Network Lifetime Improvement Mechanism based on Genetic Recovery and its Comparison with CHEF and LEACH Algorithm

Zaid Alhemyari [1] , Bhagyashri Pandurangi R [2]

[1]*Department of Electronics and Communication*
KLS Gogte Institute Of Technology
Belgavi, India
zaidalhemyari@gmail.com

Assistant Professor
[2] *Department of Electronics and Communication*
KLS Gogte Institute of Technology
Belgavi, India
brpandurangi@git.edu

***Abstract*— Wireless Sensor Networks (WSN) has been used in a wide variety of applications ranging from enemy vehicle detection to delivery of television packets. WSN nodes are also subjected to limited battery capacity and memory capabilities. When the nodes participate in the routing process and then send the sensed data towards the destination node, they will lose their energy drastically over a period of iterations and eventually get converted into holes and reduces the overall lifetime of the network. In order to reduce the number of holes and periodically recover the dead nodes in the network GENETIC CHEF algorithm is proposed which will find the faulty nodes in the network, Once the faulty nodes are found out it will find the chromosomes, after finding chromosomes it will find the best two chromosomes, after that crossover concept is applied which will generate new population set, for the new population set one of the bit is changed and then few of the dead nodes are recharged so that network lifetime is improved. The GENETIC CHEF is also compared with CHEF and LEACH algorithms with respect to the Number of Alive Nodes, Number of Dead Nodes, Lifetime Ratio, and Residual Energy.**

***Keywords*— Cluster Head, Fuzzy Logic, Crossover, Mutation**

I. INTRODUCTION

WSN is a trend that is used in many industrial and economic fields. The main aim of WSN is to collect the sensed data and then send it towards the receiver [1] and this takes a more amount of energy and also the energy consumption depends on the energy required for transmission, reception, and distance and attenuation factor. Since the energy and distance are directly proportional to each other. As the distance increases the energy consumed also increases. A special node known as Cluster Head (CH) is used as an intermediary node responsible for communication between two different areas/clusters. The energy dependence is provided in the equation (1)

$$Ec = 2 * Etx + Egen * D\hat{}delta \qquad (1)$$

Where,
Ec= energy consumed on a link
Egen= energy required for packet generation
Etx= energy required for transmission
D= distance between nodes
delta= attenuation factor

In a sensing environment, the sensor nodes detect the activity and propagate the information to a special node [2] which renders the information to the internet. The nodes who participate in the sensing paradigm will lose their energy drastically with respect to time. When the data is transmitted hop by hop there will be holes created in the path which increases the packet drop ratio in the network.

Consider that there is huge amount of data that is transferred to the cluster head from the normal nodes. This data collection can be transmitted in a better fashion to control station by making use of mobile sink node which is the hot topic in the field of routing and also helps in achieving better Network Lifetime and efficient performance.

LEACH [3] is an algorithm that selects the cluster head in a random fashion in each cluster. The normal nodes and CHs both maintain local topology. There is a lot of back and forth propagation which will happen between the normal node, CH and Base station which increases the delay, routing overhead and energy consumption and eventually leads to more amount of dead nodes in the network.

LEACH is enhanced by selecting the CH based on the combination of two parameters namely energy and transmission distance into the fuzzy engine and then obtaining the chance value for the node to become the CH. The routing process will happen in less number of hops due to the maintenance of global limited topology by CH and local topology by normal nodes and this method is called as CHEF [4]

Many approaches present in the literature which work on sleep scheduling, data collection techniques in order to reduce energy consumption and help in improving the lifetime of the network. The techniques talk about making use of the sink node and making use of optimized routing techniques.

The proposed method will trigger periodically. It will transform the region into multiple clusters. Each cluster will select the cluster head based on a fuzzy truth table and the node with a better chance will be elected as the cluster head. The normal nodes and cluster heads are used in the routing process. As the number of iterations increases periodically genetic algorithm is triggered to find faulty nodes and recover few or all of them so that there is a balance between the network lifetime and radio frequency cost.

II. BACKGROUND

CHEF [5] makes use of a fuzzy based mechanism for the local cluster head election. The advantage of using a fuzzy based scheme is that the cost for computation and also lifetime ratio is improved. The sensor nodes communicate among themselves in order to compute the CH

In order to improve life expectancy, the LEACH was modified and an improvement was suggested by Nguyen et al [6].

The fixed relay stations can be placed randomly in the network and a then a good amount of energy balancing can be achieved to improve the lifetime ratio as proposed by Wang et al. [7]

The suggested protocol by Yu-Chen and his co-authors [8] can be used in path restoration and monitoring of the network in an energy efficient approach in order to discover the moving target. In some instances, there might be a chance for a connection to be linked or broken.

The mobile station can be used for all transmissions and the base station is selected by measuring the average energy for the cluster which provides an energy efficient routing mechanism as proposed by Xun-Xin, Yuan, and Zhang Rui-Hua in [9]

The entire sensor region is classified and also each node is assigned a specific task. The routing process is divided into the setup phase and data forwarding phase with the help of hierarchy-based routing [10].

The communication between the two clusters can be a single hop based or multi-hop based and then the data packets are sent towards the base station in either way. The hop based approach is also compared with existing routing processes [11]

The prediction method makes use of techniques which can determine the location of the receiver and then send data from static data source to the mobile station with efficiency in terms of delay and energy efficiency and performs better than conventional routing [12]

When the routing packets can be sent towards the receiver based on a mobile assistance method using sink [13]. The method also reduces the number of links in order to send data towards the sink which will decrease the amount of delay and then increase the network lifetime.

Mobile Sink Assisted Energy Efficient Routing Algorithm (MSA) [14] makes use of a low number of hops. The mobile sink will reduce the energy required for transmission and also since the data collection is done by sink the hops are also reduced.

The issues which come in the way of energy control mechanism are discussed [15] along with two different categories of methods like active and passive. The energy management and energy control mechanism and the amount needed are also provided.

Mobile sink based Energy-efficient Clustering Algorithm (MECA) [16] makes use of a predetermined path by the sink. The entire area is divided into clusters and CH will be obtained by making use of residual energy levels of the nodes. The normal nodes within an area will send data to CH and then data is sent to sink.

III. NODE PLACEMENT MECHANISM

Node is a device that has three parameter representation Residual Energy, Buffer Representation and Sensor entity (R,B,S). The network is a combination of several (R,B,S) with the limits of an area given by $x_s x_e, y_s$ *and* y_e. Where x_s is the starting point of an area with respect to x, x_e is the ending point of an area with respect to x. y_s is the starting point of an area with respect to y and y_e is the ending point of an area. Two nodes cannot be placed at the same location. All nodes should satisfy the condition $(X_1, Y_1) \neq (X_2, Y_2)$. The placement of nodes in a single cluster can be done using the process as described in Algorithm1 presented in Fig1.

Algorithm1: Node Placement for simulation

Input: N_n, x_s, x_e, y_s, y_e

Output: Node Placement Matrix (NPI)

Detail Steps:

a) $k = 1$

b) $k : 1 ---> N_n$

c) Generate a x value of node which satisfies the objective function

$x_k = v, \ any\ v\ which\ satifies$

$x_s \le v \le x_e \ \& v \ne x_h$

d) Generate a y value of node satisfies the objective function

$y_k = v\, any\ v\ which\, satifies$

$y_s \le v \le y_e \ \& v \ne y_H$

Where,

$x_H - history\ of\ x\ positions\ previously\ assigned$

$y_H - history\ of\ y\ positions\ previously\, assigned$

$(k,(x_k, y_k))$

k (x_k, y_k)

IV. CLUSTER FORMATION MECHANISM

Cluster Formation is responsible for spreading the nodes across multiple clusters in the network. For each of the cluster indpendently node placement algorithm is executed and the nodes are placed in that area. The cluster formation for the four clusters in the network is shown in Fig2.

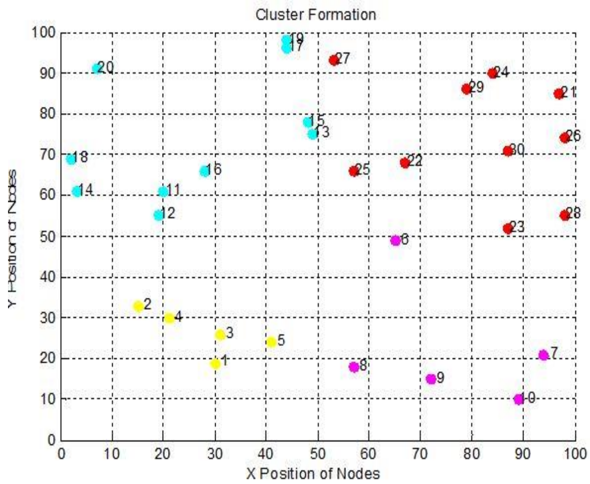


Fig2. Cluster Formation Algorithm

Cluster Formation will spread the nodes in multiple clusters. Cluster 1 will have the endpoints as (1, 50, 1, 50) and a number of nodes are 5. For Cluster 1 the node placement algorithm is executed and 5 nodes are placed with the limits of 1 to 50 x and 1 to 50y. In a similar fashion, the cluster formation is executed for Cluster2, Cluster 3 and Cluster 4.

V. BATTERY UPDATION

The node loses its energy whenever nodes participate in routing. Suppose the routing path ***is s-->i1--->i2-->d***, where s is the source node, i1 and i2 are the intermediate nodes and d is the destination node. The energy consumed between nodes ***s-->i1*** by using a distance of 30m. can be computed using equation (1) and we will get a value of 2* 50 nJ + 100 pJ * 30^0.5 and that will be 0.0055 μJ .The energy required for transmission and generation is defined in table1 as provided by the classical model of energy consumption [17]

Table 1: Energy Computation Values

Parameter Name	Energy Consumption		
Energy required for transmission	50 nJ/bit		
Energy required for generation	100 pJ bit/m		

The dependence of energy consumption on distance by keeping the transmission and generation energy as per table1 can provide the graph as shown in Fig3.

The updated battery energy can be computed by making use of the following equation (2)

$$UEnode = CEnode - Ec \quad (2)$$

Where CEnode is the current energy of each node and Ec is energy consumed on a link.

When the same nodes are used over a period of time, they lose their energy levels drastically and then to become faulty nodes in the network. i.e. If IB represents the initial battery energy during network formation then count of a set of nodes whose remaining energy is less than IB/4 are faulty nodes. Faulty nodes have a negative effect on the lifetime ratio of the network.

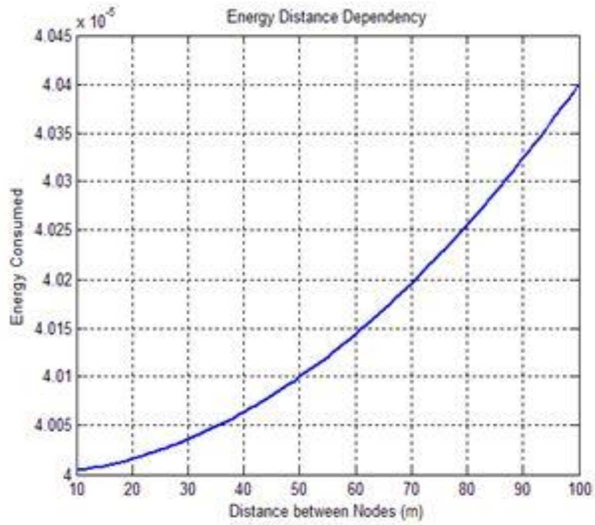


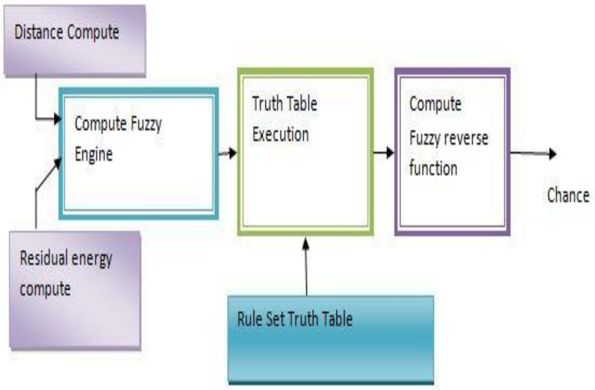
Fig3. Energy Dependence graph

VI. PROPOSED METHOD

The proposed method can be divided into multiple phases namely Cluster Head Election based on the Fuzzy Method, Route Discovery process, Genetic method for recovery of dead nodes periodically.

A. *Fuzzy Based Cluster Head Election*

The sensor nodes will compute the distance from itself to the base station; also collect the information about the residual energy of the nodes. The nodes are classified as FAR, MEDIUM and NEAR based on distance and then nodes are also classified as LARGE, MEDIUM and SMALL with respect to remaining energy. The fuzzy based system for cluster head election is described in Fig 4.



energy. The Trust table defined in Table 2 will be used for Truth Table execution and the fuzzy reverse function is computed to obtain the chance variable.

Table 2: Truth Table Execution

Residual Energy	Local Distance	Chance
LOW	FAR	V.SMALL
LOW	MEDIUM	R.SMALL
LOW	NEAR	SMALL
MEDIUM	FAR	S.MEDIUM
MEDIUM	MEDIUM	MEDIUM
MEDIUM	NEAR	V.MEDIUM
HIGH	FAR	S.LARGE
HIGH	MEDIUM	LARGE
HIGH	NEAR	V.LARGE

B. Genetic CHEF Route Discovery

The Genetic CHEF Route discovery will make use of the following steps

1. Source Node, Destination Node will act as an input
2. Checking whether the source node and destination node will be in the same cluster. If yes, the source node and destination node will communicate with each other directly
3. Check whether source node is the cluster head then execute step5
4. Find the cluster head of the source node
5. Add the Source node and source node cluster head to route
6. The source node cluster head will send the RREQ to all neighboring cluster heads.
7. The destination node cluster head will send a REPLY to source node cluster head
8. The source node cluster head will communicate to destination node cluster head
9. The destination node cluster head will communicate to the destination node.

Genetic Process for Dead Node Recovery

The genetic process for dead node recovery can be defined in the following steps

1. Find the faulty nodes in the network whose remaining energy is less than IB/4
2. Measure the count of faulty nodes
3. If the number of faulty nodes is higher than or equal to 1 then continue with step 4.
4. The four chromosomes are generated with a length equal to number of dead nodes in the network. Each chromosome is a combination of 0's and 1's. For the given set of faulty nodes {7,9,12,22,35,40,45,60,66} the four chromosomes (CM) can be defined as below
   CM1= {0,0,1,0,1,1,0,1,1,0}
   CM2= {1,1,0,0,0,1,0,1,0,1}
   CM3= {0,0,1,0,1,1,0,1,1,1}
   CM4= {1,1,0,0,1,1,0,1,1,0}
5. The fifth step is to select two chromosomes which has highest count of 0s. For example, CM1 has 5 zeros, CM2 has 5 zeros, CM3 has 4 zeros and CM4 has 4 zeros. Hence CS1 and CS2 are filtered as they have highest number of zeros
   C1= {0,0,1,0,1,1,0,1,1,0}
   C2= {1,1,0,0,0,1,0,1,0,1}
6. The two chosen chromosomes {C1, C2} undergo a process known as a crossover in which each of the two chromosomes is divided equally. The division follows the following process
   a. Measure the length of C1 as LC1
   b. Measure the length of C2 as LC2
   c. Measure the half- length of C1 as HLC1
   d. Measure the half -length of C2 as HLC2
   e. Obtain the bits from C1 starting from HLC1 to LC1
   f. Obtain the bits from C2 starting from HLC2 to LC2
   g. Exchange the HLC1 and HLC2 while keeping the starting bits to obtain the cross over sets CO1 and CO2
7. After obtaining the crossover objects {CO1, CO2} the positions of 0 bits are found out in the two crossover objects
8. After finding the position of 0 bits from CO1 one of the 0 bit is randomly changed to 1 to get mutation M1.

9. After finding the position of 0 bits from CO2 one of the 0 bit is randomly changed to 1 to get mutation M2.

VII. Short Notes on Comparison Algorithms

This section describes the algorithms with which the proposed method is compared with LEACH and CHEF

A. *LEACH*

The LEACH algorithm will elect the cluster head. The Source Node will communicate with the destination node if both of them reside in the same cluster. If the source node and destination node are in different clusters then the source node will find cluster head and communicates with it. After that, the cluster head will communicate with the base station. The base station will scan the remaining clusters until the destination is reached.

B. *CHEF*

The CHEF algorithm will find the cluster head based on fuzzy logic. The CHEF routing process will work in a similar fashion as that of the proposed method. The difference is that the proposed GENETIC method will trigger the recovery of dead nodes at regular intervals.

VIII. Simulation Results

In this section simulation results related to the proposed method and its comparison to CHEF and LEACH. Table 3 shows the simulation set up for the result graphs.

TABLE 3. SIMULATION SET UP

Parameter Name	*Parameter Value*
Transmission Energy	20 mJ
Generation Energy	10 mJ
Attenuation Factor	0.7
Topology Generation	Random
Number of Iterations	60
Initial Battery Energy	200 mJ
Number of Clusters	4
Number of Nodes in Cluster1	5
Number of Nodes in Cluster2	5
Number of Nodes in Cluster3	5
Number of Nodes in Cluster4	5

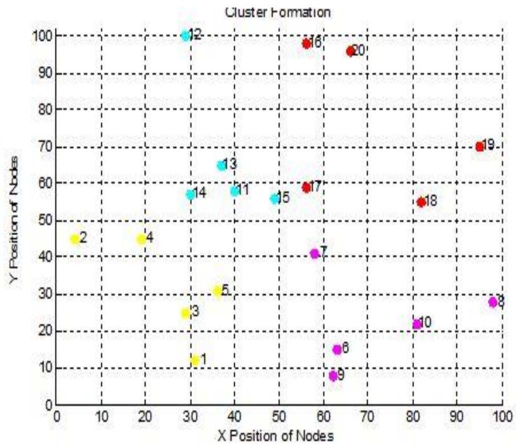


Fig5. Cluster Formation

Fig5. Shows the cluster formation. Cluster 1 has 5 nodes which are {Node1, Node2, Node3,Node4,Node5}, Cluster 2 has 5 nodes which are placed between 51 to 100 on the x and 1 to 50 on the y which are {Node6, Node7,Node8,Node9,Node 10}, Cluster 3 will have 5 nodes which are placed in the range of 1 to 50 on x and 51 and 100 on the y which are {Node11, Node12, Node13, Node14,Node 15}. Cluster 4 has 5 nodes which are place between 51 to 100 on x and 51 to 100 on y which are {Node16, Node17, Node18, Node19,Node20}.

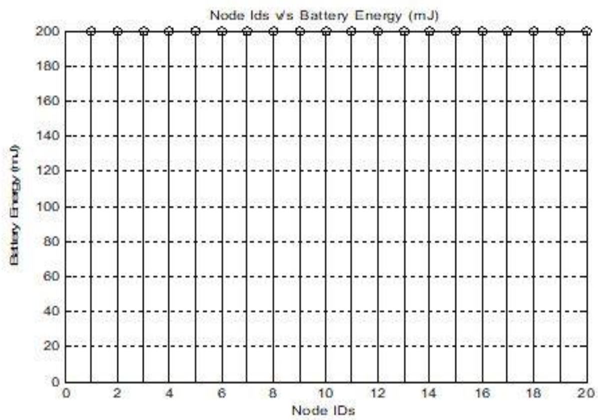


Fig6.Battery Initialization

Fig 6. Shows the battery initialization will be having the same amount of battery level during the network initialization.

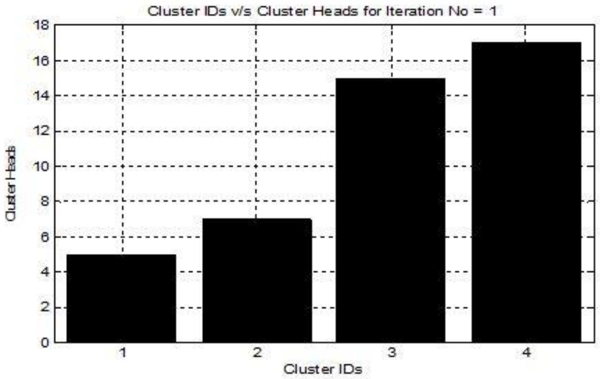


Fig 7. Cluster Head Election

Fig 7 shows the Cluster Head Election. As shown in the fig Cluster 1 has the Cluster head is 5. Cluster 2 has the cluster head is 7, Cluster 3 has the cluster head is 15 and Cluster 4 has the cluster head is 17.

The route discovery of the proposed method is shown in fig 8. Source Node 2 , Destination Node 20. The path between the source node to the destination node and is given by 2→ 5→7→20. The source node cluster head is Node5 and then of destination node cluster head is 7 and the route discovery is given in Fig 8. Like this, the routing process is executed for a period of 10 iterations.

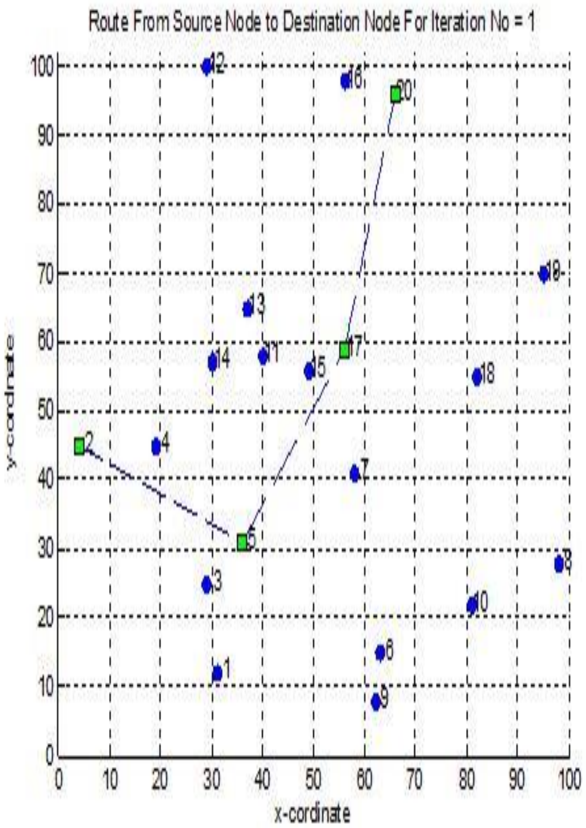


Fig 8. Route Discovery

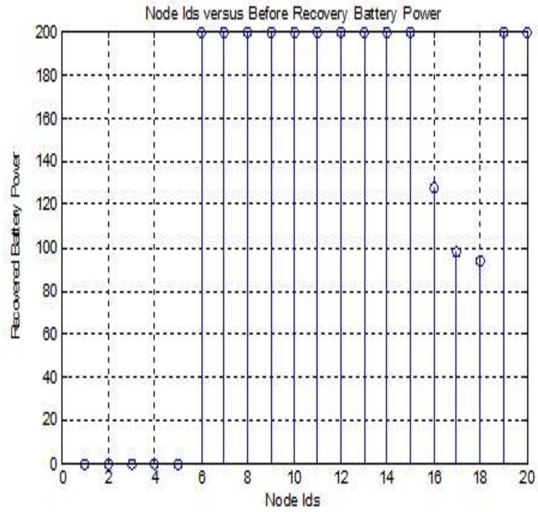


Fig 9. Battery Energy before Node Recovery

Fig 9. Shows the battery energy before node recovery just after 10 iterations. As shown in Fig 9. Node1, Node2, Node3, Node4, Node5 shows that they have lost their battery level completely and then Node 16, Node 17 and Node 18 have lost a little amount of energy because of participating in routing.

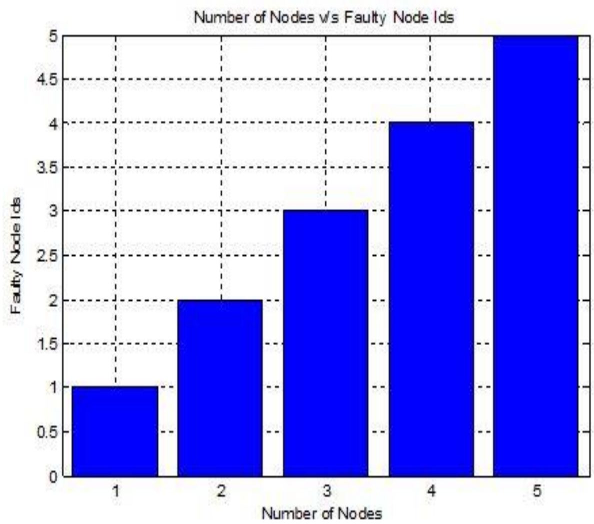


Fig 10. Faulty Nodes across four clusters

Fig 10. Shows that there are 5 faulty nodes. As shown in the Fig the 1st faulty node is Node1, the 2nd faulty node is Node2, 3rd faulty node Node3, 4th Faulty Node is 4 and 5th faulty Node is 5. These nodes are faulty nodes because the remaining energy of these nodes is below 50 mJ because it is less than 200/4.

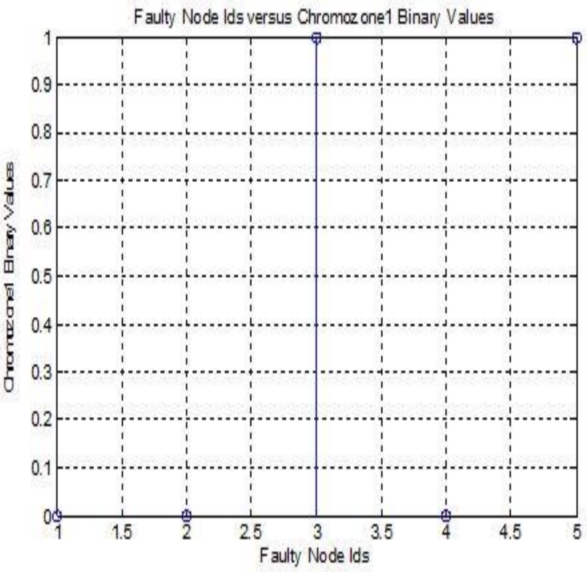


Fig 11. Chromosome1 Formation

Fig 11. Shows the Chromosome Formation in which the for the 5 faulty nodes the first chromosome is {0.0,1.0,1}.

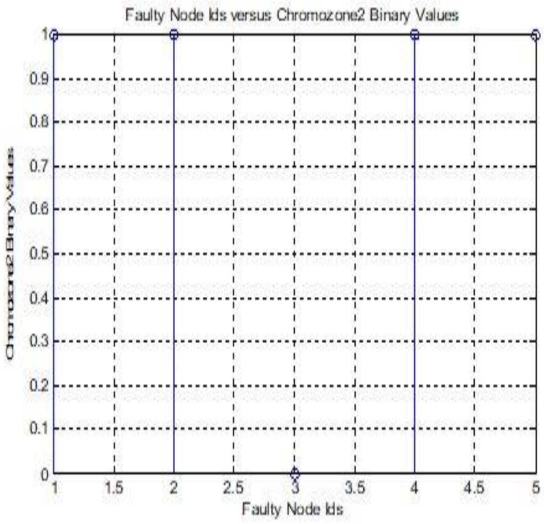
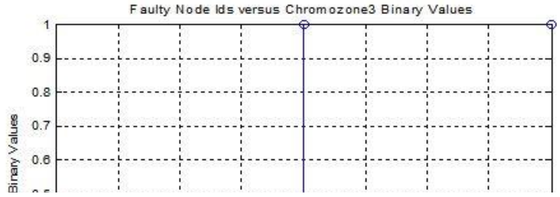


Fig 12. Chromosome2 Formation

Fig 12. Shows the Chromosome Formation in which the for the 5 faulty nodes the second chromosome is {1.1,0.1,1}.



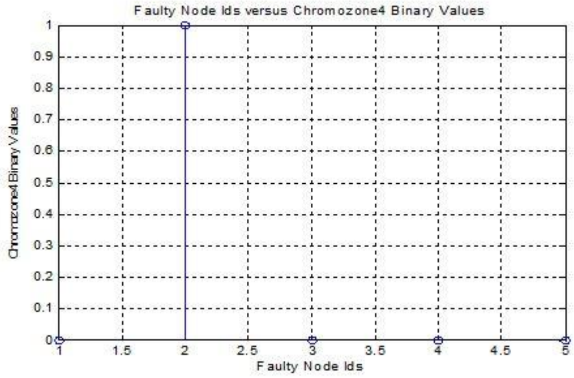


Fig 14. Chromosome4Formation

Fig 14. Shows the Chromosome Formation in which the for the 5 faulty nodes the fourth chromosome is {0.1,0.0,0}.

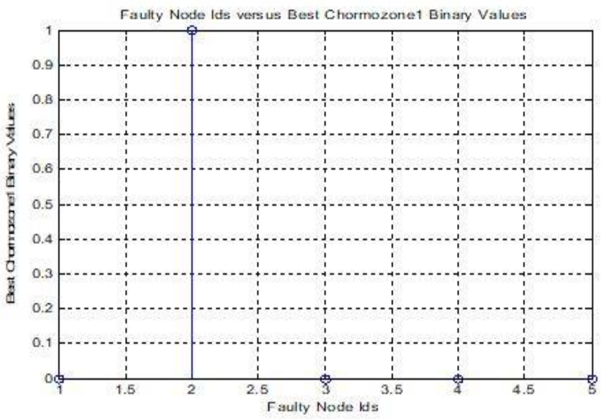


Fig 15. Best Chromosome1 Formation

Fig 15. Shows the best chromosome1 formation which maximum number of zeros and it is {0,1,0,0,0}

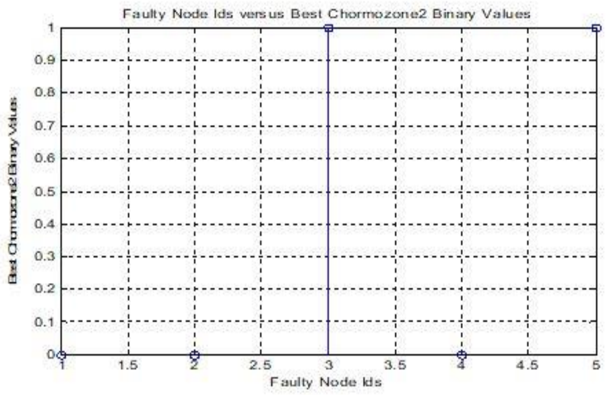


Fig 16. Best Chromosome2 Formation

Fig 16. Shows the best chromosome2 formation which maximum number of zeros and it is {0,0,1,0,1}

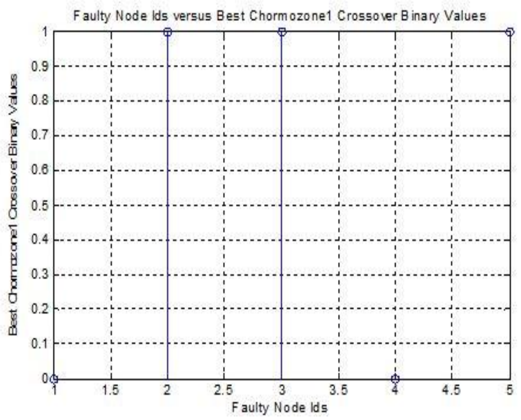


Fig 17. Crossover 1 Formation

Fig 17 shows the crossover 1 for the best chromosomes which is {0,1,1,0,1}

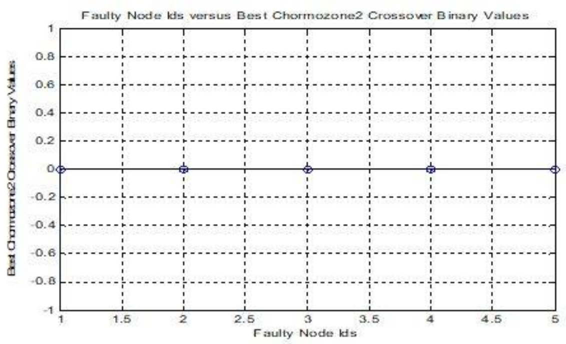


Fig 18. Crossover 2 Formation

Fig 18 shows the Crossover2 formation in which the best chromosomes bits were exchanged to form {0,0,0,0,0}

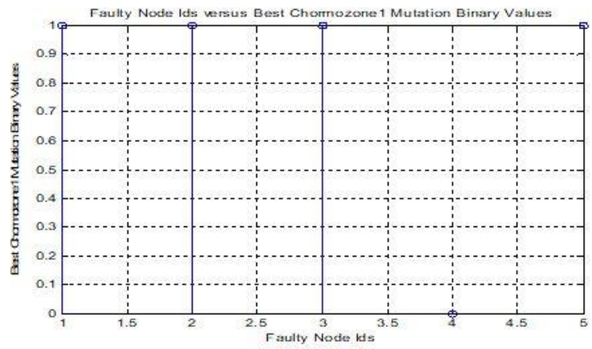


Fig 19.Mutation1 Formation

Fig 19 shows the muatation 1 formation in which one of the bit of crossover object{0,1,1,0,1} is changed from 0 to 1 is {1,1,1,0,1} . In this example the first bit has been changed from 0 to1.

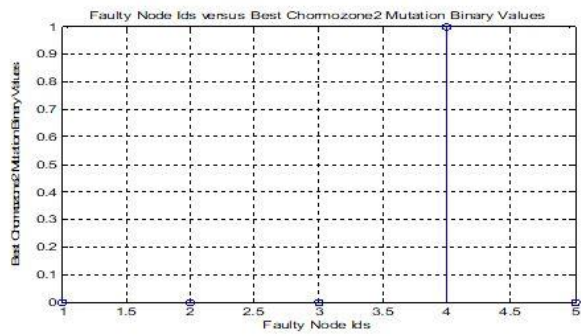


Fig 20.Mutation2 Formation

Fig 20 shows the mutation 2 formation in which one of the bit of crossover object{0,0,0,0,0} is changed from 0 to 1 is {0,0,0,1,0} . In this example, the fourth bit has been changed from 0 to1.

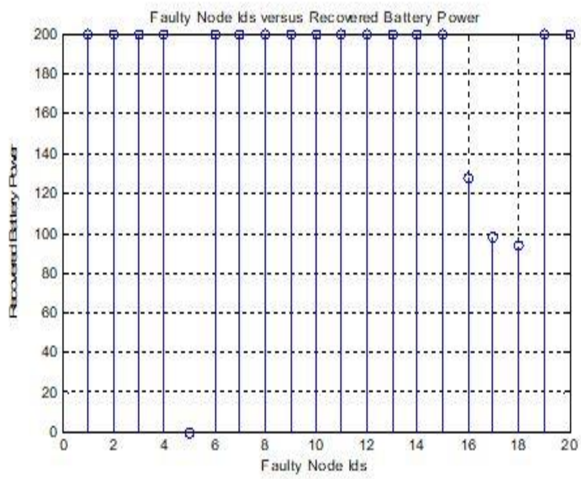


Fig 21. Nodes Battery Energy after the Execution of Genetic

Fig 21 shows the battery energy of four nodes which have been recovered {Node1, Node2, Node3, Node4} after the genetic algorithm is applied and then all the four nodes have been recharged with 200 mJ.

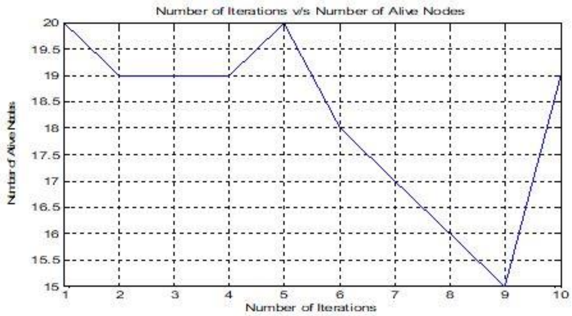


Fig 22. Number of Alive Nodes

Fig 22 shows the Number of Alive nodes for the period of 10 iterations of routing. As shown in the fig at the end of 4 iterations there are 19 alive nodes among 20 and at iteration 5 the genetic is triggered and all 20 nodes are alive. Also at th

ar

al

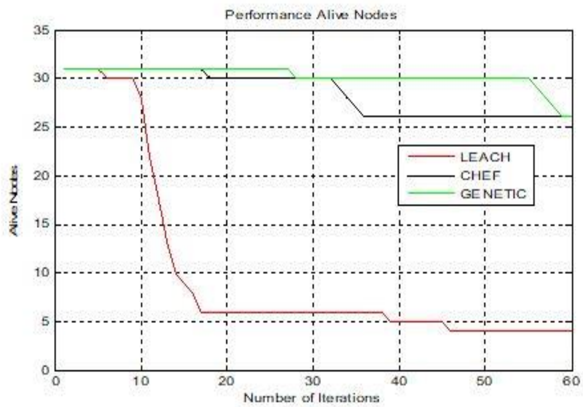


Fig 2

Fig

thre

LEACH has the lowest number of alive nodes followed by CHEF and then GENETIC. The proposed GENETIC method has the highest number of alive nodes on an average as compared to CHEF and LEACH.

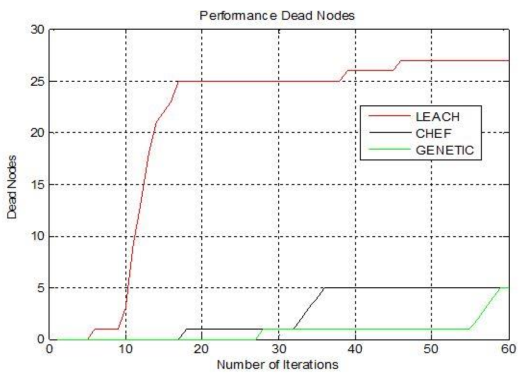


Fig 24 shows the performance number of dead nodes for the three algorithms namely LEACH, CHEF , and GENETIC. LEACH has the highest number of dead nodes followed by CHEF and then GENETIC. The proposed GENETIC method has the lowest number of dead nodes on an average as compared to CHEF and LEACH.

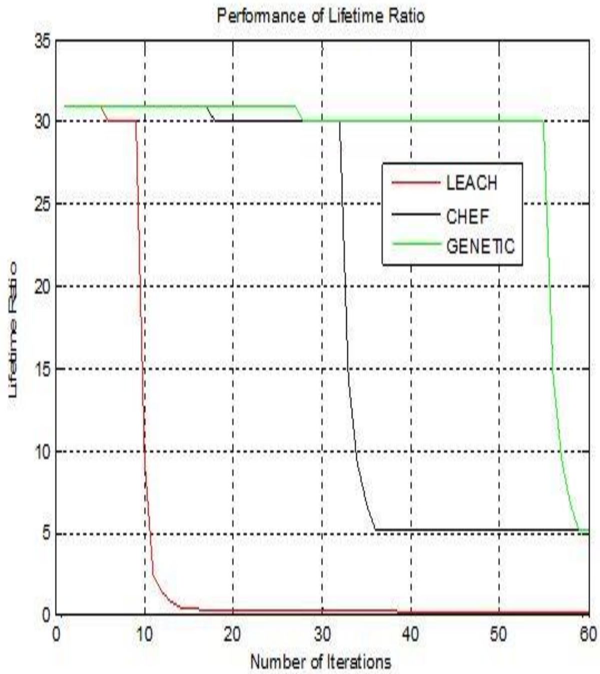
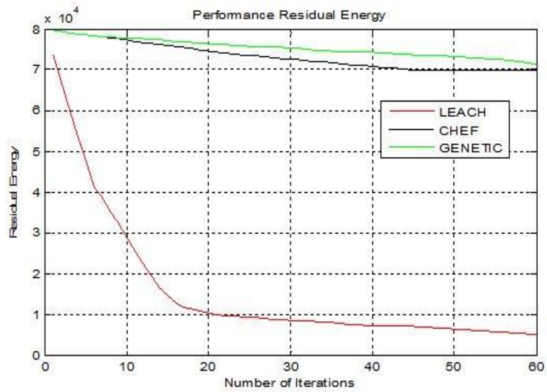


Fig 25 shows the performance of the Lifetime Ratio of the nodes. As shown in the fig the Lifetime ratio of GENETIC will be highest followed by CHEF and LEACH algorithm. The proposed GENETIC method is having a better lifetime as compared to CHEF and LEACH.



hich

as

IX. CONCLUSION

In this paper GENETIC method is proposed which overcomes the disadvantage of the LEACH algorithm. LEACH algorithm picks the cluster head randomly and then during the routing process if the source and destination node are in different clusters then there is a lot of back and forth propagation between the base station and normal nodes. Also since the path is large and path travels large distances and hence will have a direct impact on energy consumption and hence lead to more number of dead nodes in the network as the number of iterations increasing. The GENETIC and CHEF improves the routing process by providing the path with only cluster heads, the source node, and the destination node. The GENETIC method will recover dead nodes at regular intervals by applying chromosomes generation, best chromosome formation, crossover and mutation which will identify the nodes to be recovered so that the overall lifetime ratio can be improved. The paper also presents the simulation results of cluster formation, battery initialization, selection of cluster heads in an optimized manner by making use of the fuzzy engine, route discovery, chromosomes formation, best chromosome selection, crossover, mutation and recover of identified nodes. Also, there is a comparison done between proposed GENETIC, CHEF and LEACH and then proved that with respect to the Number of Alive Nodes, Number of Dead Nodes, Lifetime Ratio, and Residual Energy GENETIC is the best as compared to CHEF and LEACH.

X. REFERENCES

[1] Muhammad Ali Khan,Arif Iqbal Umar, Babar Nazir, Noor ul Amin, Shaukat Mehmood,Kaleem Habib, “Energy Efficient Clustering Using Fixed Sink Mobility for Wireless Sensor Networks”, (IJACSA) International Journal of Advanced Computer Science and Applications,Vol. 7, No. 2, 2016

[2] Sonu Pant,Ramesh Kumar,Ajeet Singh, “Adaptive sink transmission and relocation to extend the network lifetime of wireless sensor network,” 3rd International Conference on Advances in Computing,Communication & Automation (ICACCA) (Fall) September 2017.

[3] W. R. Heinzelman, A. Chandrakasan and H. Balakrishnan, “An application-specific protocol architecture for wireless microsensor networks”, in IEEE Transactions on Wireless Communications, 1(4), 660 – 670, 2002.

[4] Jong-MyoungKim, Seon-HoPark, Young-Ju Han, and Tai-Myoung Chung (2008), “CHEF: Cluster head election mechanism using fuzzy logic in wireless sensor networks”,ICACT, 654-659, 2008.

[5] E.H. Mamdani, and s. Assilian, “An experiment in linguistic synthesis with a fuzzy logic 98 controller”, International Joumal of Man-Machine Studies, vol. 7, issue. 1, pp. 1-13, 1975

[6] Nguyen, Lan Tien, Xavier Defago, Razvan Beuran, and Yoichi Shinoda, “An energy efficient routing scheme for mobile wireless sensor networks” , Wireless Communication Systems, ISWCS'08, IEEE International Symposium, 568-572, 2008

[7] Wang, Jin, Zhongqi Zhang, Feng Xia, Weiwei Yuan, and Sungyoung Lee, “An Energy Efficient Stable Election-BasedRouting Algorithm for Wireless Sensor Networks”Sensors ,13, (11) 14301-14320, 2013

[8] Yu-Chen, Kuo, Yeh Wen-Tien, C. H. E. N. Ching-Sung, and C. H. E. N. Ching-Wen, “A lightweight routing protocol for mobile target detection in wireless sensor networks” ,IEICE transactions on communications ,93,(12) 3591-3599, 2010

[9] Xun-Xin, Yuan, and Zhang Rui-Hua, “An energy-efficient mobile sink routing algorithm for wireless sensor networks” ,Wireless Communications, Networking and Mobile Computing (WiCOM), International Conference ,1-4, 2011.

[10] Sarma, Hiren Kumar Deva, Avijit Kar, and Rajib Mall, “Energy efficient routing protocol for Wireless Sensor Networks with Node and Sink mobility ” , Sensors Applications Symposium (SAS), IEEE, 239 - 243, 2011

[11] Arshad, Muhammad, Naufal M. Saad, Nidal Kamel, and Nasrullah Armi, “Routing strategies in hierarchical cluster based mobile wireless sensor networks”, Electrical, Control and Computer Engineering (INECCE), International Conference, 65-69, 2011

[12] Munari, Andrea, Wolfgang Schott, and Sukanya Krishnan, “Energyefficient routing in mobile wireless sensor networks using mobility prediction”, Local Computer Networks, LCN , IEEE , Conference , 514-521, 2009

[13] A. A. Taleb, T. Alhmiedat, O. Al-haj Hassan, N. M. Turab, “A Survey of Sink Mobility Models for Wireless Sensor Networks”, Journal of Emerging Trends in Computing and Information Sciences, 2013.

[14] Deepa V.Jose and Dr.G. Sadashivappa, “Mobile Sink Assisted Energy Efficient Routing Algorithm for Wireless Sensor Networks”,World of Computer Science and Information Technology Journal (WCSIT), ISSN:2221-0741, 5, (2) 16-22,2015

[15] Pantazis, Nikolaos A., and Dimitrios D. Vergados , “A survey on power control issues in wireless sensor networks”, Communications Surveys & Tutorials, IEEE , 9, (4) 86-107,2007

[16] Jin Wang, Yue Yin, Jeong-Uk Kim, Sungyoung Lee and Chin-Feng Lai , “An Mobile-sink Based Energy-efficient ClusteringAlgorithm for Wireless Sensor Networks”, IEEE 12th International Conference on Computer and Information Technology, 2012

[17] W. R. Heinzelman, A. Chandrakasan, and H. Balakrishnan, “Energy-efficient communication protocol for wireless microsensor networks” in IEEE Hawaii International Conference on Systems Sciences, 2000.