cluster based protocol [4]. The cluster based routing is a technique to reduce the energy consumption by using the data aggregation algorithm. Data aggregation is a technique of gathering the data from all the sensor nodes and transmitted that information to the aggregator. The main objective of data aggregation algorithm is to gather and aggregate data in an energy efficient manner so that network lifetime is enhanced [5]. In the wireless sensor network, all the nodes can't communicate directly to base station. One of the sensor nodes also called "data aggregator" or "cluster head" gather the information from its neighboring nodes and aggregates them and then sends the aggregated information to the Base Station[6].

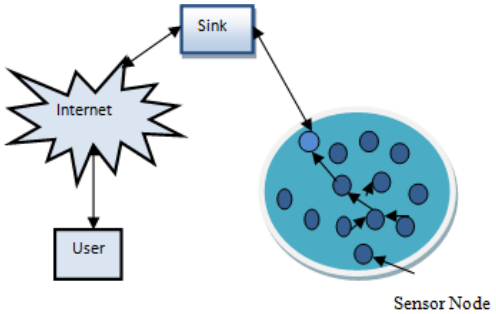

Fig1: Hierarchical wireless sensor network [15]

The primary hierarchical protocol is the Low Energy Adaptive Clustering Hierarchy (LEACH). The LEACH enhances the energy consumption because the transmission will only be completed by the cluster heads rather than the all the nodes [7].

LEACH Protocol

Low Energy Adaptive Clustering Hierarchy (LEACH) is one of the mostly used hierarchical cluster-based routing protocols for wireless sensor network. LEACH is a data aggregation algorithm that is based on cluster based routing. In such a situation, the data from the each node must be sent to a central base station, often located far from the sensor network, through which the end-user can access the data. LEACH is a self-organizing, adaptive clustering protocol that uses randomization to allocate the energy load equally among the sensors in the network. The LEACH protocol is works in rounds such that each round has two phase's i.e setup and steady state phase [8].

In the setup phase, Cluster Head (CH) selection is based on two factors. First, the percentage P of nodes in network and secondly history of nodes that has served as CH. A threshold value T (n) is set and decision is made by each node n based on the random number i.e. lies between 0 and 1. If the random number is less than threshold value, (T (n)), then, the node become a cluster head for the current round. The threshold value calculated based on the equation [10] i.e. given below:

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

Here *P* is the desired percentage of cluster heads and *r* is the current round, G is the group of nodes that has not been the CHs in the last rounds. The sensor node i.e. selected as a CH is not selected in the next rounds until all other nodes in the network becomes cluster heads.

In the steady state phase, nodes send their collected data by using their allocated TDMA slot to CH. The CH aggregates the data when received and send it to the Base Station (BS). Fig. 2 shows the LEACH protocol as given below.

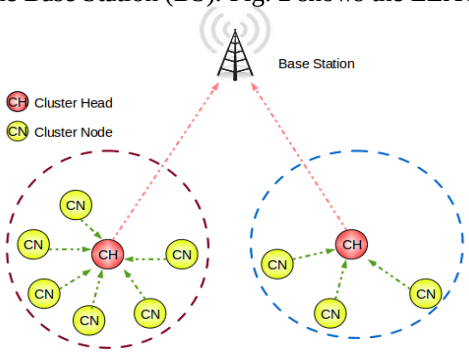

Fig 2: LEACH aggregation algorithm [11]

II. RELATED WORK

In the hierarchical routing protocols, whole network is divided into the clusters. One node from each cluster plays the leading role. Because only the cluster head can communicates to the base station. All other node of the cluster sends the sensed information to the cluster head. The cluster head transfer that information to the base station. This significantly reduces the energy consumption of the network. Description of some hierarchical routing protocols in discussed in below.

LEACH (Low Energy Adaptive Clustering Hierarchy)

LEACH randomly selects an only some sensor nodes as cluster heads (CHs) and rotates this task to equally allocate the energy load among the sensor in the Network. LEACH protocol is able to enhance the network lifetime. But there are some issues about the LEACH protocol [9].

- LEACH is not suitable protocol.
- Data is sending to base station at every round so energy consumption is high.

MULTI-HOP LEACH

Multi-hop LEACH (LEACH-M) [10].In this protocol, the sensor nodes can communicate with in multi-hop fashion. It's not necessary all the nodes send the data only to base station. The one node sends the data to its neighbor. However, this proposed protocol requires each sensor should be able to aggregate data, which increase the cost and overhead of sensor nodes.

LEACH-C

LEACH-Centralized (LEACH-C) [14] is similar to LEACH protocol. In this LEACH performs a centralized algorithm. The base station gathers the location data of all the nodes and then transmits its result of which node are act as a cluster head. The overall operation of LEACH-C is better than LEACH. But when the energy charge of communicating with the base station becomes higher than the energy cost for cluster formation, then, LEACH-C don't provides good performance. The base station may be placed far away from the network. in much WSN application.

LEACH-V

To reduce the energy consumption of the nodes, new version has been proposed i.e. LEACH-V [13] [16]. In this, each cluster has one CH i.e. accountable for transfer information that is received from the sensor nodes to the BS, vice-CH is a node that will become a CH of the cluster when the CH dies, and the cluster nodes gather data from environment and send to the CH. There is no need to select a new CH every time the CH dies. This will expand the overall network lifetime.

EELEACH-C

To improve the energy consumption and to enhance the network lifetime of the WSN, new version of LEACH-C has been proposed. This presents the energy efficient LEACH-C (EELEACH-C) protocol. In this, the base station runs a sorting algorithm and creates the list of nodes in descending order based on their remaining energy. The node that has maximum residual energy will be selected as a cluster head for the current round. The overall performance of the protocol is good. But there are some disadvantages of the EELEACH-C protocol. Because if the two or more nodes having the same energy in the network then, cluster head will be selected based on the node's id rather than distance [12]. So this technique will not be able to increase the performance of existing LEACH protocol in a very significant manner. It consumes the more energy and greater cost. So in the proposed work our aim is to design a protocol over which the cluster head will be selected on the basis of optimization technique such as PBO (pollination based optimization), in this, the nodes will be selected as the cluster head based on the energy and distance. If the two nodes that can be selected as cluster head having same energy, then cluster head will be selected on the basis of distance rather than their ID. The node that has minimum distance from the base station will be selected as a CH. The proposed system model will be able to improve the performance of existing LEACH protocol to significant level in terms of energy efficiency, cost and network lifetime.

III. PROPOSED WORK

The proposed work is the enhancement over the LEACH-C protocol by using the optimization technique i.e. pollination based optimization. Pollination based optimization (PBO) algorithm is used to improve the lifetime of the network and to reduce the energy consumption of the nodes. The pollination base optimization is a latest population based optimization algorithm by simulating flower pollination deeds. The PBO algorithm is used to solve the optimization problems, integer programming problems and problems related to the wireless sensor network etc. The objective of the PBO is the survival of the fittest and reproduces the new generation of the plants. Basically the pollination process transfer the pollen from the male parts of a flower to the female part called stigma of a flower and reproduce the plants. There are two types of pollination [18].

First one is biotic pollination process and second is abiotic pollination process. In Biotic pollination, pollen is transfer to the stigma by insects and animals. In abiotic pollination, pollen is transfer by wind or diffusion in water. Pollination can be achieved by two ways:

- Self pollination
- Cross pollination

Self pollination: self pollination is the process of transferring the pollen of one flower and the flowers of the same plants. It occurs when a flower contains both the male and the female gametes. The self and abiotic pollination is used in short distance. And self and abiotic pollination is used for local pollination.

Cross pollination: cross pollination occurs when the pollen transfer from flowers of the different plants i.e. flowers of the one plant communicate with another plant. The cross and biotic pollination is used in long distance. The biotic and cross pollination is used for global pollination. The global and local pollination is controlled by the switch probability i.e. $p \in [0, 1]$.

In wireless sensor networks, the pollination based optimization improves the network lifetime by associating the nodes of the cluster according to the distance to the proper cluster head. The main purpose to intra- cluster distance, the PBO algorithm divides the network into clusters and selects the cluster head based on energy as well as distance. It associate the cluster nodes to each cluster based on the intra cluster distance optimization function. It selects the best cluster head that gives the guarantees of least amount of cost between the communication of cluster head and cluster members and communication between base station and cluster head and nodes also consume less energy for transferring the data between the cluster and from cluster head to base station[18].

Pseudo code for selection of cluster head and cluster member nodes using proposed pollination based algorithm

Considering BS as the base station, A_E is the average energy of the network, CH is the cluster head, and CM is the cluster member, $dist_i$ and $dist_j$ are the distance of nodes from the base station. Considering E as the set of energy of all the nodes, N is the total number of nodes.

a) All the nodes send their location and present energy to BS.
b) BS marks only the higher energy nodes and calculates the A_E of the network

Cluster head Selection (A_E, CM, N, CH, E)

1. I ← 1
2. While I <= N
3. If ($E_i > A_E$) then

4. CH (i) = True
5. Else
6. CM (i) = True
7. End if
8. For(j = 1; j < N; j++)
9. If (E_i = E_j)
10. i++ then
11. Apply the PBO algorithm
12. If ($dist_i$ < $dist_j$) from BS, then
13. CH (i) = True
14. Else
15. CH (j) = True
16. End if
17. End if
18. End while

IV. SIMULATION RESULTS

To confirm the performance of OLEACH-C, we create a wireless sensor network. The matlab software MATLAB (matrix laboratory) has been used to simulate the results. After creating nodes are deployed into the network. Number of nodes is fixed. There are 100 nodes in the network as shown in Figure. The nodes are moving to their respective places in the network. All the nodes considered here are homogeneous in nature. Each function in the network consumes significant amount of energy of the nodes. This section presents the results obtained for the EELEACH-C protocol and the Proposed optimized LEACH-C (OLEACH-C) protocol as well as its comparison with other protocols like LEACH and LEACH-C. The fig. 3 shows the wireless sensor network.

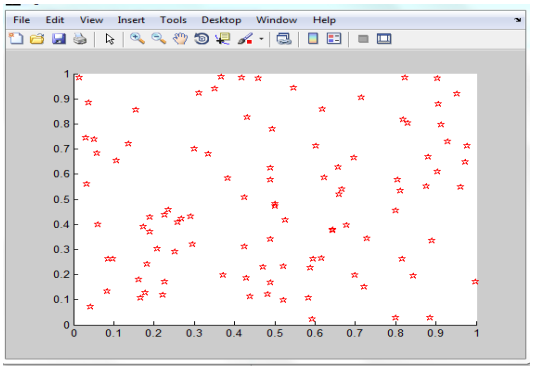

Fig 3: wireless sensor network

The fig. 4 shows the comparison of proposed OLEACH-C with existing LEACH, LACH-C, and EELEACH-C protocols. The LEACH protocol loose their energy in cluster formation. Because clusters are formed after every round so that it consume more energy. But in case of LEACH-C cluster formation is done by Base Station and in case of EELEACH-C cluster formation is done in an energy efficient manner and in OLEACH-C cluster formation is done based on the energy and distance by using the optimization technique called pollination based optimization(PBO) The node that has minimum distance from the base station will be select as a cluster head.So that number of nodes alive in case of OLEACH-C is greater than the LEACH, LEACH-C, EELEACH-C. The OLEACH-C protocol gives the performance around 3217 rounds. It give the better results than the existing protocols.

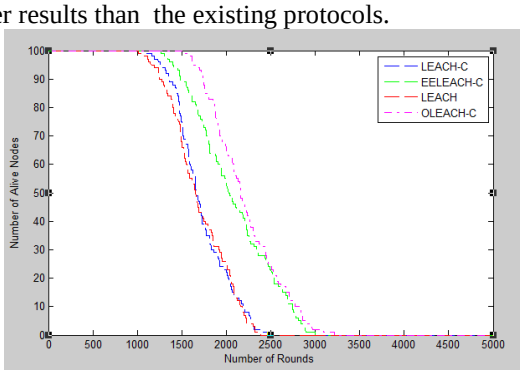

Fig 4: Alive nodes v/s rounds plot comparison of proposed OLEACH-C with other existing protocols

The fig. 5 shows the comparison of dead nodes between the proposed optimized LEACH-C (OLEACH-C) protocol and the existing protocols. The OLEACH-C protocol gives the better results than the other protocols. In OLEACH-C, the first node is dies around 1553 rounds. The tenth node is dies around 1738 rounds and the last node is dies around the round number 3217.

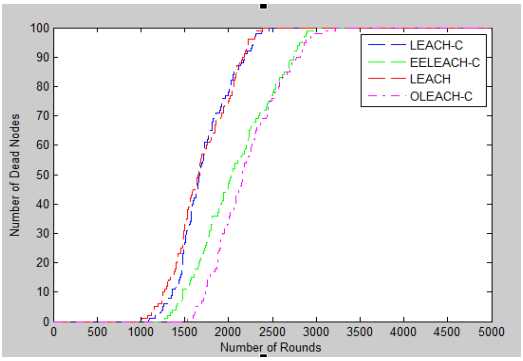

Fig 5: Dead nodes v/s rounds plot comparison of proposed OLEACH-C with other existing protocols

In the fig. 6, the OLEACH-C protocol gives the better results than LEACH, LEACH-C, and EELEACH-C. In optimized LEACH-C (OLEACH-C), packets that are sending to base Station and packets sent to cluster head are more than the other protocols and it improve the network lifetime and also reduce the energy consumption.

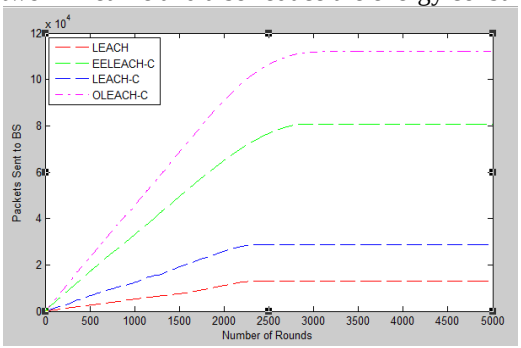

Fig 6: Packets to BS v/s rounds plot comparison of proposed OLEACH-C with other existing protocols

The fig. 7 shows the comparison of lifetime of the network between the OLEACH-C protocol and the existing protocols. From the figure, the proposed optimized LEACH-C protocol provides the more network lifetime than the other protocols.

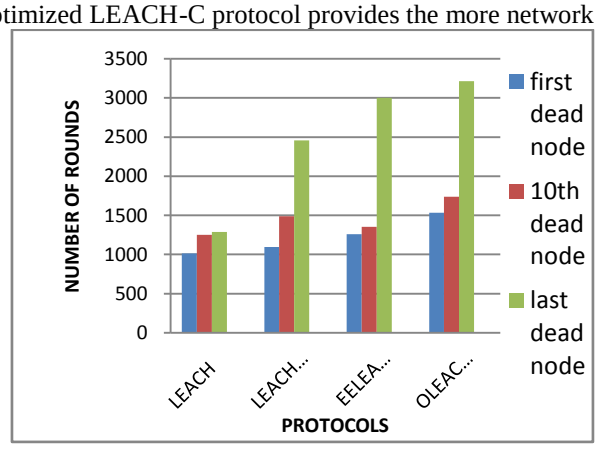

Fig 7: Network lifetime comparison of proposed OLEACH-C with other existing protocols

V. CONCLUSIONS

Energy efficient cluster based routing protocol is used to enhance the lifetime of the network. In this paper, The PBO algorithm is used for clustering in WSN. It is showing for homogenous wireless sensor environment. This protocol enhances the wireless sensor network lifetime by selecting the cluster head based on their remaining energy as well as distance. And it associates the cluster nodes according to the distance to the proper cluster head. Therefore, OLEACH-C protocol selects the best CHs that guarantee a routing optimization with the minimum energy consumption and minimum communication links` cost between nodes within each cluster and other energy efficient communication protocols for WSN. The simulation is done by using MATLAB. The simulation results shows that proposed OLEACH-C protocol has better performance than the existing LEACH, LEACH-C and EELEACH-C protocols, because in optimized LEACH-C protocol, cluster head is selected based on the node's remaining energy and distance.

REFERENCES

[1] S. Vashist, M. K. Soni. Himanshi, "Study of Wireless Sensor Network Using LEACH Protocol," *International Journal of Innovative Technology and Exploring Engineering (IJITEE)*, vol. 3 (2), 2013.

[2] France, O. Ingelrest, G. Barrenetxea, G. Schaefer, and M. Parlange, "SensorScope: Application-Specific Sensor Network for Environmental Monitoring," *ACM Transactions on Sensor Networks*, Vol. 6(2), 2010.

[3] G.S Baicher, A. A. A. Alkhatib, "Wireless Sensor Network Architecture," *International Conference on Computer Networks and Communication Systems (CNCS)*, vol. 35, pp. 11-15, 2012.

[4] T. Abdelzaher, T. He, R. Kravets, Q. Cao, "Cluster-Based Forwarding for Reliable End-to-End Delivery in Wireless Sensor Networks," *IEEE communications*,pp. 1928-1936, 2007

[5] Arijit Ukil, "Privacy Preserving Data Aggregation in Wireless Sensor Networks," *Sixth International Conference on Wireless and Mobile Communications*, pp. 435-440, IEEE 2010

[6] W. He, X. Liu, H. Nguyen, K. Nahrstedt, T. Abdelzaher, "PDA: Privacy-preserving Data Aggregation in Wireless Sensor Networks," *IEEE Communications*, pp. 2045-2053, 2007.

[7] V.A. Geetha , P.V. Kallapurb, S. Tellajeera, "Clustering in Wireless Sensor Networks: Performance Comparison of LEACH & LEACH-C Protocols Using NS2," *procedia technology*, vol. 4 pp. 163-170, Elsevier 2012.

[8] A. Chandrakasan, H. Balakrishnan, W. R. Heinzelman,"Energy-Efficient Communication Protocol for Wireless Microsensor Networks," *in Proceedings of the 33rd Hawaii International Conference on System Sciences IEEE*, 2000.

[9] N. Jamal . A. Karaki and A. E. Kamal, "Routing Techniques in wireless sensor networks," in *International Workshop on Wireless Networks and Energy Saving Techniques (WNTEST)*, 2009.

[10 N. Nasri, A. WEI, A. Kachouri, S. E. Khediri , "A New Approach for Clustering in Wireless Sensors Networks," *International Workshop on Wireless Networks and Energy Saving Techniques (WNTEST)*, vol. 32, pp. 1180-1185 Elsevier 2014.

[11 R.M.B. Hani and A.A. Ijjeh, "A Survey on LEACH-Based Energy Aware Protocols for Wireless Sensor Networks," *Journal of Communications* vol. 8(3), pp. 192-206, 2013

[12] M. Tripathi,, M.S. Gaur, V. Laxmi and R.B. Battula, " Energy Efficient LEACH-C Protocol for Wireless sensor Network," *In computational intelligence and information technology*, pp. 402 - 405, IET 2013

[13] R. V. N. Sindhwani, "V LEACH: *An Energy Efficient Communication*," vol. 2(2), 2013.

[14] N. Nasri, A. WEI, A. Kachouri, S. E. Khediri , "A New Approach for Clustering in Wireless Sensors Networks," *International Workshop on Wireless Networks and Energy Saving Techniques (WNTEST)*, vol. 32, pp. 1180-1185 Elsevier 2014.

[15] P. Garg K. Saroha, R. Lochab, "Review of Wireless Sensor Networks - Architecture and Applications,",*International Journal of Computer Science & Management Studies (IJCSMS)*, Vol-11, 2011

[16] W. B. Heinzelman, A.P. Chandrakasan, and H. Balakrishnan, "An Application-Specific Protocol Architecture for Wireless Micro sensor Networks," *IEEE transactions on wireless communications*, vol. 1(1), pp.660-670, 2002

[17] E. Deni Raj, "An Efficient Cluster Head Selection Algorithm for Wireless Sensor Networks –Edrleach," *IOSR Journal of Computer Engineering (IOSRJCE)*, Vol.2, PP.39-44 2012

[18] K. Balasubramani, K.Marcus, "A Study on Flower Pollination Algorithm and Its Applications," *International Journal of Application or Innovation in Engineering & Management (IJAIEM)*, vol.3, 2014

[19] H.M. Abdulsalam, B.A. Ali, A. AlYatama, E.S. AlRoumi, "Deploying a LEACH Data Aggregation Technique for Air Quality Monitoring in Wireless Sensor Network," *The 2nd International Workshop on Communications and Sensor Networks*, vol. 34, pp. 499-504, Elsevier 2014

[20] S.Hussain, A.W. Matin, O. Islam, "Genetic Algorithm for Hierarchical Wireless Sensor Networks," *Journal of Networks*, Vol. 2, pp. 87-97, 2007

