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Genetic Algorithm based Stable Election Protocol for WSN

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Abstract**—**Wireless Sensor Network is an auspicious network in which wireless sensors are disseminated in a region for examining the physical world. Wireless sensor network consists of nodes called sensor nodes that does data acquisition and transmit the acquired data to sink. Since the power source has limited energy, so to prolong the lifetime of WSNs clustering is considered as an effective technique. One of the clustering techniques is Stable Election Protocol. The communication among nodes leads to loss of energy. Once, the energy of node is bygone then that node is declared as dead node and hence the network becomes shaky. The goal of SEP protocol is to improve the stability period of a network. So this paper focuses on increasing the stability period of WSN using Genetic Algorithm (GA). The GA is applied on SEP for the proficiency in stability period.

Keywords**—** Wireless Sensors Network, clustering, energy, stable election protocol, genetic algorithm.

I. INTRODUCTION

Wireless sensor network is network of tiny and battery-powered sensor nodes that are set up over the region for determining the physical phenomena like temperature, rainfall, humidity etc. Sensor nodes usually sense information from the external environment and send it to base station which aggregates this information. Advancement in wireless communications has enabled us to use the sensor nodes for variety of applications such as military, manufacturing, area monitoring etc. A wireless sensor network has expanded to many areas due to low cost or inexpensive nature of sensor nodes such as monitoring, healthcare applications and traffic control.

Data transfers from sensor nodes to sink. Sensor nodes have limited energy. A power source supplies the energy needed for the device to perform the task. This power source consists of battery with a limited energy. It is very difficult to recharge the battery, because nodes may be deployed in a hostile environment and also the sensor network should have a lifetime long enough to fulfill the application requirements. In some cases it is possible to recharge the battery from the external environment by using solar cells. External power supply sources show a non-continuous behavior. Energy conservation is the main issue in wireless sensor network [15]. A sensor node is a tiny device that includes three basic components: Sensing subsystem is used for collected data from surrounding Environment. Processing subsystem is used for local data processing and storage. Wireless communication subsystem is used for data transmission.

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A. MODEL

In Figure 1: Sensor network model consists of one sink node and a large number of sensor nodes deployed over a large geographic area. Data is transferred from sensor nodes to the sink.

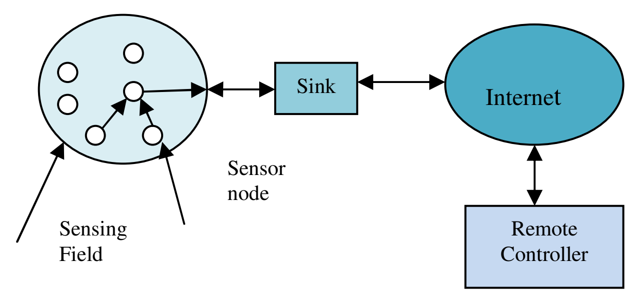

Figure-1 Model of Sensor Network

B. ARCHITECTURE OF WIRELESS SENSOR NETWORK

It consists of following components as shown in Figure 2:

1. A sensing subsystem used for collecting data from the surrounding environment.
2. A processing subsystem including a micro-controller and memory for local data processing.
3. A radio subsystem for wireless data communication.
4. A power supply unit: used to supply power to the device to perform a task.
5. Location finding system :-to find their position
6. Mobilizer:- to change their location

A power source supplies the energy needed for the device to perform the task. This power source consists of a limited energy. It could be impossible to recharge the battery, because nodes may be deployed in a unpractical environment. Energy conservation is the main issue in wireless sensor network [15]. In Wireless Sensor Network number of protocols has been developed to utilize the energy of network efficiently.

II. CLUSTERING TECHNIQUE

This Technique divides the network into different sub networks called clusters. Depending upon special factor value a network is divided into clusters. Each cluster contains cluster head and several ordinary nodes. Clustering can be effective in one to many, many to one, one to all communication [16]. Main idea of clustering is select set of cluster heads among normal nodes in the network. Cluster head is responsible for communication between nodes within cluster or outside their clusters and within each cluster sensor node sends data to cluster head then cluster head aggregates data and sends directly or may through cluster head to observer.

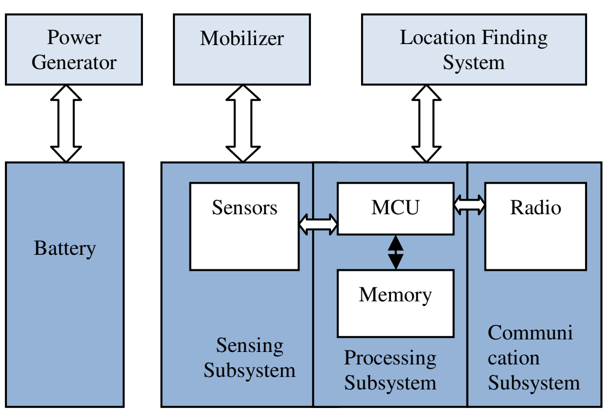

Figure-2 Architecture of Wireless Sensor Network

A. OPTIMAL CLUSTERING

In SEP [12] optimal probability of a node to becomes cluster head is a function of spatial density when nodes are uniformly distributed over the sensor field. Clustering is said to optimal when total energy consumption is minimum and energy consumption is well distributed over all sensors. Such optimal clustering depends on the radio energy model. Radio energy dissipation model is illustrated in Figure-3. In this model L - bit message transmitting over a distance d, the energy expended by the radio is given below:

$$E_{TX}(l,d) = \begin{cases} L.E_{elec} + L.\epsilon_{fs}.d^2 & if\ d < d_o \\ L.E_{elec} + L.\epsilon_{fs}.d^4 & if d \geq d_0 \end{cases}$$

Where E_{elec} is the energy dissipated per bit , ϵ_{fs} and ϵ_{mp} are depend on the transmitter amplifier model and d is the distance between the sender and the receiver.

III. SEP PROTOCOL

SEP is based on weighted election probabilities of each node becomes to be cluster head according to the initial energy in each node [12]. It consists of two types of nodes:-Normal Node, Advanced Node. SEP increases network stability period by efficiently utilizing the energy of advanced nodes by giving them more chance to become cluster head.

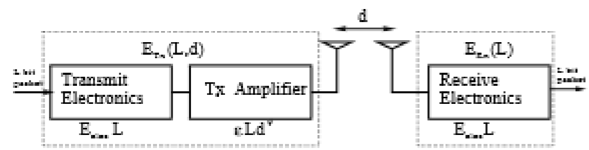

Fig No-3 Radio Energy Dissipation Model

n is total number of nodes, (n*m) is number of advanced nodes and (1-m)*n is number of normal nodes. Advanced node has α times more energy than normal nodes. As reference [12]E_o is initial energy of each normal sensor node. $E_o \cdot (1 + \alpha)$ is energy of each advanced sensor node.
The total energy of the new heterogeneous $= n\cdot(1-m)\cdot E_o + n\cdot m\cdot E_o \cdot(1 + \alpha) = n \cdot E_o \cdot(1 + \alpha\cdot m)$.
Total energy of the network is gained by $(1 + \alpha\cdot m)$ times. The weighed probability for normal node is:

$$p_{nrm} = \frac{p_{opt}}{1+\ \alpha.m}$$

The weighed probability for advanced nodes is:

$$p_{adv} = \frac{p_{opt}}{1+\alpha\ .m}\ (1+\alpha)$$

Threshold of normal nodes is:

$$T(S_{nrm}) = \begin{cases} \dfrac{p_{nrm}}{1-p_{nrm}\ .(r\ \ mod\ \frac{1}{p_{nrm}})} & if\ s_{nrm}\ \epsilon\ G' \\ 0 & otherwise \end{cases}$$

Where r is the current round,
G'is set of non cluster head of normal nodes. If S_{nrm} belongs to be set G'. Assign a random number to S_{nrm}. If the random number is less than $T(S_{nrm})$ then normal node becomes to be a cluster head exactly once every $p_{nrm} = \frac{p_{opt}}{1+\alpha.m}$ rounds

Threshold of advanced nodes is :

$$T(S_{adv}) = \begin{cases} \dfrac{p_{adv}}{1-p_{adv}\ .\left(r\ \ mod\ \frac{1}{p_{adv}}\right)} & if\ S_{adv}\epsilon\ G'' \\ 0 & otherwise \end{cases}$$

where G'' is set of non cluster head of advanced nodes. If S_{adv} belongs to be G''. Assign a random number to S_{adv}. If the random number is less than $T(S_{adv})$ Each advanced node will become to be a cluster head cluster head exactly once every $p_{adv} = \frac{p_{opt}}{1+\alpha.m}(1+\alpha)$per round.

IV. GENETIC ALGORITHM

This algorithm is used for cluster formation and cluster head selection. This algorithm increases stability period by the evaluating fitness function. In the WSNs each node is defined by a chromosome. Two values of binary bits 0 or 1 is assigned to each node. If the value of node is 1 then node is an advanced node otherwise it is a normal node. For the increasing stability of network the genetic algorithm is applied on SEP. The main functions of the genetic algorithm are:

1) *Population:* A population is collection of several chromosomes and a chromosome is a collection of genes. A gene consists of two parts gene index and gene value. The gene index provides the position of the node and gene value provides the nodes value ,and the best chromosome is used to generate the next population.

2) ***Fitness:*** It is power of chromosome to pass on its genetic material[9]. The main aim of fitness of the chromosome is to reduce the energy consumption and to increase the network lifetime. Fitness function is *F = Residual Energy* weight + Distance from sink*

a) ***Residual Energy****:*Residual Energy represents the amount of energy is left to transfer the data Those nodes have high residual assign some weight.

$$R.E = E - E_{Tx}(l,d)$$

Where

$$E_{Tx}(l,d) = \begin{cases} L.E_{elec} + L.\epsilon_{fs}.d^2 & if\ d < d_0 \\ L.E_{elec} + L.\epsilon_{fs}.d^4 & if\ d \geq d_0 \end{cases}$$

.

b) ***Distance from sink***: It represents the distance from node to cluster head and distance from cluster head to sink.

Distance = MAXD - D_i

3) *Selection****:*** It is the method of determining which two chromosomes will mate together to produce a new chromosome. Those chromosomes have higher value of fitness have more chances of matting. We use Roulette Wheel Selection algorithm. In this algorithm individuals are selected with a probability that is directly proportional to their fitness values. Those individuals have largest fitness value have more probability to be chosen. Sum of all fitness values of the individuals is the circumference of the roulette wheel. Let 1, 2,…, n are individual and f1, f2,…, fn be fitness values of individual Then , selection probability is denoted by p_i for individual i is define as

$$p_i = \frac{F_i}{\sum_{j=1}^{n} F_j}$$

4) *Crossover:* It is depend on the selection procedure. It is a binary genetic operation which applied on two chromosomes. Crossover recombines genetic materials of two parent chromosomes to produce a child chromosome.

5) *Mutation:* The mutation adds changes in next generation

V. SIMULATION AND RESULT

The setup is run in 100*100 square meter as sensing area. Randomly 100 sensor nodes are deployed inside the sensing area Sink is located at the center of the sensor network. The initial energy of a normal node is set as E_0 = 0.5 J, α = 3, m = 0.2, ϵ_{fc} =10 pJ/bit/m^2, ϵ_{mp} = 0.0013pJ/bit/m^4 and E_{DA} = 5nJ/bit/report, L= 4000 bits. Figure-4 represents a network of nodes advanced node is represented by +, normal node is represented by o, sink is represented by x and cluster head is represented by *.

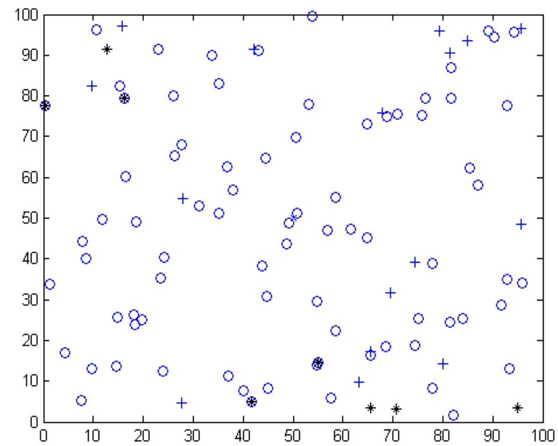

Figure- 4 Network of Sensors

Figure-5 represents the number of alive nodes per round. Alive nodes are those total number of nodes that have not yet spent all of their energy. Figure 6 shows that as number of round increases number of alive nodes decrease. This figure also represents the stability period is the time period from start of network operation to dead of the first node. In SEP Protocol first node is dead at 1330 round but in case SEPGA first node is dead at 1672 round. Hence stability period of SEPGA protocol is greater than the original SEP Protocol. Stability Period of SEPGA is improved 342 rounds.

Figure-6 represents energy dissipation of the network. Energy of network decreases as number of round increase. Sensor nodes use their energy to send data, to aggregate data and to receive the data. The amount of energy available to send, receive and process data at the initial state is less than amount of energy available at final state is called Energy dissipation. This figure shows that energy dissipation is decreases gradually.

VI. CONCULUSION

This paper concludes with implementation, evaluation and analysis of an improved protocol for WSN. SEPGA outperforms SEP in terms of parameters like stability period, energy dissipation. Genetic algorithm is used to optimize

SEP protocol by efficient utilizing the energy of WSN. SEPGA gives the stability period of 1672 rounds as compared to SEP having 1330 rounds with an average increase of 25%.

This work can be extended to by considering three levels of heterogeneity to improve the network lifetime. In SEPGA Protocol, we use two levels of heterogeneity. In future, lifetime of the network is improved by considering three levels of heterogeneity.

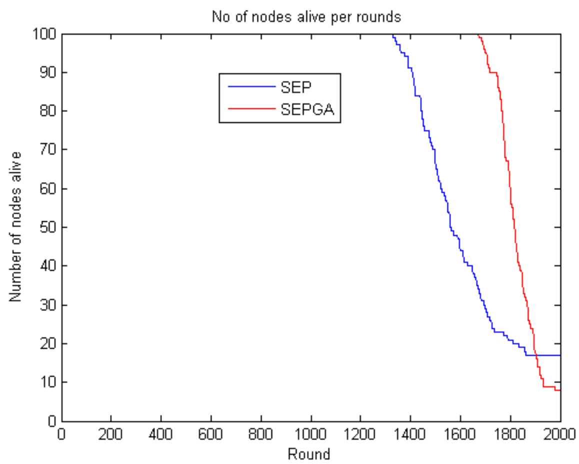

Figure-6 Number of alive nodes per round

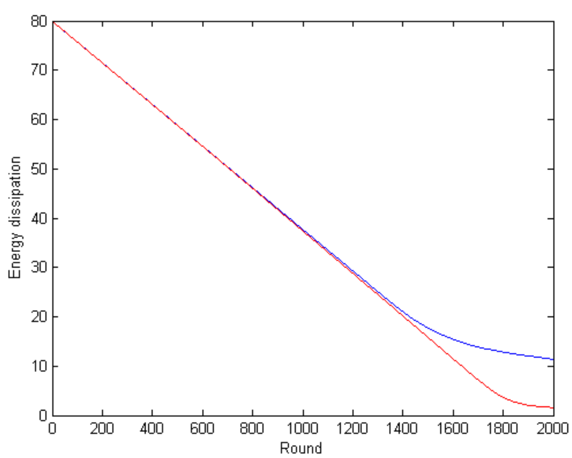

Figure-7 Energy dissipation of network

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