IJDACR
ISSN: 2319-4863

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 3, Issue 12, July 2015)

Genetically Optimized Energy Efficient Clustering Algorithm in Wireless Sensor Networks

Amit Thakur
amitthakurbist@gmail.com

Vikram Garg
vikramgarg85@gmail.com

Abstract – **Heterogeneous Wireless Sensor Network (WSN) comprises of sensor nodes with distinctive capability, for example, diverse computing power and sensing range. Contrasted with homogeneous WSN, arrangement and topology control are more perplexing in heterogeneous WSN. Distinctive energy efficient clustering protocols for wireless sensor networks systems and thinks about these protocols on a few focuses, in the same way as clustering method, location awareness, heterogeneity level and clustering attributes. Though, each protocol is not appropriate for heterogeneous WSNs. In this paper, we test Low-Energy Adaptive Clustering Hierarchy (LEACH) and Genetic Algorithm (GA) optimized-LEACH under a few distinctive situations holding high level heterogeneity to low level heterogeneity. To close the conduct of this heterogeneous protocols.**

Keywords– **Genetic Algorithm, Low-Energy Adaptive Clustering Hierarchy, Wireless Sensor Network.**

I. INTRODUCTION

The key encounter in in setting up and legitimate operation of WSN is expand the lifetime of the system by minimizing the consumption of energy. Since from last few year mixed bag of progressions have been made to point of confinement the energy necessity in WSN, as principally energy dispersal is more for wireless transmission and reception [1]. Principle methodologies till proposed were centering at rolling out the improvements at MAC layer and network layer to minimize the energy dissipation. Two more real difficulties are the manner by which to place the cluster heads over the network and what number of clusters would be there in a framework. In the event that the cluster heads are accurately situated over the network and sufficient clusters are displayed, it will help to lessen the dispersal of energy and would help to expand the lifetime of the system to handle with all the aforementioned difficulties clustering have been discovered the effective procedure [2] [3]. Clustering is dependably been alluded as a compelling technique to improve the lifetime of WSN.

Technological developments in the field of Micro Electro Mechanical Sensors (MEMS) have enabled the development to tiny, low power, low cost sensors having limited processing, wireless communication and energy resource capabilities. With the passage of time researchers have found new applications of WSN. In many critical applications WSNs are very useful such as military surveillance, environmental, traffic, temperature, pressure, vibration monitoring and disaster areas. To achieve fault tolerance, WSN consists of hundreds or even thousands of sensors randomly deployed inside the area of interest [4].

All the nodes need to send their information towards BS regularly called as sink. Generally nodes in WSN are force compelled because of constrained battery, it is likewise impractical to energize or supplant battery of effectively sent nodes and nodes may be set where they can't be gotten to. Nodes may be available far from BS so control correspondence is not possible because of restricted battery as direct communication obliges high energy. Clustering is the key system for diminishing battery utilization in which parts of the cluster select a Cluster Head (CH). Numerous clustering conventions are outlined in this respect [5, 6]. All the nodes having a place with cluster send their information to CH, where, CH totals information and sends the collected information to BS [7-9]. Under aggregation, fewer messages are sent to BS and only few nodes have to transmit over large distance, so high energy is saved and over all lifetime of the network is prolonged. Energy consumption for aggregation of data is much less as compared to energy used in data transmission. Clustering can be done in two types of networks i.e. homogenous and heterogeneous networks. Nodes having same energy level are called homogenous system and nodes having distinctive energy levels called heterogeneous system.

In this paper, we perform an investigational comparison among LEACH and GA optimized LEACH, so as to find a method which can fulfil the goals set, as follows:

- Minimize the energy dissipation of the network.
- Increase the network life time.
- Clusters must be better balanced.
- Better distribution of cluster heads in the network.

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 3, Issue 12, July 2015)

II. Proposed Methodology

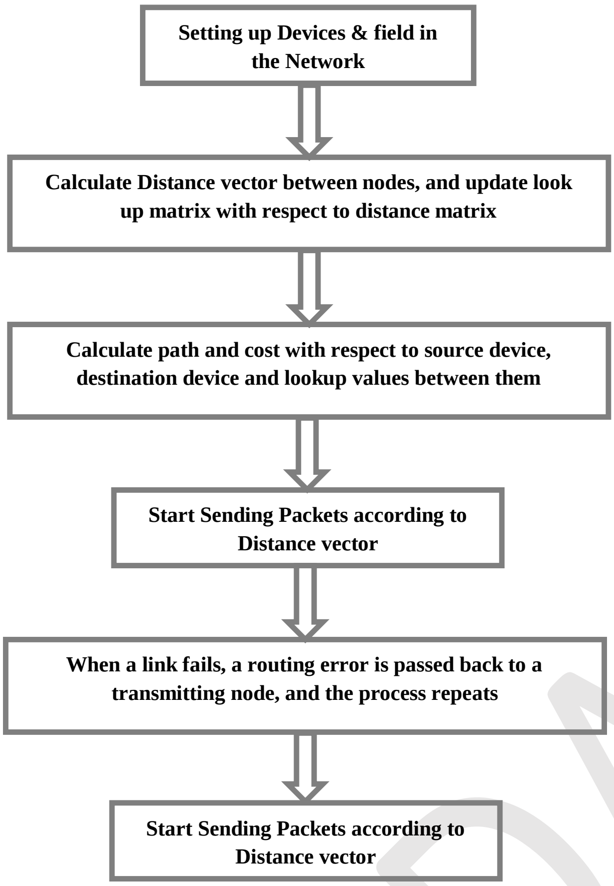

Figure 1: Flow diagram of proposed work

Method of Cluster Head Selection

Let $p_i = 1/n_i$, which might be additionally viewed as the average probability to be a cluster head throughout n_i rounds. At the point when nodes have the same measure of energy at every epoch, picking the average probability pi to be p_{opt} can guarantee that there are p_{opt} N cluster heads each round and all nodes pass on give or take in the meantime. On the off chance that the nodes have diverse measures of energy, pi of the nodes with more energy ought to be bigger than p_{opt}. Let $\bar{E}(r)$ means the average energy at round r of the system, which might be acquired by:

$$\bar{E}(r) = \frac{1}{N}\sum_{i=1}^{N} E_i(r) \quad (1)$$

The probability of the nodes of nodes will be given by:

$$\sum_{i=1}^{N} P_i = \sum_{i=1}^{N} P_{opt}\frac{E_i(r)}{\bar{E}(r)} = \sum_{i=1}^{N}\frac{E_i(r)}{\bar{E}(r)} = Np_{opt} \quad (2)$$

It is the ideal cluster head number. The probability threshold that every node s_i consumes to figure out if itself to turn into a cluster head in each one round, as take after:

$$T(S_i) = \begin{cases} \frac{p_i}{1-p_i\left(r \bmod \frac{1}{p_i}\right)} & if\ s \in G \\ 0 & otherwise \end{cases} \quad (3)$$

Where, G is the set of nodes which are qualified to be cluster head sat round r. On the off chance that node s_i has not been a cluster head throughout the latest n_i rounds, we have $s_i \in G$. In each one round r, when node s_i discovers it is qualified to be a cluster head, it will pick an arbitrary number somewhere around 0 and 1. On the off chance that the number is short of what limit T(si), the node s_i turns into a cluster head throughout the present round.

Coping with Heterogeneous Nodes

When the networks are heterogeneous, the reference value of each node should be different according to the initial energy. In the two-level heterogeneous networks, we replace the reference value p_{opt} with the weighted probabilities given in below equations for normal and advanced nodes [10].

$$p_{adv} = \frac{P_{opt}}{1+am}, P_{nrm} = \frac{P_{opt}(1+a)}{1+am} \quad (4)$$

Therefore p_i changes to

$$(P_i) = \begin{cases} \frac{p_{opt}E_i(r)}{(1+am)\bar{E}(r)} & if\ s_i\ is\ the\ normal\ node \\ \frac{p_{opt}(1+a)E_i(r)}{(1+am)\bar{E}(r)} & if\ s_i\ is\ the\ advanced\ node \end{cases} \quad (5)$$

Thus the threshold is correlated with the initial energy and residual energy of each node directly.

Average Energy Estimation of Network

In an ideal situation, the energy of the network and nodes are uniformly distributed, and all the nodes die at the same time. Thus estimated average energy $\bar{E}(r)$ of r^{th} round is as follow:

$$\bar{E}(r) = \frac{1}{N}E_{Total}\left(1 - \frac{r}{R}\right) \quad (6)$$

Where, R signifies the aggregate rounds of the network lifetime. It implies that each node expends the same measure of energy in each one round, which is additionally the focus on that energy-efficient algorithms ought to attempt to attain [11].

Genetic Algorithm

Genetic algorithms (GA) were initially presented by John Holland in the 1970s (Holland 1975) as an aftereffect of examinations concerning the likelihood of computer program experiencing advancement in the Darwinian sense.

GA are a piece of a more extensive delicate registering ideal model known as evolutionary calculation. They endeavour to touch base at ideal results

IJDACR
ISSN: 2319-4863

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 3, Issue 12, July 2015)

through a methodology like living advancement. This includes after the standards of survival of the fittest, and crossbreeding and transformation to create better results from a pool of existing results.

Genetic algorithms have been discovered to be equipped for discovering answers for a wide assortment of issues for which no adequate algorithmic results exist. The GA philosophy is especially suited for optimization, a problem solving procedure in which one or all the more great results are hunt down in a solution space consisting of countless results. GA lessen the inquiry space by persistently assessing the current era of hopeful results, disposing of the ones positioned as poor, and delivering another era through hybrid and changing those positioned as great. The positioning of applicant results is carried out utilizing some decided measure of goodness or wellness.

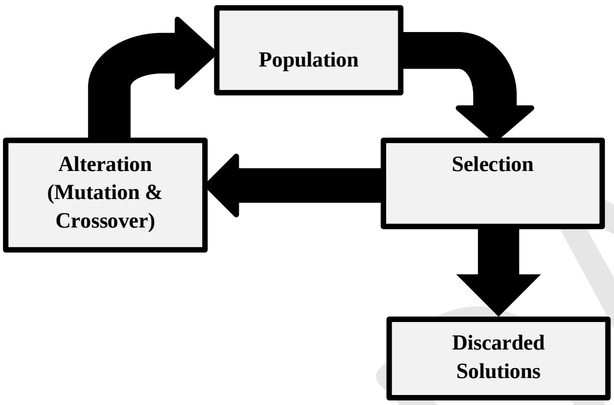

Figure 2: Genetic algorithm evolutionary cycle [12]

A genetic algorithm is a probabilistic inquiry procedure that computationally simulates the methodology of biological advancement. It emulates development in nature by over and again modifying a populace of applicant results until an ideal result is found.

The GA progression cycle starts with a self-assertively picked starting population. The progressions to the population happen through the methods of determination focused around wellness, and change utilizing hybrid and transformation. The provision of determination and change prompts a population with a higher extent of better results. The evolutionary cycle proceeds until a satisfactory result is establish in the existing generation of population, or some control parameter, for example, the amount of generations is surpassed.

The most modest unit of a genetic algorithm is known as a gene, which speaks to a unit of data in the issue space. An arrangement of genes, known as a chromosome, speaks to one conceivable answer for the issue. Every gene in the chromosome speaks to one part of the solution pattern.

The most well-known manifestation of speaking to an answer as a chromosome is a string of binary digits. Every bit in this string is a gene. The methodology of changing over the result from its unique structure into the bit string is known as coding. The particular coding plan utilized is application dependent. The solution bit strings are decoded to empower their evaluation utilizing a fitness measure.

A. Selection

In biological development, just the fittest survive and their gene pool helps the production of the successive generation. Determination in GA is additionally focused around a comparative methodology. In a typical manifestation of choice, known as fitness proportional determination, each chromosome's probability of being chosen as a good one is relative to its fitness value.

B. Modification to develop worthy solutions

The alteration step in the genetic algorithm refines the good solution from the current generation to turn out a new species of candidates. It is carried out by performing crossover and mutation.

C. Crossover

Crossover may be viewed as artificial mating in which chromosomes from two people are joined to make the chromosome for the next generation. This is carried out by joining two chromosomes from two separate results at a hybrid point and swapping the grafted parts. The thought is that a few genes with great attributes from one chromosome might therefore join together with some great genes in the other chromosome to make a superior result spoke to by the new chromosome.

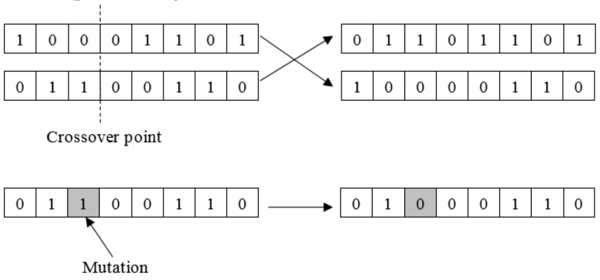

Figure 3: Block representation of Crossover and Mutation [12]

D. Mutation

Mutation is an arbitrary modification in the genetic composition. It is valuable for presenting new aspects in a population – something not attained through crossover individually. Crossover just adjusts existing attributes to give new mixtures. For instance, if the first bit in every chromosome of a generation happens to be a 1, any new chromosome made through crossover will additionally have 1 as the first bit.

IJDACR
ISSN: 2319-4863

International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 3, Issue 12, July 2015)

The mutation operator deviates the existing approximation of a gene to an alternate one. For bit string chromosome this change adds up to flipping a 0 bit to a 1 or the other way around. However helpful for presenting new characteristics in the solution pool, changes might be counterproductive, and connected just occasionally and arbitrarily.
The steps in the run of the genetic algorithm for discovering an answer for an issue are recorded underneath:

1. Create a starting solution population of a certain size arbitrarily
2. Evaluate every result in the current generation and dole out it a fitness value.
3. Select "great" results focused around fitness value and toss the rest.
4. If adequate solution(s) found in the current generation or greatest number of generations is surpassed then stop.
5. Alter the solution population utilizing crossover and mutation to make another generation of solutions.
6. Go to step 2.

Genetically Optimized Cluster-Head Selection
In wireless network with overlap and non-overlap communication various routing protocols have been proposed, where communication nodes plays an important role for energy efficient routing scenario. This paper proposes an efficient node selection scheme with clustering based routing protocols. Nodes overheads is minimized by some cluster-heads and that cluster-heads are responsible for node selections and intercommunication with various nodes. This research also proposes genetically optimized cluster-heads selection for End-to-End communication in routing protocol. The sink and source communicate with each other and maintain the routing with enough residual energy so that clustered structure may claim for maximum lifetime in a particular routing protocol.

- The paper proposes a network scenario where network nodes are dead initially unless and until it is triggered.
- Number of nodes has to be define in a given network.
- Mobility check is required.
- Selection of nodes are random where source and sink are defined.
- Every node is initialized with common energy value (i.e. 1 Joule), later on the energy level of nodes may vary according to communication.
- Calculate the shortest distance from sink for selection of source.
- Create the cluster-heads for best selection of devices into the cluster which will be responsible for communication.
- Optimize the selection of cluster-heads using fitness function of Genetic algorithm for maximum life-cycle in a network.

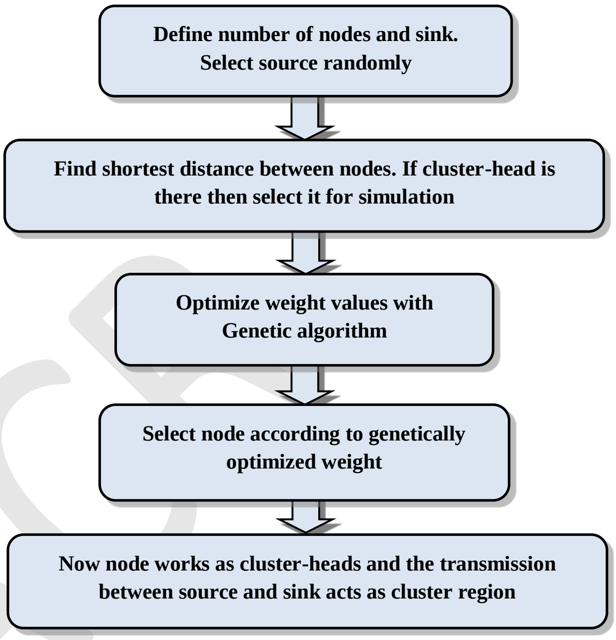

Figure 4: Flow diagram of genetically optimized cluster-heads

III. Simulation and Results

Simulation is carried out using MATLAB 2010a:

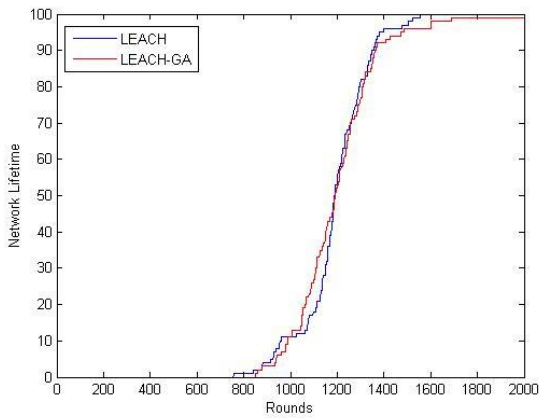

Figure 5: Network Lifetime comparison for LEACH and GA optimized LEACH

IJDACR
ISSN: 2319-4863

IJDACR
International Journal Of Digital Application & Contemporary Research

International Journal of Digital Application & Contemporary Research
Website: www.ijdacr.com (Volume 3, Issue 12, July 2015)

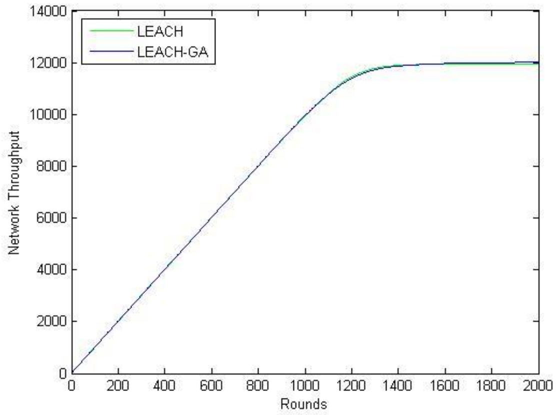

Figure 6: Network Throughput comparison for LEACH and GA optimized LEACH

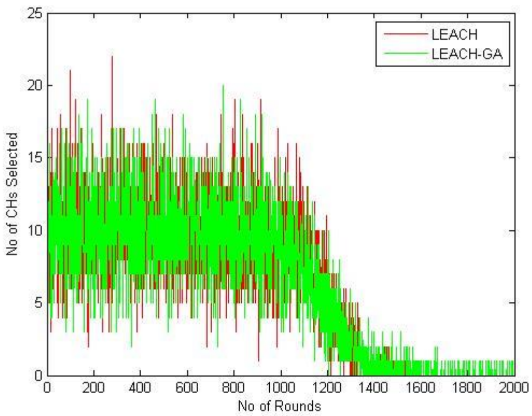

Figure 7: Cluster Head selection for LEACH and GA optimized LEACH

IV. CONCLUSION

In this paper, we have inspected the existing state of proposed clustering algorithm, particularly concerning their power and reliability quality necessities. In wireless sensor networks, the energy limits of nodes assume a pivotal part in planning any protocol for execution.

Genetic Algorithms (GA) has been a famous procedure used to take care of optimization issues in WSNs because of its straightforwardness, high calibre of result, quick joining and inconsequential computational trouble. In any case, iterative nature of GA can deny its utilization for rapid ongoing applications, particularly if optimization needs to be done frequently. GA obliges a lot of memory, which may limit its execution to asset rich base stations. Literature has inexhaustible fruitful WSN applications that endeavour preferences of GA.

We have examined LEACH and GA-LEACH for heterogeneous WSNs containing different level of heterogeneity. Simulations prove that GA-LEACH perform well in all scenarios. It has best performance in terms of Network Throughput and Lifetime.

REFERENCE

[1] Heinzelman W, Chandrakasan A, Balakrishnan H. "Energy-Efficient Communication Protocol for Wireless Micro sensor Networks" Proc. 33rd HICSS, 2000.

[2] N. Vlajic and D. Xia Wireless Sensor Networks: To Cluster or Not To Cluster? WoWMoM'06, 2006.

[3] Vivek Katiyar, Narottam Chand, Surender Soni, Clustering Algorithms for Heterogeneous Wireless Sensor Network: A Survey International Journal of Applied Engineering Research, DINDIGUL Volume 1, No 2, 2010.

[4] I. F. Akyildiz, W. Su, Y. Sankara subramaniam, E. Cayirci, "Wireless sensor networks: a survey, Computer Networks", 38 (4) (2002) 393-422.

[5] P. Krishna, N.H. Vaidya, M. Chatterjee, D. Pradhan, "A cluster-based approach for routing in dynamic networks, ACM SIGCOMM Computer Communication Review", 27 (2) (1997) 49-65.

[6] B. McDonald, T. Znati, "Design and performance of a distributed dynamic clustering algorithm for Ad-Hoc networks", in: Proceedings of the Annual Simulation Symposium, 2001.

[7] V. Mhatre, C. Rosenberg, D. Kofman, R. Mazumdar, N. Shroff, "Design of surveillance sensor grids with a lifetime constraint", in: 1st European Workshop on Wireless Sensor Networks (EWSN), Berlin, January 2004.

[8] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "Energy efficient communication protocol for wireless micro sensor networks", in: Proceedings of the 33rd Hawaii International Conference on System Sciences (HICSS-33), January 2000.

[9] W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, "An application specific protocol architecture for wireless micro sensor networks", IEEE Transactions on Wireless Communications 1 (4) (2002) 660-670.

[10] G. Smaragdakis, I. Matta, A. Bestavros, "SEP: A Stable Election Protocol for clustered heterogeneous wireless sensor networks", in: Second International Workshop on Sensor and Actor Network Protocols and Applications, 2004.

[11] L. Qing, Q. Zhu and M. Wang, "Design of a distributed energy-efficient clustering algorithm for heterogeneous wireless sensor networks," Computer Communications, Vol. 29, pp. 2230–2237, 2006.

[12] R. K. Gupta, "Genetic Algorithms-an Overview", IMPULSE, ITM University, Vol. 1, 2006.