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Optimization Technique to Improve the Lifetime of Wireless Sensor Network

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ABSTRACT: wireless sensor network (WSN) [1] consists of a collection of wireless sensor nodes that sense the application environment, collect the information and send it to the sink node or to the base station. Presently wireless sensor networks are becomes very popular. But the nodes associated with wsn have restricted energy and every node operation required some energy so the efficient energy consumption by the node is main design issue in wsn.Although LEACH-GA is a protocol which not only provides optimal cluster head solutions but also increase the energy efficiency in WSN. But it is very complex and time consuming so here we proposed a technique which reduce time consumption and complexity of GA (genetic algorithm), increase WSN lifetime and also provide more optimal solution for cluster head selection. This paper also presents the comparison of existing and proposed.

KEYWORDS: Wireless Sensors Network, Clustering Algorithm; energy efficiency; optimization algorithm;

I. INTRODUCTION

Wireless sensor networks have wide range of application area such as military applications, field surveillance, Automobiles and many more. Wireless sensor networks consist of various densely deployed sensor nodes inside the application area. Advancement in micro-electro-mechanical-systems (MEMS) provides low cost, small sized and powerful sensor nodes that are capable of data sensing, data processing and wireless communication and have a limited power battery. Sensor nodes work together to complete the task in time and to provide information accurately. Sensor nodes sense the external environment or application area and send the data to base station located inside or outside the network via single hop or multi-hop. User accesses the collected data through some remote access. Sensor nodes work with some limited resources like battery power, bandwidth, memory and etc. Wireless sensor network lifetime depends upon battery power of nodes as every node operation consumed energy. These nodes cannot be replaceable and rechargeable so efficient energy consumption by the nodes is the main design issue in wireless sensor network (WSN) from the circuitry of sensor nodes to application level to network protocols. [2]

Clustering algorithms are considered energy efficient approach for wireless sensor network. Clustering divides the nodes into independent clusters and where each cluster elects one cluster head. Nodes send the collected data to respective cluster head; cluster head (CH) applies data fusion/aggregation to reduce the collected data to some useful information and sends the aggregated data to base station (BS). Communication between two nodes is the main energy consumption process that depends upon the distance between the two nodes. Clustering avoids long distance communication between two nodes and only cluster heads are allow to communicating to base station (BS). To load balance the network, the cluster head is rotated among all nodes. [3]

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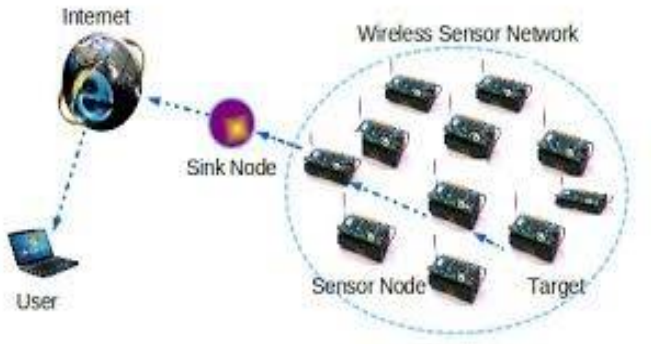

Fig.1: wireless sensor network architecture [4]

II. RELATED WORK

Fan Yiming et al., 2007 [5] Low energy adaptive clustering hierarchy (LEACH) is a fully distributed clustering algorithm. In setup phase, cluster head selection, cluster formation and TDMA scheduling of nodes are performed. In steady phase, nodes send the Data to cluster head and cluster head aggregates the data. Aggregated data is send to base station. Re-clustering is done after a regular period to rotate the role of cluster head among all the nodes that makes network load balance. LEACH does not consider the remaining energy of nodes for cluster head selection that is all nodes have equal probability of cluster head, addresses problem of fixed round time in LEACH. Increase of network lifetime by about 30% can be accomplished.

Wu Xinhua et al., 2010 [6] LEACH-C is centralized variant of LEACH. In setup phase nodes send their energy and location information to base station. Base station applied simulated annealing to select cluster heads and forms clusters. Base station sends the cluster head and cluster information to the nodes along with their TDMA scheduling. Steady phase is same as LEACH. LEACH-C outperforms LEACH to extend network lifetime.

Mu Tang et al., 2010 [7] In each round, after first selection of cluster head (CH) according to LEACH protocol, a second selection is introduced by LEACH-B to modify the number of cluster head in consideration of nodes residual energy. As a result of now the nodes with maximum residual energy choose as cluster heads in second round and only 3% or 5% cluster heads are near optimal per round.

Ningbo Wanget al., 2012 [8] LEACH-R improves the selection of cluster-head (CH) and selected a relay node between all cluster heads. Residual energy of each node is considered during selection of cluster-head (CH. Based on both residual energy and distance from base station, relaying node is chosen from cluster heads with maximum energy to become the relay node between base station (BS) and other cluster-heads.

Asha Ahlawat et al., 2013 [9] In LEACH-V the Vice Cluster head is that alternate cluster head that will perform only when the cluster head will die. As a cluster head died it will be replaced by a vice Cluster head. The new version of improved V- LEACH out performs much better than original version of LEACH protocol and increase the network life time about 49.37%.

Chunyao FU et al., 2013 [10 Proposed a new improved version of LEACH protocol i.e (LEACH-TLCH) which was intended to load balance the network energy consumption of the entire network by selecting two cluster heads within same cluster. And improve the lifetime of the network.

Vipin Palet al., 2015 [11] Presented a genetic algorithm based on cluster head selection for clustering algorithms to have a better load balanced sensor. Proposed solution provides the optimal cluster heads (CHs) and has prolonged sensor network lifetime than the traditional clustering algorithms. But it is very complex and time consuming process so it is need to improve.

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III. PROPOSED WORK

QBGA Algorithm for Cluster Head Selection

Here we used the Queen-bee genetic algorithm to create energy efficient clusters in wireless sensor networks. The Queen-bee genetic algorithm (QBGA) is similar to nature in that the queen-bee plays a major role in reproduction process. The results of the simulation showed that the clustering by the QBGA algorithm decreases the energy consumption with regard to the existing genetic algorithms and increases the lifetime of the network. The HCR (hierarchal cluster routing) protocol is enhanced by using GA to create energy-efficient clusters for a given number of transmissions. But QBGA outcome identifies the more optimal cluster head solutions for the network. The base station assigns member nodes to each cluster head using the minimum distance strategy.Since in QBGA only one mother that is the Queen-bee is necessary and selected for the reproduction of bees and the Queen-bee reproduces many children with a number of the bee-population using the crossover operator, so the number of marriages in the Queen-bee algorithm are much less than that of the genetic algorithm which results increasing the rate of this algorithm as regards the genetic algorithm. So QBGA has fast convergence than GA. And it is done to reduce the time consumption by genetic algorithm.

QBGA Procedure

Like GA in QBGA first encoding is done. The cluster head and member nodes are represented as 1s and 0s respectively. Then QBGA starts with possible number of solutions and each solution individually called as chromosomes. The fitness of a chromosome is determined by several parameters, such as node energy and node distance from the base station consumption. The fitness function is given as follow:

$$\text{Fitness function} = E + (N - CH) + \frac{IC}{N} + \frac{BSD}{N}$$

Initial population consists of several chromosomes. After checking the fitness of all chromosomes, then three QBGA operators (selection, crossover and mutation) are applied.
Selection- operator selects one of the best from all chromosomes and some choose randomly by tournament selection and generate a new population.
Crossover- is applied on the two parents selected from new population for crossover. The swapping of two parents generates two new children. The fitness of a chromosome is designed to minimize the energy consumption and to extend the network life time.

Parent 1 1 1 1 0 **0 1 1 1 0**
Parent 2 0 1 0 1 **1 0 0 1 0**

After crossover, two new children are generated as below:

Child 1 1 1 1 0 **1 0 0 1 0**
Child 2 0 1 0 1 **0 1 1 1 0**

Mutation- after crossover there is little chance of mutation in QBGA there is two types of mutation. Strong mutation for the individual which need to be strongly changed, and weak for the individual which need to be little change.

Before Mutation 1 1 **1** 0 0 1 1 1 0
After Mutation 1 1 **0** 0 0 1 1 1 0

LEACH- QBGA
Proposed clustering algorithm, LEACH-QBGA, is a base station assisted approach. Nodes send their energy and location information to base station. Base station applies proposed QBGA for optimal selection of cluster heads. Base station sends the information message to assigns cluster head to all nodes. Also provide TDMA scheduling for each cluster. Nodes wake up and send sensed data to their respective cluster head using TDMA time slots. Nodes are in sleep state otherwise. Re-clustering is done after round-time is over.

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IV. SIMULATION RESULTS

Simulation Results and Analysis

Network parameters are listed in the table 1. Performance of proposed LEACH-QBGA is compared with LEACH-GA.

Table.1 Parameter Used

Parameters	Value
Number Of Nodes(N)	50
Network Area	100x100m^2
Size Of Population	N
Selection Type	Tournament Selection
Crossover Rate	0.2
Weak Mutation Rate	0.1
Strong Mutation Rate	0.5
Base Station Location	50,50
Initial Energy	0.1J
Data Packet Size	500 Bytes or 4000 bits

Table.2 shows the first node dead and half node dead comparison of Genetic Algorithm with proposed Algorithm QBGA. Here first node is dead at 124th round where in QBGA first node dead achieved later. Similarly half nodes are dead in GA at 199th round but in QBGA half nodes of the network dead at 208th round which clearly shows that QBGA performed much better than GA.Thus improve the lifetime of wireless sensor network.

Table.2 Dead node comparison

Algorithm	FND	HND
LEACH-GA	124	199
LEACH-QBGA	196	208

Fig.1 and Fig.2 shows that in case of first node dead and half node dead the QBGA performs much better than GA.first node is dead at 124 round where in QBGA first node dead achieved later.

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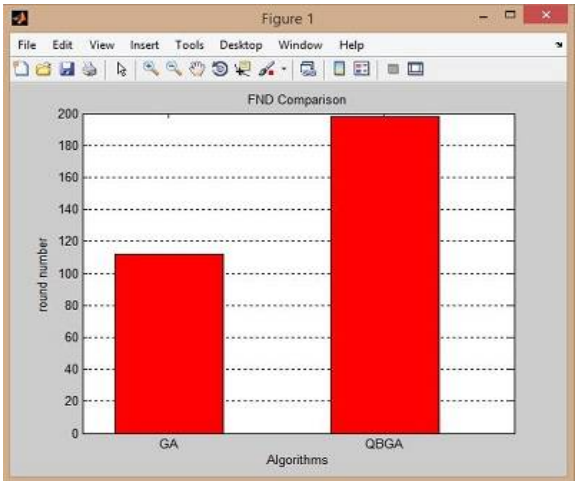

Fig.2 First node dead comparison

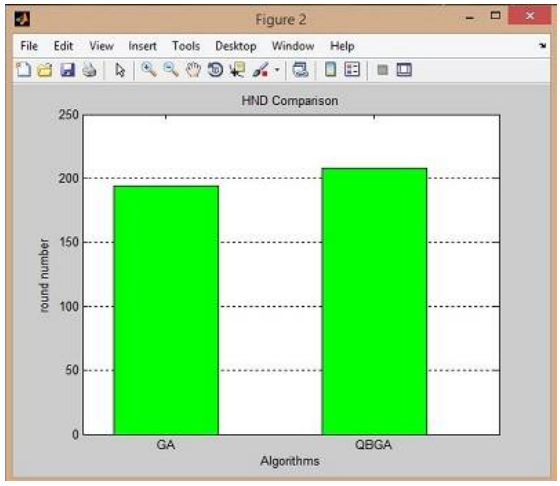

Fig.3 Half node dead comparison

Fig.4 and Fig.5 shows the energy and dead nodes comparison of GA and QBGA respectively. Both showed that QBGA perform much better than GA. Half nodes are dead in GA at 199th round but in QBGA half nodes of the network dead at 208th round which clearly shows that QBGA performed much better than GA. Thus improve the lifetime of wireless sensor network.

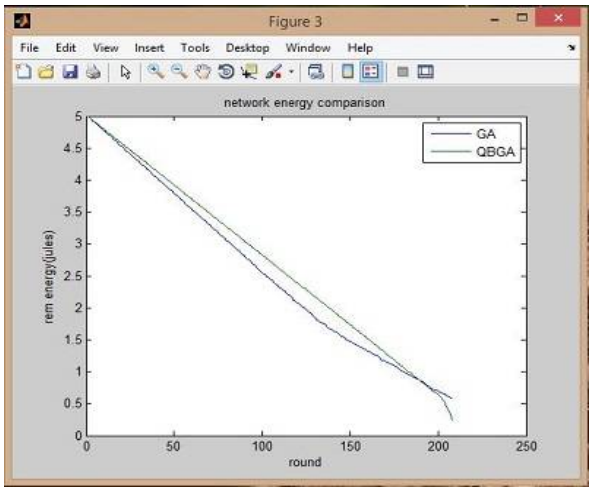

Fig.4 Network energy comparison

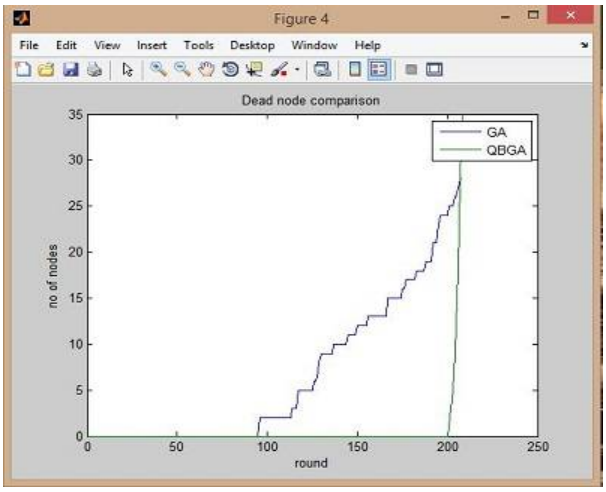

Fig.5 Dead node comparison

V. CONCLUSION

After having gone through different literatures published on the topic of energy conservation in WSN. Mainly energy consumption in CH is due to its sending and receiving operations. Although LEACH-GA is the routing protocols which not only provide optimal cluster head solution but also increase the energy efficiency of WSN still it needs to be improved ,but the main disadvantage is that it is very time consuming process. Here we proposed a technique for called QBGA which provide more optimal cluster head selection and increase the lifetime of wireless sensor network. It has the fast convergence than GA also reduce time consumption by GA.

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