

# Clustering and Energy Efficient Routing Protocol for Wireless Sensor Network using Genetic Algorithm

Amit Singh  
Computer Science  
Ajmer, India

Khushbu Babbar  
Computer Science  
Ajmer, India

Apeksha Malik  
Computer Science  
Ajmer, India

## ABSTRACT

Energy consumption is the most important issue in wireless sensor networks. In wireless sensor network, node is battery driven so when the data is transferred or received by node energy is consumed and lifetime of node gets decreased. So in order to increase the network lifetime, we propose an energy efficient routing protocol for wireless sensor network for randomly deployed sensor nodes. The basic purpose of the project is to develop a new routing protocol for the Wireless sensor network (WSN) under hierarchical approach. A sensor network is composed of a large number of sensor nodes which consist of sensing power, computation and communication capabilities. The major entities in WSN are sensing node, base station, and end user. Clustering is used as key techniques in energy efficient routing protocol. Genetic algorithm is used for selection of cluster head. In this protocol multi hop communication is used between the cluster heads and cluster head to base station. For cluster head selection, each node calculates its fitness function which is based on distance, energy and probability and uses distribution function for crossover. MATLAB is used for the simulation. The routing protocol produces optimal cluster heads for wireless sensor network for the communication which results in nodes alive for the long time a comparison of algorithm with benchmark algorithms is also performed. Simulation results shows that propose algorithm increases the network lifetime

## Keywords

Wireless sensor network, Energy, Base station, Cluster, Genetic algorithm

## 1. INTRODUCTION

A Wireless Sensor Networks (WSN) is a set of hundreds or thousands of micro sensor nodes that have capacity of sensing and establishing wireless communication between nodes and doing computational and processing operations. A wireless sensor network consists of sensor nodes deployed over geographical area for monitoring physical phenomena like temperature, humidity, vibrations and so on. WSN consists of one or more base stations (or sinks) and a large number of sensor nodes which are used for monitoring or sensing data. Wireless nodes are smaller in size and power supply is limited which is provided by a small battery which cannot be replaced or recharged frequently when deployed in a non-reachable places.

The rest of the paper is structured as follows. In section 2, we briefly review about the genetic algorithm. Section 3 provides brief description about network preliminaries. In section 4 proposed approaches is explained Section 5 describes the simulation parameters and assumptions made. Section 6

presents the experimental setup and simulation results. Section 7 concludes this paper by describing the summary of results obtained.

## 2. GENETIC ALGORITHM

Genetic algorithms are randomized search and optimization techniques guided by the principles of evolution and natural genetics. Initially, the genetic algorithm begins with a random population that consists of genes. In the next step, the algorithm lean individuals toward the optimum solution through repeated processes such as crossover and selection operators.

Steps used in proposed genetic algorithm are:

Begin

1.  $t=0$
2. Initialized population  $P(t)$
3. Computer fitness  $P(t)$
4.  $t=t+1$
5. If termination criterion achieved go to step 10
6. Select  $P(t)$  from  $P(t-1)$
7. Crossover  $P(t)$
8. Mutate  $P(t)$
9. Go to step 3
10. Output best and stop

End

## 3. NETWORK PRELIMINARIES FOR THE PROPOSED WORK

- Simulation is performed in MATLAB
- The network is homogenous and all nodes have same initial energy and probability  $p$ .
- A network with 100 nodes deployed randomly over an area of size  $100 \times 100 \text{ m}^2$ .
- All nodes consume same energy for transmission and reception.
- Data aggregation is done by the Cluster Head.
- A node, which has become cluster head, shall be eligible to become cluster head after  $1/p$  rounds.
- Energy of transmission is depends on the distance (source to destination).

## 4. PROPOSED APPROACH FOR CLUSTERING USING GENETIC ALGORITHM

The methodology used for clustering and energy efficient routing protocol we used Genetic algorithm for selection of cluster head. In this protocol multi hop communication is used within cluster and cluster head to base station. For cluster head selection, each node calculates its fitness function which is based on energy, probability and distance between base station and node. Selected nodes send its information to base station. Base station performs the genetic algorithm to select the best cluster head and then non cluster head send their data to near cluster head and these cluster head forward data to their near head cluster head or base station which results in nodes alive for the long time. Proposed clustering and routing algorithm works in rounds. In this study, multi-hop communication is used within the normal nodes and from cluster head to BS. Each round consists two phases- Initial phase and Steady phase. In Initial phase all nodes send the residual energy, distance and probability parameters to the own fitness function. The nodes with maximum result of fitness function are choosed by the network administrator and notify its candidacy as cluster head to the BS. The aim of the project is to find the cluster heads with higher capabilities and distribute them in the network so that the total network energy consumption is minimized.

### 4.1 Initial Phase

In initial phase of each round a population and fitness function is be used to select cluster head and cluster member. In first round of algorithm choose  $M$  initial cluster heads  $a_1, a_2, \dots, a_M$  from the  $n$  nodes  $\{y_1, y_2, \dots, y_n\}$ . Then cluster member will be selected for each cluster head.

Step1: At the beginning all nodes have same probability to become a cluster head.

Step2:  $F(x)$  is the fitness function used to select the cluster head and defined as

$$F(x) = (G(n) * E(r) * D)$$

Where

$G(n)$  = Probability of node to become cluster head as used in LEACH

$E(r)$  =Node residual energy

$D$  = Distance between node and base station

#### Step 3:

After calculating the built in  $F(x)$  function each node start a counter till predefined threshold value. For each network, network administrator decides number of cluster heads. The first node which reaches at a predefined threshold value will send its candidature to the base station for cluster head selection.

#### Step 4: Selection of Cluster Head

BS selects the cluster head and the result is sent to the network. At the base station selected number of nodes introduced themselves as the candidate of cluster head.

Single-point crossover is performed using a distribution function on candidate nodes which is selected and mutation is

performed. After this base station selects a chromosome that has minimum difference of energy from last round and with best probability and high distribution function as cluster head. Other nodes tie to the closest CH.

**Step 5:** BS sends the message to selected CH

#### Step 6: Cluster Formation

Selected cluster head send advertisement to cluster nodes or normal nodes. Normal nodes join to closest cluster head to form cluster.

### 4.2 Steady State Phase

After initial state each node knows its CH. Cluster head receive only one packet from member nodes of the cluster in each period. Cluster head aggregate and compress the data received from the attached normal node. After defining the head cluster in the initial phase, the multi-hop communication is used for transmission and the cluster head send controlled messages to the nearby cluster heads and the perfect path would be chosen. The perfect path is a way which the cluster head has more energy and closer distance to the base station and has no traffic. Then the data after being collected by the head cluster are sending to the same path and these would go on in the next cluster head until it is sent to the base station.

**Step 1:** Send a control message by cluster head to their surrounding cluster heads.

**Step 2:** The best head cluster is choose among all heads cluster which has best output for routing data.

**Step 3:** Check selected head cluster for traffic status and select other head cluster if traffic has happened.

**Step 4:** Send data to Specified head cluster.

**Step 5:** Execution steps 1 to 4 until the base station receive packets

## 5. SIMULATION PARAMETERS

Table 1: The values of genetic algorithm

Parameter	Value
Initial population	100
Crossover rate	0.5
Mutation rate	0.5

**Table 2 Simulation parameter for Proposed Algorithm**

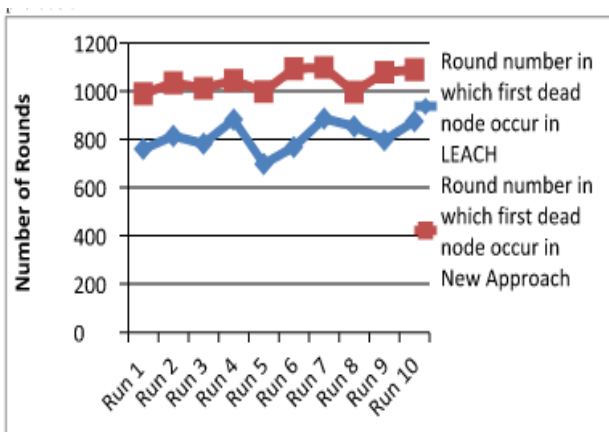
Parameter	Values
Simulation Round	8000
Number of nodes	100+1(Node + BS)
Topology Size	100 X 100
Probability	0.05
Initial Node Power	0.5 Joule
Nodes Distribution	Nodes are Randomly Distributed
Energy for Transmission (ETX)	50*0.000000001
Energy for Reception (ERX)	50*0.000000001
Energy for Data Aggregation (EDA)	5*0.000000001

## 6. SIMULATION RESULTS

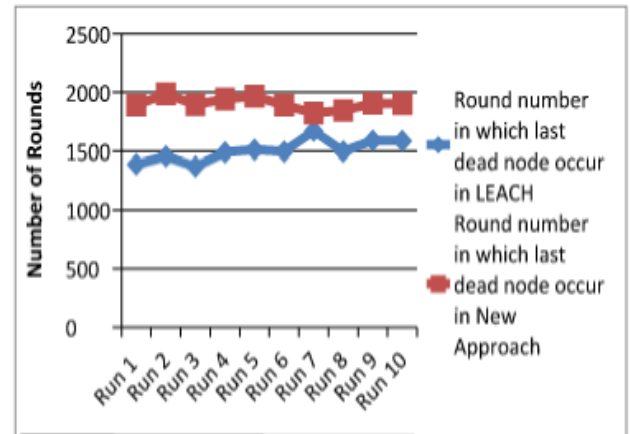
Simulation shows the following results in different scenario

### 6.1 Comparison of LEACH and New Approach

In this simulation result, the comparison is done between new approach and benchmark algorithm. In this the data is sends directly to base station which shows that the proposed algorithm increases the network lifetime by comparing with the LEACH protocol.



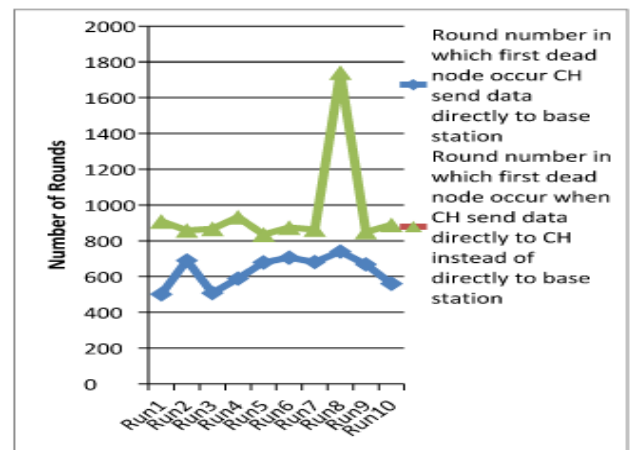
**Fig 1. Number of Round in which first dead node occur**



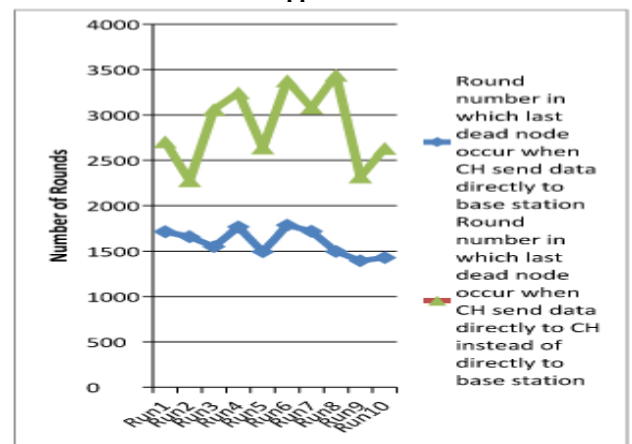
**Fig 2: Number of round in which last dead node occur**

### 6.2 Round number in which dead node occur in New Approach

In this simulation result, the comparison is done between two new approaches. First one the cluster head sends data directly to base station and second, the cluster head sends data to near cluster head instead directly to base station. In this round number is compared for first and last dead node for both the approaches which shows that by sending data to near cluster head instead of base station increases the network lifetime by consuming less energy.



**Fig 3. Number of Round in which first dead node occur in new approach**



**Fig4: Number of Round in which last dead node occur in new approach**

## 7. CONCLUSION

This paper presents the simulation result Table 8 shows the comparison and the number of rounds after which first dead node and last dead node occur in the network using LEACH and new approach. Table 9 shows the comparison and the number of rounds after which first dead node occur in the network when data sends directly to base station and data sends near CH instead of base station in new approach. The results show that the proposed approach outperforms LEACH terms of lifetime of network. We compared the LEACH protocol with the new technique under the same simulation condition and values. As results shows that the number of round in which first round dead is 734 from 10 simulations with LEACH protocol is increased to 1043 rounds with proposed algorithm. The proposed technique has improved the performance in terms of increasing the network lifetime by comparing with LEACH. Table 9 shows the results that the number of round in which first and last dead nodes when data is sends directly to base station are 1043 and 1904 is increased to 1861 and 2877 respectively when data is sends to near CH instead of base station.

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