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Optimization Technique to Enhance the Energy Efficiency in WSN

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***Abstract*—Wireless sensor network (WSN) is a self-organized network made up of hundreds or thousands of sensor nodes. These sensor nodes works with some limited resources like battery power, memory, bandwidth 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 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.**

***Index Terms*— wireless sensor network; clustering algorithm; energy efficiency; genetic algorithm.**

I. INTRODUCTION

Wireless sensor networks (WSNs) 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 the area of 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 access the collected data through some remote access. Sensor nodes work with some limited resources like battery power, bandwidth, and memory etc. Wireless sensor network lifetime depends upon battery power of nodes as every node operation consumed energy. These nodes cannot be replaceable and

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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.
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. [1]

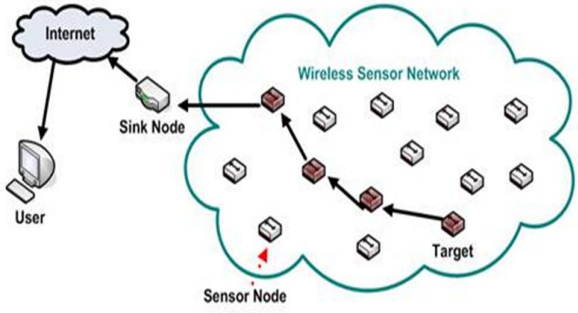

Fig.1: Wireless Sensor Network Architecture [2]

II. Design Factors Of Wsn

There are various challenges which affect the wireless sensor network (WSN) these are:

A. Node deployment

Node placement in WSNs is of two types manual or randomized. In manual placement, the sensors are manually allocated and data is routed across predetermined paths. Though, in random node placement, the sensor nodes are dispersed randomly, crafting an ad hoc routing infrastructure. The node deployment in WSN should be in such way that the communication between nodes never failed. So to maintain the proper communication between these nodes an excellent routing protocol is required.

B. Fault tolerance

Some sensor nodes could block due to lack of domination, physical damage, or environmental interference. Individual nodes are liable to unexpected failure with a much higher probability when compared with other type of network. The network should keep alive information dissemination in spite of failure.

C. Scalability

Sensor network is made up hundreds or thousands of nodes. Protocols should be able to work to such high degree of nodes and take advantage of the high density of such networks. So the routing protocol should not limit with the fixed nodes. But it should operate with large number of node and should be varies with the network size.

D. Power consumption

WSN is made up of thousands of nodes and these nodes are energy restricted and cannot replaceable and rechargeable. WSN lifetime depends on these nodes energy as every nodes operation required some energy. So the efficient energy consumption by the node is the main design issue in WSN.

E. Transmission media

In WSN the transmission medium between sensor nodes is radio waves or infrared waves. The communication medium should be universally present it should not bound with any standards and should not require any license to operate.

III. Literature Review

Fan Yiming et al., 2007 [3]:- Low energy adaptive clustering hierarchy (LEACH) is a fully distributed clustering algorithm. In setup phase, cluster head selection, cluster formation and TDMA scheduling to the nodes are performed. In steady phase, nodes send the Data to cluster head and cluster head aggregated the data. Aggregated data is then sends to the 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 [4]:- 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 [5]:- 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 Wang et al., 2012 [6]:- LEACH-R improves the selection of cluster-head (CH) and selected a relay node between all cluster heads as compare to LEACH. Based on both residual energy and distance from base station, relaying node is chosen from cluster heads with maximum energy and minimum distance from BS to become the relay node between base station (BS) and cluster-heads.

Asha Ahlawat et al., 2013 [7]:- 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 [8]:- Authors 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 Pal et al., 2015 [9]:- Presented a genetic algorithm based on cluster head selection for clustering algorithms to have a better load balanced sensor network. 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.

IV. Proposed Work

A. 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 re-production of bees and thus Queen-bee reproduced the many children with a number of the bee-population using the crossover, so the number of marriages in the Queen-bee algorithm are much less than that of the genetic algorithm which results increased the rate of QBGA as compare to genetic algorithm. So QBGA has fast convergence than GA. And it is done to reduce the time consumption by genetic algorithm.

B. 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. The fitness function is given as follow:

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 increase the wireless sensor 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 strong change, 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

C. LEACH- QBGA

Proposed clustering algorithm, LEACH-QBGA, is a base station assisted approach. Node sends their energy and location information to the base station (BS). 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 all the information about the clusters and TDMA scheduling for each cluster and TDMA is broadcasted to the network. 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 a regular round time is over.

V. Simulation Results And Analysis

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

TABLE I. PARAMETER USED

Parameters	Value
Number Of Nodes(N)	100
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 II. RESULTS COMPARISON

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

Fig.2 First node dead comparison

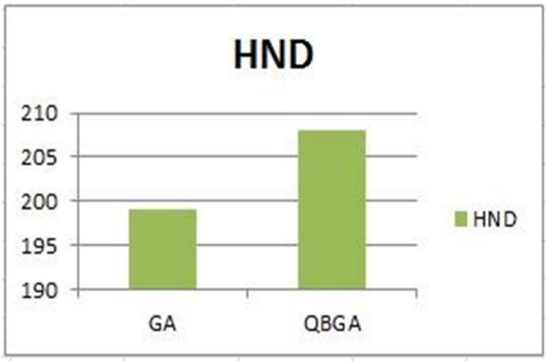

Fig.3 Half node dead comparison

Here the fig.2 and fig.3 shows that in case of first node dead and half node dead the QBGA performs much better than GA. In GA first node dead is achieved at 124th round where in QBGA it is achieved later at 199th round and half node at 196th round and in QBGA at 208th round. So here it cleared that QBGA is better than GA in case of first node dead and half node dead.

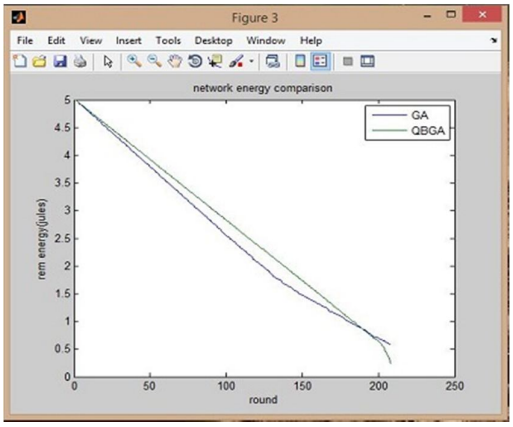

Fig.4 Network energy comparison

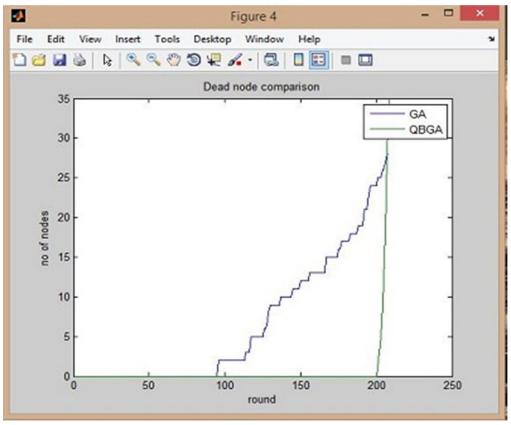

Fig.5 Dead node comparison

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.

VI. CONCLUSION

After having gone through different literatures published on the topic of energy conservation in WSN, It is concluded that mainly energy consumption in CH is due to its sending and receiving operations. Although LEACH-GA provides optimal cluster head solution for the selection of CH but GA is very time consuming and complex hence it needs to be improved. Here we implemented a technique called QBGA which not only provides more optimal cluster head selection to reduce the complexity and time consumption by Genetic algorithm but also increases the lifetime of WSN. The results are implemented on MATLAB.

REFERENCES

[1] Parul Khurana and Inderdeep aulakh," Wireless Sensor Network Routing Protocols: A Survey", International journal of computer applications, vol. 75, No. 15, 2013.

[2] Pankaj Chauhan and Tarun Kumar," Power Optimization in Wireless Sensor Network: A Perspective", International Journal of Engineering and Technical Research (IJETR), vol. 3, issue-5, May 2015.

[3] Fan Yiming, Hangzhou, Yu Jianjun," The Communication Protocol for Wireless Sensor Network about LEACH, IEEE International Conference on CISW, 2007.

[4] WU Xinhua and Wang Sheng, "Performance Comparison of LEACH and LEACH-C Protocols", IEEE 9th International Conference on Distributed Computing and Applications to Business, pp. 255-258, 2010.

[5] MU. Tang and Minghao Tang," *LEACH-B:* An Improved LEACH Protocol for Wireless Sensor Network", IEEE, PP. 1-4, 2010.

[6] Ningbo Wang and Hao Zhu," An Energy Efficient Algorithm Based On LEACH Protocol", IEEE International Conference on Computer Science and Electronics Engineering, PP. -339-342, 2012.

[7] Asha Alawat and Vineeta Malik," An Extended Vice-CH selection Appraoch to Improve LEACH Protocol in WSN", IEEE 3rd International Conference on Advance Computing & Communication technologies, pp.236-240, 2013.

[8] Chunyao FU, Zhifang JIANG, Wei Wei," An Energy Balanced Algorithm of LEACH Protocol in WSN", International journal of computer science IJCSI,vol. 10, issue 1,No. 1, 2013.

[9] Vipin Pal, Yogita, Girdhari Singh, RP.Yadav," CH Optimization based on Genetic Algorithm to prolong lifetime of WSN", Elsevier: third international conference on recent trends in computing, pp. 1417-1423, 2015