

Performance analysis of LEACH-GAC over LEACH-B, LEACH-C, LEACH-GA

Abstract

Wireless sensor network is not fixed infrastructure which contain either homogenous or heterogeneous sensor node. Each node have own residual energy .So it's very important factor of network to prevent the energy of nodes, so that nodes alive more and network establishment in long time without disturbance. LEACH is one of hierarchical routing protocol which is use for secure the energy. For past few year , develop many algorithm to improve the hierarchical routing protocol so improve the overall network and minimize energy consumption ,which includes new algorithm based on clustering based genetic algorithm i.e. Low Energy Adaptive Clustering hierarchical –cluster based genetic algorithm(LEACH-GAC) and also research on security in cluster so unauthorized not access so private data easily transfer and received into cluster. Compare with LEACH-B,LEACH-C,LEACH-GA,LEACH-GAC varying with residual energy, Cluster formation, security.

Keywords-LEACH-GA,LEACH-B,LEACH-GAC,LEACH-C,WSN,Hierarchical routing protocol

Introduction

Wireless sensor network is a tiny collection of sensor nodes. In wireless sensor network have self organizing sensor nodes which are interconnect to each other. In network have limited number of constraints like battery use, energy consumption, memory, life of nodes, remote , moving or hostile behaviors[1].For these reason past few decades wireless sensor networks (WSNs) use in many application like medicine, military, traffic control, environmental monitoring, construction of different architecture, battle field[2,8].Due to limited constraints wireless network have many challenges. In these case it is very necessary to improve the network life, communication establish in proper way so the based on overall network structure ,developed new routing algorithm which are classified in Flat based, location based, hierarchical based routing protocol[3].

Sensor network routing protocol are divided into two parts: the flat routing protocols and clustering routing protocols [4]. The drawback of flat routing protocols is that in without any organization or segmentation structure between sensor nodes order. This is not suitable for large-scale networks. In clustering based routing protocol can resolve these problems. LEACH protocol[5], one of the clustering based routing algorithm in WSN, is the LEACH protocol which delivers the collected data from cluster head node to base station node directly. Compared with the flat routing protocols, LEACH can consume less residual energy of every node and life of overall network will be increased through a particular parameter. In LEACH protocol[6] energy consumption of the nodes sending data to CH(cluster head) and receiving data from the CH depend on distance between nodes and their energy consumption utility. So main focus on residual energy saving economize research. So now these scenario many researcher improve the LEACH protocol and its efficiency and security LEACH-B,LEACH-C,LEACH-GA LEACH-GAC.

Related Work

In this literature [9] LEACH is hierarchical protocol in clustering based routing protocol WSN.It have minimum energy occupying. LEACH protocol have 2 phases 1.Steady State 2.Setup Phase. In Steady State phase cluster formation and CH selection, non CH send their information to CH, then CH merge all information of non CH and send information to sink node .In Setup phase with the divided nodes, one of the nodes will acts as a CH that receive a message from Base Station, and send that message to all non CHs [9].

In literature survey [10] LEACH-B ,research on BIRCH(Balancing iterative reducing clustering hierarchical) algorithm, Which is based on hiererarchical clustering.In these method large cluster divide sub cluster. Hierarchical clustering algorithm apply directly to sub cluster ,its using CF(clustering factor) through this CF build CH tree. It's overcome the problem which are in LEACH protocol unevenly distribution. It also improves the efficiency, network life in WSN.

In this literature survey [7] have 2 main goal LEACH and LEACH-C (centralized), it can be mentioned that LEACH protocol having highest energy node is CH not equal residual energy to all the nodes and without interference of sink node in etc. and LEACH-C is a centralized protocol having BS have full involvement to overall network who have less energy so remove those node maintain the equality of residual energy chosen when centralized and deterministic approach covering entire network is expected still bringing in increased network lifetime and desired number of clusters [7, 11].

In this literature survey[12] research new enhanced version of LEACH protocol i.e. LEACH-E, use minimum spanning tree technique for the cluster head selection have based on energy.

Inthis literature survey[13] selection of CH based on their residual energy .new version of LEACH is LEACH-GA was proposed. In LEACH-GA starting roun of seclction CH is same as LEACH protocol i.e setup phase and steady state phase after that for optimal solution using genetic algorithm .To improve the overall network life.

This paper is organized as Section III gives the introduction for Genetic Algorithm, Section IV represents the proposed method of new algorithm i.e. LEACH-GAC Section V represents the Analysis and Experimental result of performance of LEACH-B, LEACH-C, LEACH-GA and LEACH-GAC with varying Initial Energy, security and Cluster probability.

III. Genetic Algorithm

The Genetic Algorithm (GA) is a heuristic search algorithm for generating solution of optimal problems. Genetic Algorithm was proposed by John Holland in the year 1970 based on the Genetic and Darwinism theory, who was the father of Genetic Algorithm. Later, Charles Darwin defined GA with an addition of fittest survival to improve the solution for optimization over depth-first, breath-first and linear programming genetic algorithm (GA) as a dynamic method for finding optimal states.. This algorithm includes no. of stages to find out optimal result

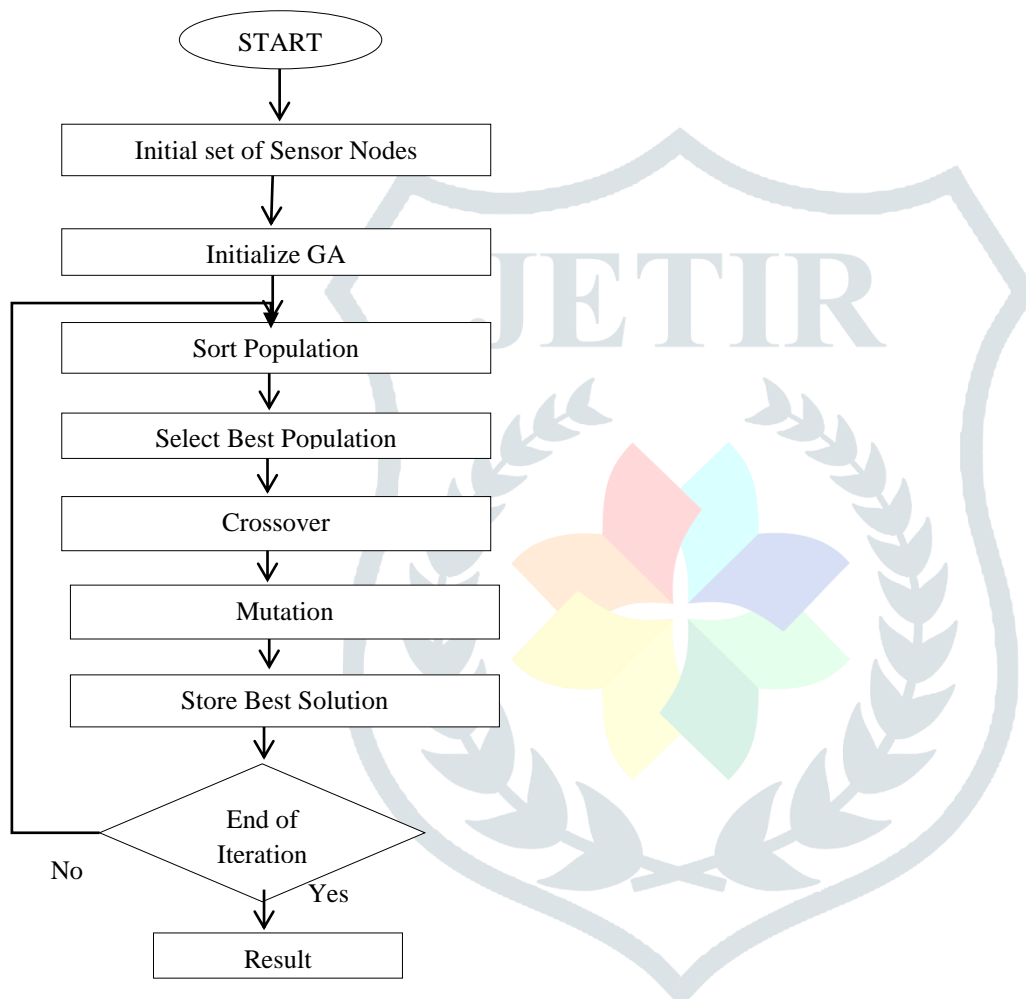


Figure 1: Genetic Algorithm Flow Chart

Algorithm for genetic algorithm based clustering

Initialization: In Initial stage chromosome can be generated through the Main Nodes.

Calculate Fitness Function: In fitness function calculating fitness of nodes through equation no.III:

$$\text{Fitness Function} = D_c + E_c \quad (\text{iii})$$

Where D_c is the cost of distance and E_c is the cost of energy.

$$D_c = \frac{d_{sc}}{d_{sc} + d_{cb}}$$

d_{sc} = distance between sensor and cluster head node

d_{cb} = distance between cluster head node and base station node.

$$E_c = \frac{E_s}{E_{TS}}$$

E_s = Each sensor node's energy

E_{TS} = Total residual energy of nodes residing in a cluster.

Selection: After fitness function selection process is started in chromosome new population is created by selecting the members of the current generation based on their relevance.

Crossover: After selection processes generate a new chromosome crossover method is applying, the crossover process selects some people as parents from the collection selected by the selection process

IV. Proposed Methodology

The proposed algorithm is performed in following stages:

Stage I: Using symmetric and asymmetric key for node enter into for cluster formation

Stage II: Designing of new LEACH-GAC algorithm

Stage III: Performance Evaluation of LEACH-GAC with some existing Cluster based protocols

4.1 Secure Genetic Algorithm based Clustering

Secure Genetic Algorithm based Clustering (LEACH-GAC) algorithm is designed in order to achieve the security over WSN [14,15]. In this scenario in WSN any sensor node identify any node which have sufficient residual energy send data to CH and CH send data to sink node same as LEACH protocol.

The proposed LEACH-GAC algorithm is designed in following steps:

1. In sensor network first establish a key i.e. initial key
2. Cluster formation
3. Cluster head selection using genetic algorithm
4. Distribution of secret key and public key by the base station.
5. Data transmission of encrypted data packets using AES algorithm and RSA algorithm and sending of data to base station.
6. Decryption of data packets at base station using private key.

For the proposed algorithm 3 different types of keys are generated, they are: Initial Secret Key (ISK), Sensor Cluster (SCK) and Cluster Base Key (CBK).

Each sensor node has an ISK (initially loaded into the memory of each sensor node) with its ID. First, each sensor node uses the ISK and the ID for authentication with the base station.

The SCK key is used to communicate in a cluster between the cluster head and sensor nodes. SCK is generated by the base station with the cluster ID and sent to all cluster heads. This key is then distributed to all nodes using ISK.

CBK is used to communicate between the cluster's root node and the base station [16].

4.2 WSN Establishment

Each node send authentication request to base station. The request message contains ID encrypted with ISK Base station then decrypt ID using ISK of node If ID matched then authenticated and base station assigns SBK to each node.

V Simulation and Result Analysis

The protocols was analyzed by using the radio model which is illustrated in figure 6.

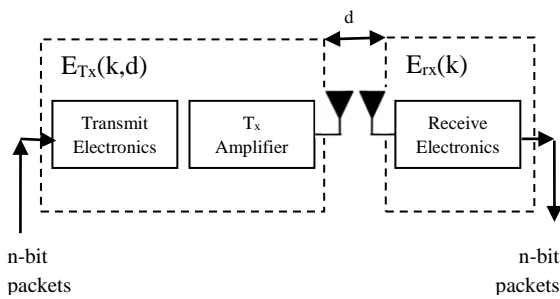


Figure 2: Radio Model

In WSN, the radio energy dissipation model is a simple model of wireless energy consumption. The transmitter circuit dissipates the energy needed to operate the transmission electronics and power amplifiers. The receiver circuit dissipates energy to operate only the electronics of the receiver [15].

Depending on the distance between transmitter and receiver, multiple fade and free space channel patterns are used. The free space model (loss of power d^2) is mainly used for communication in a cluster or when the threshold distance is less than d_0 , while the power loss model d^4 is used for communication between clusters. The threshold distance is greater than or equal to d_0 . The radio energy consumed by the transmitter to transmit a 1bit message at a distance d is:

$$\begin{aligned}
 E_{Tx}(I, d) &= E_{Tx-elec}(I) + E_{TX-amp}(I, d) \\
 &= IE_{elec} + IE_{fs}d^2, d < d_0 \\
 &= IE_{elec} + IE_{amp}d^4, d \geq d_0
 \end{aligned}
 \tag{iv}$$

And energy consumed by the receiver is:

$$E_{Rx}(I) = E_{Rx-elec}(I) = IE_{elec}
 \tag{v}$$

where E_{elec} = Per bit energy consumed to execute transmitter and receiver

E_{fs} = amplifier energies for free space

E_{amp} = amplifier energies for multipath models

The threshold transmission distance may be chosen as follows:

$$d_0 = \frac{E_{fs}}{E_{amp}}
 \tag{vi}$$

According to proposed algorithm different stages results are analyzed as following:

Table I: Simulation Parameters

Parameter Name	Values
Network Area	100*100
Number of nodes	100
Packet Size	4000 bits
Initial Energy, E_0	.5J
Transmitter Energy, E_{TX}	50nJ/bit
Receiver Energy, E_{RX}	50nJ/bit
Amplification Energy for short distance, E_{fs}	10pJ/bit/m ²
Amplification Energy for long distance, E_{mp}	0.0013pJ/bit/m ²
Number of Rounds	25

In this research work the MATLAB tool is used to simulate and verify the validity of LEACH-GAC protocol. For simulation environment we have assumed WSN consisted of 100 sensor nodes and nodes are randomly distributed in the 100*100m area as well as base station is located at the coordinates (50,50). The simulation parameters are given below in table I.

Performance Evaluation of LEACH-GAC with part of existing Clustering based Protocols

The comparison of LEACH-C, LEACH-B, LEACH-GA and LEACH-GAC was done by using MATLAB simulation tool. The nodes are randomly distributed in the area of 100 x 100 m². The base station is located at the centre point (50, 50) as blue colored circle and the cluster heads are represented as blue filled triangle and sensor nodes are represented by green triangle as shown in figure .

In figure-3 firstly identify cluster formation using security algorithm and selection of cluster head through genetic algorithm in LEACH-GAC algorithm. Blue color show the cluster head. No of node is (100*100).DOT node show sink node when cluster formation is completed selection of cluster head after CH send data to sink node.

In figure-4 shows if we compare LEACH-GA and LEACH-GAC algorithm LEACH-GAC have high residual energy and more security in overall cluster so that unauthorized nodes not access our network and network secure to different active and passive attack.

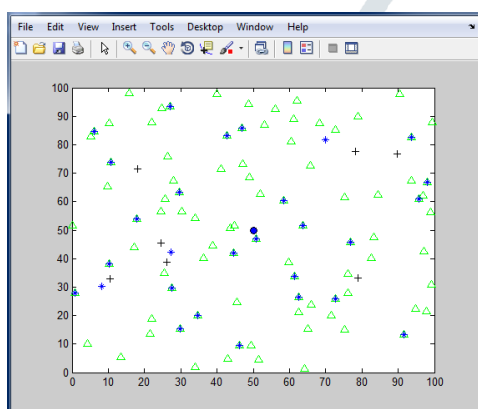


Figure-3

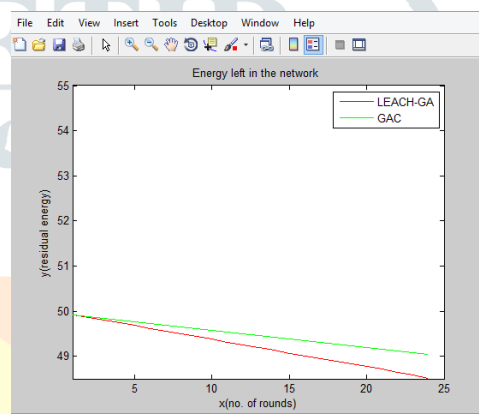


Figure-4

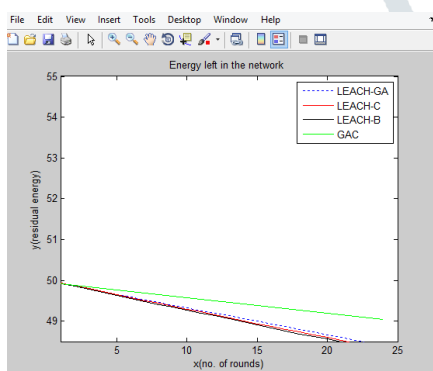


Figure 5

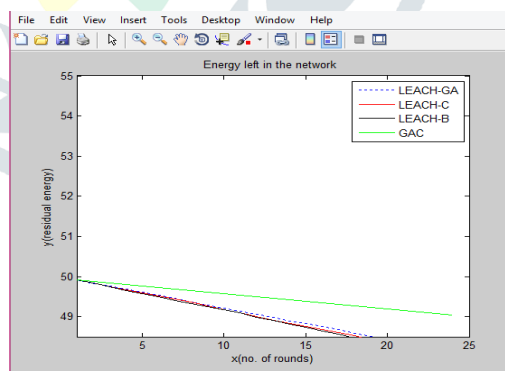


Figure-6

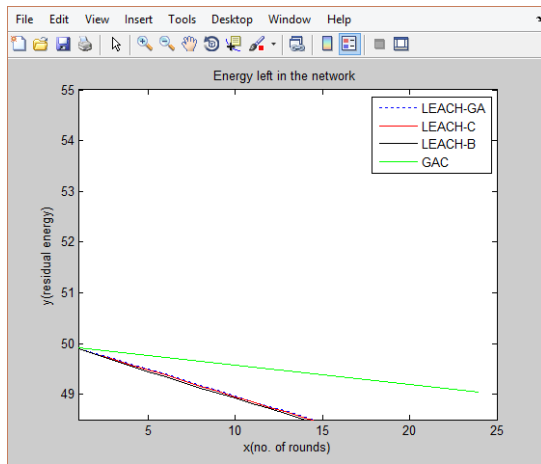


Figure-7

With Initial Energy 0.5 J/node

In Fig.5, we compared the network lifetime of LEACH, LEACH-C and LEACH-GA with Initial Energy 0.5 J/node. initial energy is **0.5 J/node** then number of nodes alive in a network ,So the lifetime of LEACH GAC, overheads when compare to LEACH-B, LEACH-C,LEACH-GA.

With Initial Energy 0.7 J/node

In Fig.6, we compared the network lifetime of LEACH, LEACH-C and LEACH-GA with Initial Energy 0.7 J/node. initial energy is **0.7 J/node** then number of nodes alive in a network ,So the lifetime of LEACH GAC, overheads when compare to LEACH-B, LEACH-C,LEACH-GA.

With Initial Energy 1 J/node

In Fig.7, we compared the network lifetime of LEACH, LEACH-C and LEACH-GA with Initial Energy 1 J/node. initial energy is **1 J/node** then number of nodes alive in a network ,So the lifetime of LEACH GAC, overheads when compare to LEACH-B, LEACH-C,LEACH-GA.

VI. Conclusion

In this paper, compare the LEACH-GAC,LEACH-GA,LEACH-C,LEACH-Band its shows LEACH-GAC have high residual energy compare to other LEACH protocol in WSN a novel LEACH-GAC algorithm is proposed for wireless sensor network. Varying the initial energy and compare the residual of energy overall network.

References

1. A Survey Paper on Leach Routing Protocol and Its Variants in Wireless Sensor Network Vijay kumari1 , Sunil nandal2 Dept. of Computer Science and Engineering, Guru Jambheshwar University of Sci. & Tech., Hisar, India1,2.
2. Muhammad Omer Farooq, Abdul Basit Dogar, Ghalib Asadullah Shah "MR-LEACH: Multi-hop Routing with Low Energy Adaptive Clustering Hierarchy "IEEE Fourth International Conference on Sensor Technologies and Applications, Venice, pp 262 -268,18-25July 2010
3. Karaki.Al, and Kamal.A.E. (2004) "Routing techniques in Wireless Sensor Networks: A survey", IEEE Wireless Communications: 6 – 28.
4. Li Shancang, Zhang Kewang: Principles and applications of wireless sensor networks. China Machine Press, Beijing (2008) 58~59
5. . Bao Zhenshan, Xue Bo, Zhang Wenbo. "HT-LEACH: An Improved Energy Efficient Algorithm Based on LEACH", International Conference on Mechatronic Sciences, Electric Engineering and Computer (MEC), 2013

6. Jing Zhang, Ting Yang, Chengli Zhao: Energy-efficient and self-adaptive routing algorithm based on event-driven in wireless sensor network. Vol. 7. International Journal of Grid and Utility Computing (2016) 41-49
7. P. Nayak and D. Ph, "Comparison of Routing Protocols in WSN using NetSim Simulator : LEACH Vs LEACH-C," Int. J. Comput. Appl., vol. 106, no. 11, pp. 1-6, 2014.
8. S. R. Jino Ramson ; D. Jackuline Moni" Applications of wireless sensor networks — A survey"IEEE wireless communication Proceedings of IEEE International Conference on Innovations in Electrical, Electronics, Instrumentation and Media Technology ICIEEIMT 17
9. Heinzelman.W, Chandrakasan.A and Balakrishnan.H. (2002) "An Application-Specific Protocol Architecture for Wireless Microsensor Networks", *IEEE Transactions on Wireless Communications* **1(4)**: 660-670.
10. Peng Li^{1,2}, Wanyuan Jiang¹, He Xu^{1,2}, Wei Liu¹" Energy Optimization Algorithm of Wireless Sensor Networks based on LEACH-B" College of Computer, Nanjing University of Posts and Telecommunications, Nanjing 210003, China(2017)
11. . V. Geetha, P. V. Kallapur, and S. Tellajeera, "Clustering in Wireless Sensor Networks: Performance Comparison of LEACH & LEACH-C Protocols Using NS2," *Procedia Technol.*, vol. 4, pp. 163-170, 2012.
12. Salim.A, Osamy.W, and Khedr.A.M. (2014) "IBLEACH: Intra-balanced Leach protocol for Wireless Sensor Networks", *Wireless Network* **20 (6)**: 1515 – 1525
13. Liu.J.L and Ravishankar.C.V. (2011) "LEACH-GA: Genetic Algorithm-based energy efficient adaptive clustering protocol for Wireless Sensor Networks", *International Journal of Machine Learning and Computing* **1(1)**: 79 – 85.
14. Alka Singh, Shubhangi Rathkanthiwar, Sandeep Kakde, "LEACH Based- Energy Efficient Routing Protocol for Wireless Sensor Networks", IEEE, 2016
15. Hiren Kumar Deva Sarma, Avijit Kar, Rajib Mall, "A Hierarchical and Role Based Secure Routing Protocol for Mobile Wireless Sensor Networks", *Wireless Pers Commun*, Springer, 2016
16. Nitika Singhi, Ravi Singh Pippal, "analysis of Key Management Schemes in MANET", *International Journal of Applied Environmental Sciences*, Volume 13, Number 2, pp. 161-169, 2018

