EFFICIENT ENERGY CONSUMPTION IN WIRELESS SENSOR NETWORKS USING OPTIMIZATION TECNIQUE

Rupinder Kaur[1], Mrs. Sonia[2]

[1]*Assistant Professor, Lala Lajpat Rai Institute of Engineering and Technology, Moga, Punjab,* ***bhangu1987@gmail.com***
[2]*Assistant Professor, Punjabi University, Patiala, Punjab*

Abstract

Wireless Sensor Networks (WSN) find wide applications in defense, environmental monitoring like temperature, pressure, vibration, moisture, industrial monitoring, medical monitoring, habitat surveillance etc. The application of WSN consists of small sensor nodes that are low-cost, low power and multi-functional. The most important task of WSN is to send the collected data to the sink node and minimize the energy consumed during data transport. Sensor nodes forming a sensor network usually have limited energy capacity so it is important to minimize sensor nodes' energy consumption because of difficulty in supplying additional energy for the sensor nodes. This paper proposes an optimization of energy consumption in wireless sensor networks. Genetic algorithm is used to optimize this problem. The simulation results showed that Genetic algorithm reduces the energy consumption in wireless sensor networks.

Keywords*—genetic algorithm, sensor network*

---***---

1. INTRODUCTION

With the advance of micro sensor technologies, wireless sensor networks are gaining increasing interest. In many applications of these networks, dense collections of sensors can be deployed in the monitored area to ensure scalability, high-speed communication, and long network lifetime. [1] [2]

Basically, wireless sensor networks are used to gather and transmit data in particular physical environments in which energy consumption is the most important design consideration. The sensor nodes have limited battery power; and they may be located in remote or inaccessible regions, and thus replacing battery packs are almost always impossible. [5]

One of the design methods to efficiently manage the network energy consumption is partitioning sensors into clusters in which one node acts as a cluster head to manage the transmissions of other nodes and to communicate with the far base stations. Clustering reduces the number of long distance communications and hence prolongs the network lifetime [5]. Many protocols had been used to reduce energy usage in Wireless sensor networks. Protocols that were used are like LEACH, ACO, and PSO etc.

2. NETWORK AND RADIO MODEL

In this section, we shall explain assumed network as well as radio model

2.1 Network Model

Set of sensor nodes are assumed that are randomly deployed in the square field to continuously monitor the phenomenon under inspection. Sensor network is assumed which possess following properties.

1. All sensor nodes are having mobility and BS are stationary.
2. Base Station can be placed any where inside the sensing field or away from it.
3. Nodes use power control to tune the amount of send power according to the transmission distance. [1] [4] - [6]

2.2 Radio Model

Currently, there is a great deal of research in the area of low-energy radios. Different assumptions about the radio characteristics, including energy dissipation in the transmit and receive modes, will change the advantages of different protocols. A simple model is assumed where the radio dissipates E_{elec}= 50 nJ/bit to run the transmitter or receiver circuitry and ϵ_{amp}= 100 pJ/bit/m^2 for the transmit amplifier to achieve an acceptable $E_{b/no}$ [1] [4]-[7]. These parameters are slightly better than the current state-of-the-art in radio design1. Energy loss r^2 due to channel transmission is also assumed.

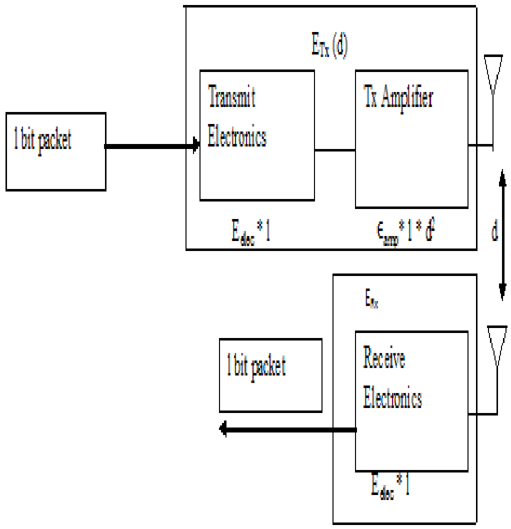

Fig-1: Radio model

Thus, to transmit a l-bit message a distance d using radio model, the radio expends:

$E_{Tx}(l,d)=E_{Tx\text{-}elec}(l)+E_{Tx\text{-}amp}(l,d)$ (1)

$E_{Tx}(l,d) = E_{elec} * l + \epsilon_{fs} * l * d^2$,if $d<d_0$ (2)

$E_{elec} * l + \epsilon_{amp} * l * d^4$, if $d>d_0$

Where threshold d0 is done by:

$d_0 =(\epsilon_{fs} / \epsilon_{amp})^{1/2}$ (3)

and to receive this message, the radio expends:

$E_{Rx}(l) = E_{Rx\text{-}elec}(l)$ (4)

$E_{Rx}(l)=E_{elec}*l$ (5)

3. IMPLEMENTATION

A Genetic Algorithm performs fitness tests on new structures to select the best population. Fitness determines the quality of the individual on the basis of the defined criteria.

3.1 Genetic Algorithm Background

1) Population: A population consists of a group of individuals called chromosomes that represent a complete solution to a defined problem. Each chromosome is a sequence of 0s or 1s

2) Fitness: In nature, an individual's fitness is its ability to pass on its genetic material. This ability includes traits that enable it to survive and further reproduce.

3) Selection: The selection process determines which of the chromosomes from the current population will mate (crossover) to create new chromosomes. These new chromosomes join the existing population. This combined population will be the basis for the next selection.

4) Crossover: Crossover is also known as recombination of component materials due to mating. It is a simulation of the sexual reproductive process which is responsible for the transfer of genetic inheritance. The outcome of crossover heavily depends on the selection of chromosomes made from the population. An example of single-point crossover is shown in Figure 2

	First	Second
Chromosome	11001 | 01100000110	10010 | 10110001110
Offspring	11001 | 10110001110	10010 | 01100000110

Fig-2: A Single Point Crossover

In Figure 2 the bit sequences of first chromosome, starting from the crossover point, are copied to the second chromosome and vice versa. The crossover resulted in two new offspring that have different bit sequence from their parents. Crossover is done after the selection process and depended on the probability defined for the crossover called crossover rate. The probability that the crossover will take place depends on the crossover rate.

5) Mutation: As a result of crossover, the new generation introduced will only have the traits of the parents. This can sometimes lead to a problem where no new genetic material is introduced in the offspring. Mutation allows new genetic patterns to be introduced in the new chromosomes. Mutation introduces a new sequence of genes into a chromosome but there is no guarantee that mutation will produce desirable features in the new chromosome.

	Offspring 1
Original	1001110**1**10001110
Mutated	1001110**0**10001110

Fig-3: Above example showed the mutation example

Figure 3 shows the effect of mutation on the offspring1 created as a result of crossover. During mutation, the eighth bit of offspring 1 is changed from 1 to 0;

3.2 Algorithm Used

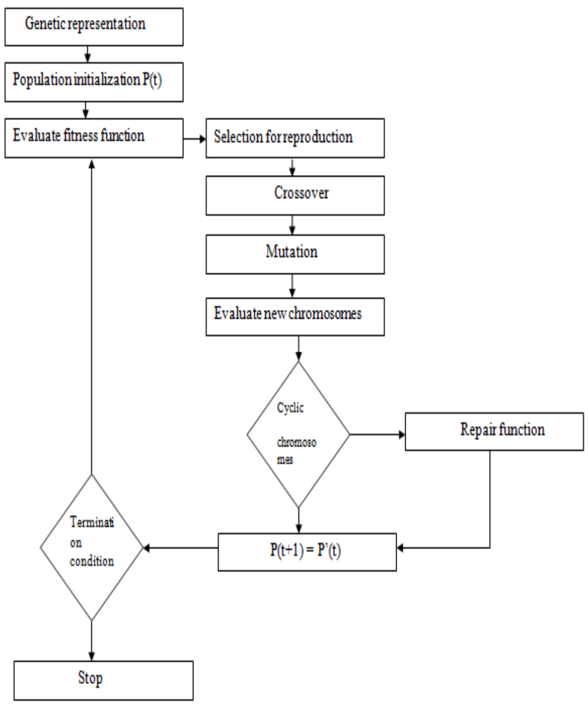

Fig-3.3: GA flow

Genetic Algorithm.

Begin
Create initial population
Evaluate fitness of each chromosome
while (not satisfy termination condition) **do**
Perform selection of two parents from population
Perform crossover
Perform mutation
end
end

3.3 Fitness Parameters

The fitness of a chromosome is designed to minimize the energy consumption and to extend the network life time. A few fitness parameters are described in this section.

In nature, an individual's fitness is its ability to pass on its genetic material. This ability includes traits that enable it to survive and further reproduce. In a GA, fitness is evaluated by the function defining the problem. The fate of an individual chromosome depends on the fitness value. The chances of survival are higher for better fitness values.

The design of objective function should be such that it should consider all the parameters on which minimization of the energy depends. For this purpose, following parameters are considered.

1) Distance between source and node.
2) Weighted coefficients.
3) Threshold distance
4) Mobility factor

Therefore a routing table for decision making should help the routing protocol to select minimum of all the above parameters. For this purpose, for avoiding extreme negative values weighted coefficients are considered for balancing the residual energy.For above states use multi-objective genetic algorithm using goal attainment algorithm having constraints and bounds based on data collected is used.

The point at which calculation of various distances and cosine angles is done, the genetic algorithm tries to find minimum distances from the sink. From all set of values and considering the mobility factor, it calculates energy fraction using energy weights whose sum is equal to 1 between the packet sending and receiving. This weighted variable basically helps to keep the distances which are within the threshold and transmission range closer for creating a link thereby helping us to save energy.

3.4 Fitness function

if (distance > d0 and distance <=transmission range)
F(x) = wt_i +(distance between source and node - do) *(mobility factor - wt_i) (6)
else
F(x) = wt_i + (distance between source and node + d0) *(mobility factor + wt_i) (7)
End

4. SIMULATION AND RESULTS

The main objective of the simulation is to optimize the energy consumption on the basis of system lifetime, energy dissipation in total transmissions achieved, and total transfer distance from network to the BS.

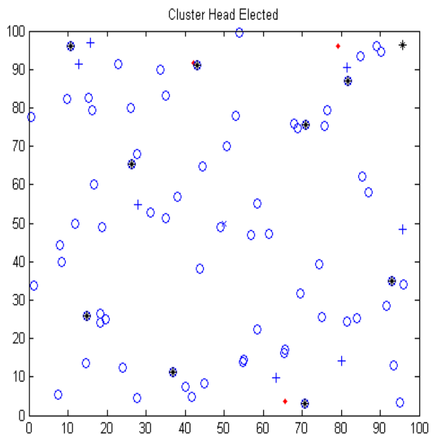

Fig-6.1: Wireless sensor network

In the above diagram wireless sensor network is shown. In this '.' represents dead nodes, 'x' represents sink node, '+' represents nodes whose energy is equal to 1, 'o' represents nodes whose energy is greater than zero, '*' represents nodes which are cluster heads.

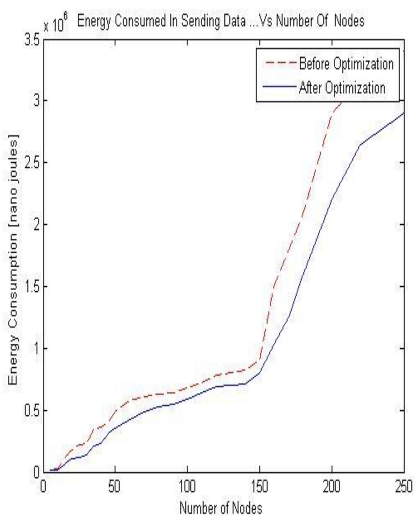

Fig-6.2: Energy consumption in sending versus number of nodes after optimization

In the above graph it is shown that how energy consumption in sending data varies when the number of nodes increases before and after optimization. It can be seen from above graph that from starting i.e. when number of nodes is 1, algorithm starts affecting the energy consumption. This trend continues till the network size of 250 nodes. So it is concluded that energy consumption in sending after optimization is less as compared to energy consumption in sending after optimization.

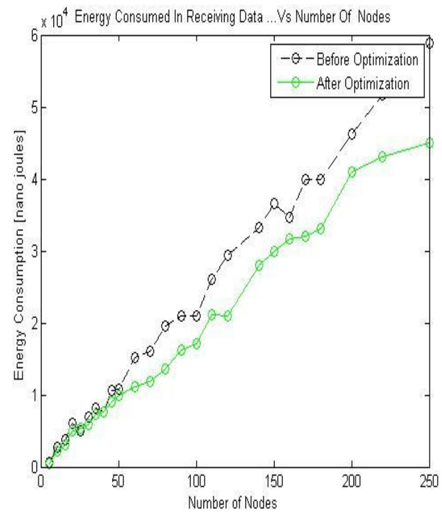

Fig-6.3: Energy consumption in receiving versus number of nodes after optimization

In the above graph it is shown that how energy consumption in receiving data varies when the number of nodes increases before and after optimization. It can be seen from the above graph that initially when the network size is below size of 50, optimization does not really help. But as the network size increases from 50, it is apparent from the graph i.e it is leading to lesser consumption of energy in receiving data. This trend continues till the network size of 250 nodes. So it is concluded that energy consumption in receiving after optimization is less as compared to energy consumption in sending after optimization.

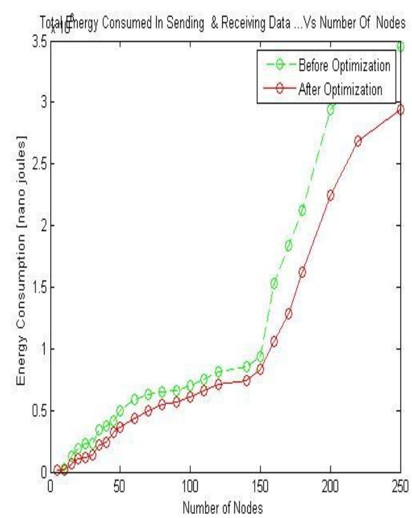

Fig-6.4: Energy consumption in sending and receiving (total energy) versus number of nodes after optimization

In the above graph it is shown that how energy consumption in sending and receiving (total energy) data varies when the number of nodes increases before and after optimization. It can be seen from above graph that from starting i.e when number of nodes is 1, algorithm starts affecting the energy consumption. This trend continues till the network size of 250 nodes. So it is concluded that energy consumption in sending and receiving after optimization is less as compared to energy consumption in sending and receiving after optimization.

CONCLUSION AND FUTURE SCOPE

This is an implementation of the genetic algorithm for wireless sensor networks. The node size is considered as fixed but in random nature which is very essential for wireless scenario. The energy of each node is fixed. The implementation and simulation is done in MATLAB. The proposed genetic algorithm shows the energy consumption decreases after optimization.

For instance, comparison of outage performance of wireless sensor network with other wireless communication systems, such as GSM, WLAN; or simulations with parameters of other sensor node models. Moreover, an extensive study in order to find optimal energy dissipation values for sensor networks can also be included.

REFERENCES

[1] W. R. Heinzelman, A. P. Chandrakasan, and H. Balakrishnan, "Energy Efficient Communication Protocol for Wireless Micro sensor Networks," in Proceedings of the 33rd Hawaii International Conference on System Science, Jan. 2000.

[2] 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, no. 4, pp. 660-70, October 2002.

[3] J. Tillet, R. Rao, and F.Sahin, "Cluster-head identification in ad hoc sensor networks using particle swarm optimization," IEEE International Conference on Personal Wireless Communications, pp. 201-205, December 2002.

[4] N. M. Abdul Latiff, C. C. tsimenidis, B. S. Sharif "Energy-aware clustering for WSN using PSO". The 18th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC'07).

[5] Morteza Ziyadi, Keyvan Yasami, Bahman Abolhassani "Adaptive clustering for energy efficient WSN based on ant colony optimization." 2009 Seventh Annual Communication Networks and Services Research Conference.

[6] M.O. Farooq, A.B. Dogar, G.A. Shah " MR-LEACH: Multi-hop Routing with Low Energy Adaptive Clustering Hierarchy" 2010 IEEE.

[7] Ouadoudi Zytoune, Youssef Fakhri, Driss Aboutajdine "A novel energy aware clustering technique for routing in WSN". Wireless Sensor Network, 2010, 2, 233-238 doi:10.4236/wsn.2010.23031 Published Online March 2010).

[8] Mr. Pottigar Vinayak .V, Dr.Sudhir Sawarkar, Mr.Avinash Gawande "Efficient Energy Consumption In Two Tiered Sensor Networks Using Genetic Algorithm" 2010 International Conference on Advances in Recent Technologies in Communication and Computing.

[9] M.Nesa Sudha,W. Angeline Sujita, Dr.M.L .Valarmathi "MAXIMUM DATA EXTRACTION IN ENERGY CONSTRAINED WIRELESS SENSOR NETWORK USING GENETIC ALGORITHM" Proceedings of the 2008 International Conference on Computing, Communication and Networking (ICCCN 2008)

[10] Sajid Hussain, Abdul W. Matin and Obidul Islam "Genetic Algorithm for Energy Efficient Clusters in Wireless Sensor Networks" IEEE 2007.

[11] J. Kennedy and R. C. Eberhart, "Particle Swarm Optimization," IEEE International Conference on Neural Networks, Perth, Australia, vol.4, pp. 1942-1948, 1995.

[12] D. E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison-Wesley, New York, 1989.