Research Article

A Novel Approach To Enhance The Qos Of Wireless Sensor Networks

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Abstract: Wireless sensor networks (WSNs) has acquired more attention because of applications in various fields. The sensors have limited power sources as they cannot be replaced because of hostile nature. In this study, Genetic Algorithm (GA) based approaches for routing and clustering in WSNs have been proposed. The significant purpose of the process is to enhance lifetime of sensor and Quality of Service (QoS). The results illustrate that proposed algorithms such as LECR-GA or NLCR-GA works better than the existing algorithm with respect to several performance metrics such as number of packets, energy consumption acknowledged by the base station.

Key Words: WSNs, Genetic algorithm, QoS, lifetime of sensor.

1. INTRODUCTION

A huge surge in the use of wireless sensor networks more commonly known as WSN has been seen in recent years. It can be used in industries like health-care, the environment, and surveillance and administering in the army, etc. So a race to find the most efficient way to fully utilize them has been started by the scientist researching about them. To achieve the goal they have to first find a solution for the problems plaguing WSNs currently. These problems include redirecting the information from the network or depleting the energy in a very fast manner [1]. A lot of basic characteristics that are possessed by them are also present in WSNs, for example, centralized control not being present in them as well as the complexity of the network increasing and a large number of nodes interacting with one another, etc. To improve the QoS and maximize the lifetime of the WSNs most aptly and appropriately possible a new type of Hierarchical Clustering and protocol of routing based on GA has been put forth in this study. New parameters have been taken into consideration in this new clustering algorithm to better the mechanism of CHs (Cluster Head) selection [2]. The two characteristics present in the more improved algorithms are the energy and the weight present in the node [3]. Thereby, to reach the desired results genetic algorithms will be used to discover and scour the total space of research. The most efficient path from all the members present in the cluster to cluster head is found out by the routing scheme, thereby making it go through sensors having more energy in it while traveling for a lesser distance [4]. It is shown through simulation that the LECR-GA or NLCR-GA (New Low energy efficient cluster routing based Genetic Algorithm) protocol has led to more improvement in the network's lifetime and the QoS than the protocols that it had succeeded.

II. GENETIC ALGORITHM

Genetic algorithms are also algorithms that are a branch of the stochastic algorithm tree. Although a major portion of the operations are done randomly [5]. The ability to put forth an amount of resolve in the genetic operators in order to get a solution is possible with the help of the evaluation function [6]. Majority of the terminologies present in the GA are derived from the field of biology.

The principle operations

The 6 elements present in the GA are:

1. The initial population of the configurations
2. coding/decoding the functions in the chromosomes
3. The genetic operators in them
4. A function of evaluation
5. An algorithm used for the process of selection
6. The parameters [7]

In order to better the settings and optimize them in the best way possible a GA crafted to WSN topologies must be in place. The battery consumption of the sensors is affected by these settings and thereby the lifetime of the network is also affected by it. On top of this certain constraints regarding connectivity and the betterment of the physical borders related to the WSN must be adhered to by the algorithm. The structure of organization of the genetic algorithm which also possess the notations as follows:

- POP_t : The population that is present during generation t;
-POP_{sel} : The selected population

The various different objectives that come along with the problem of optimization are mixed into a objective function that is one of a kind. In order to develop a function which will help it to adapt its settings are combined

which results in it providing the quality of all the topology of the wireless sensor network [8]. The parameters that are designated specifically to the application and to the settings of connection that are in relation to energy are the two main sets of parameters that play a major role in the performance and design present in the WSN . Some of the parameters that are a possibility are discussed further in the study.

The initial population: As each and every single bit of the chromosome is chosen in a random way, genetic algorithms also commence in a way which consists of the initial population of the candidates of random solutions. But contrary to this solutions that are already known can be provided and improved upon. Thereby other algorithms of research can be used to give solutions to the GA that are already in the first part of the optimization phase. Based upon the knowledge possessed by the user about the particular issue the choice of initialization will take place. To support the most possible amount of discovery and research of the research area, a uniform but random initialization will take place if the user does not have a well structured knowledge about the issue. For the WSN this is something that translates to individually placed minor programs with the ability to be run on the sensors of the nodes.

Evaluation: As per the fitness of the individuals the population will be filtered in small steps at a time. This operation takes place in a way where the best are selected to bring in a new generation derived from them. The thing that affects the value possessed by the adaptation of each specific individual being based upon the distance of the person from the proper solution to it known as the function of adaptation or the fitness function.

Termination condition: Depending upon the classification of the problem on which work is being done, the termination condition of GA varies. It is clearly implied that the value of optimum that is desired to be achieved is well known if the problem of decision is treated. But for problems related to optimization in WSNs, the optimum is not known and it will never be known if it has been reached or not. The algorithm can also be stopped when a premature divergence is found. when the amount of diversity between individuals is very low and is in high chances of escaping out of the attraction basin it is known as premature convergence.

Selection: the power and responsibility to choose the right individuals in the present population who they deem is the most apt and capable to survive and reproduce is had by the selection operator. A new population from the current one POP_{t-1} a new one POP_{sel} will be formed. Then to the POP_{sel} the genetic operators will be applied. For a matter of fact the best individuals have a very high likelihood of appearing in POP_{sel} due to the feature set that they possess.

The diversification operators: The main aid that is provided to the algorithm to discover and research the solutions space to conduct research is diversification. This process is about making new solutions (the children) from existing iterations of those particular solutions (the parents). GA is very openly inspired by the method in which the living reproduce in order to create the diversification operators that they possess.

-The exploitation operator is a lesser known name given to the crossover operator. With the help of which the most wanted solutions can be obtained by combining them with pre-existing ones. In the more classic version of GA this is done by choosing two individuals from POP_{sel} and then applying the crossover operator are present in POP_t. As a result of which two children from both the parents will be obtained where each child will have a part from both the parents. The crossover operator consists of a lot of variations dedicated to dealing with specific issues and problems.

A GA joins into an optimum present locally when without the aid of exploration. The research and discovery of the search space will be aided by the mutation operator. As only the searching of specific areas are allowed by the other operators. Mutation refers to the random change being made to one of the many genes of the chromosomes. Normally the number of mutations that take place are quite low [9].

Elitism: It is very possible that the chromosomes that are amongst the very best will be lost during the process of mutation. In order to dodge this problem Elitism is used. With the main gist of it being to copy on or many of the very best chromosomes. Then generate the new population abiding by the guidelines in the current algorithm of reproduction. The genetic algorithms are improved greatly by this which thereby helps to save the best solutions.

The parameters and the values possessed by them: The guidelines or in essence the rules that are to be abided by that initiate the union of a genetic algorithm are called as the parameters.

1. A mutation with the probability of P_m takes place inside of each every individual being.
2. Then a crossover is experienced by them with the probability of P_c, in every one of the iterations and variations that follow.
3. Guidelines and parameters that are in relation to the termination condition of the algorithm.
4. There are also the other parameters with potential for example the selection probability [10].

Studying and analyzing the problem are factors on which the value of the above parameters depend upon. A parameter that has the ability to solve all the problems does not exist. But, some of the values are used commonly and have the ability to be a good point of start to start a search of solutions with the help of a GA [11].

- The interval in which the probability of the crossover is chosen[0.7,0.99];
- The interval in which the probability of the mutation is chosen[0.001,0.01].

At times it is a very sensitive problem to find the proper values to these parameters [12]. But based on the genetic operators that are put in use when the population diversification process in between the generations and the discovery and search of the solutions place, the efficiency and performance of it as a whole may vary.

III. LECR-GA OR NLCR-GA

The proposed LECR-GA or NLCR-GA protocol has some assumptions about the network model. Base Station (BS) is resource devices which is not restricted in relation to computing power and memory. All BS and sensor nodes have become stationary after implementation. The networks have similar type of sensor nodes. All node sensors have acquired equal amount of energy. In this study, the proposed algorithm is highly compared to other energy efficient protocols namely LEACH (Low-Energy Adaptive Clustering Hierarchy), LEACH-C (Low-Energy Adaptive Clustering Hierarchy- Cluster based), GAEEP (Genetic Algorithm-based Energy-Efficient adaptive clustering hierarchy Protocol).

IV. SIMULATION RESULTS

It is essential to compare the method using various parameters like round time and transmission radius. The efficiency of this proposed protocol is compared with the four methods with respect to data packets, first node death, last node death and number of dead nodes by the base station. To determine the experimental error, each experiment run for ten time and average time was the final result. Figure 1 represents homogenous network before clustering.

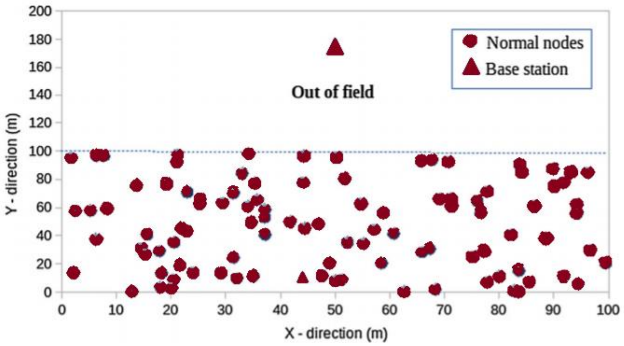

Figure1: Homogenous network before clustering

The performance of LECR-GA or NLCR-GA, LEACH-C protocol has determined with respect to the number of dead nodes. This type of protocol is used to choose the node as CH that attains criteria and energy consumption is given between nodes. Simulation results stated that network that prefers LEACH-C and LEACH protocols and there is no alive nodes after rounds 500 and 600. Network used in this proposed protocol has 100 alive nodes after 600. It is highly noted that proposed protocol become alive in 100 nodes in the network after the nodes of network using LEACH and LEACH-C were dead. If cluster head is in active status, then it acquires high amount of energy and lifetime minimize fastly case of LEACH-C and LEACH protocol.

Table 1 represents the simulation parameters for LEACH-C and LEACH.

Table 1: Simulation parameters

PARAMETERS	VALUE
NETWORK SIZE	100 X 100M
LOCATION OF THE BS	50,17
NUMBER OF NODES	100
NUMBER OF CLUSTERS	VARIABLE
INITIAL ENERGY OF NODES	2J
POSITION OF NODES	BETWEEN (0,0) AND (100, 100)
ROUND TIME	20/25 S
TRANSMISSION RADIUS	VARIABLE
SIMULATION TIME	3600 S

In this case, it is essential to compare NLCR-GA protocol with protocol GAEEP. The performance of NLCR-GA and GAEEP protocols have been determined with respect to the number of dead nodes. It is important to determine that all nodes will be died once it reach 1175 rounds in GAEEP. Figure 2 indicates that LECR-GA lifetime at 20 rounds.

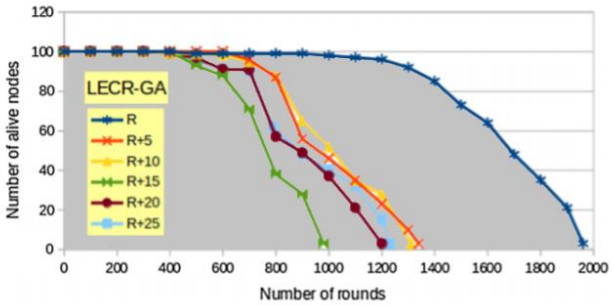

Figure 2: LECR-GA lifetime with round = 20

Table 2: Simulation parameters

PARAMETERS	VALUE
NETWORK SIZE	100 X 100M
LOCATION OF THE BS	50,300
NUMBER OF NODES	100
NUMBER OF CLUSTERS	VARIABLE
INITIAL ENERGY OF NODES	0.5 J
POSITION OF NODES	BETWEEN (0,0) AND (100, 100)
ROUND TIME	20/25 S
TRANSMISSION RADIUS	FIX
SIMULATION TIME	3600 S

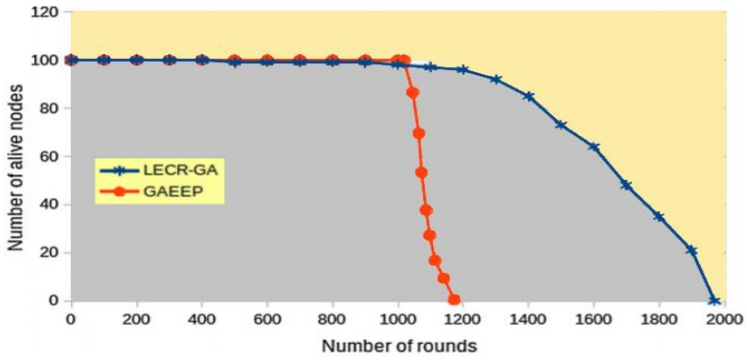

Figure 3: Lifetime of GAEEP and NLCR-GA or LECR-GA

In this proposed protocol, all nodes died after 1980 rounds and first node died after 490 rounds. This protocol increase the stability period and reliability of the clustering process in WSN. The proposed protocol choose CH from nodes which has energy greater than average energy of live nodes. Hence the proposed protocol enhance the lifetime.

Table 3: Simulation parameters

PARAMETERS	VALUE
NETWORK SIZE	100 X 100M
LOCATION OF THE BS	50,200
NUMBER OF NODES	200
NUMBER OF CLUSTERS	VARIABLE
INITIAL ENERGY OF NODES	0.5 J
POSITION OF NODES	BETWEEN (0,0) AND (100, 100)
ROUND TIME	60 S
TRANSMISSION RADIUS	FIX
SIMULATION TIME	3600 S

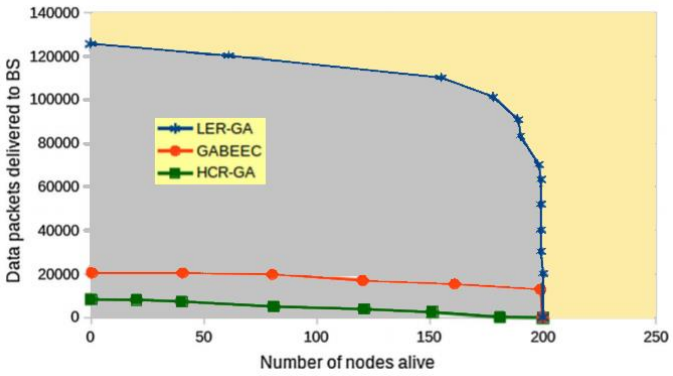

Figure 4: No of living nodes in the GABEEC and NLCR-GA or LECR-GA protocols

There are about 200 nodes are randomly distributed in 100. The BS is located in 200m away from the network. Based on the number of live nodes for NLCR-GA and GABEEC (Genetic Algorithm based energy efficient Clusters), the amount data perceived by the base station. The proposed protocol received 70000 messages whereas GABEEC received 12000 messages. If there is minimization of living node exists, the base station receive the number of messages reach 12500 messages using this protocol. It is observed that the proposed protocol performs better in terms of CH transmission.

V. CONCLUSION

This paper presented algorithms for routing in WSNs and energy efficient clustering. It is observed that clustering algorithm enhance CHs lifetime and minimize the energy consumption of sensor nodes. It can be created by recognizing an exchange between the number of hop count and transmission distance. The new proposed algorithms have been defined with derivation of fitness function and chromosome representation using the significant GA operations. The results have exhibited that the efficiency of the algorithm outperforms first node die, number of active sensor nodes and so on.

REFERENCES

[1] Hamidouche, R., Aliouat, Z. & Gueroui, A.M. Genetic Algorithm for Improving the Lifetime and QoS of Wireless Sensor Networks. Wireless Pers Commun 101, 2313–2348 (2018). https://doi.org/10.1007/s11277-018-5817-z

[2] Ferentinos, K. P., & Tsiligiridis, T. A. (2007). Adaptive design optimization of wireless sensor networks using genetic algorithms. Elsevier Computer Networks, 51(4), 1031–1051.

[3] Jia, J., et al. (2009). Energy efficient coverage control in wireless sensor networks based on multiobjective genetic algorithm. Computers and Mathematics with Applications, 57(11–12), 1756–1766.

[4] Bhondekar, A. P. et al. (March 2009). Genetic algorithm based node placement methodology for wireless sensor networks. In The international multi-conference of engineers and computer scientists, (pp. 18–20). Hong Kong, China.

[5] Song, Y., et al. (2015). A genetic algorithm for energy-efficient based multipath routing in wireless sensor networks (pp. 2055–2066). Berlin: Springer.

[6] Miao, H. et al. (September 2015). Improvement and application of leach protocol based on genetic algorithm for WSN. In 20th international workshop on computer aided modelling and design of communication links and networks (CAMAD), (pp. 242–245). Toronto, ON, Canada.

[7] Wazed, S. et al. (2007). Genetic algorithm based approach for extending the lifetime of two-tiered sensor networks. In the 2nd international symposium on wireless pervasive computing (ISWPC07).

[8] Hussain, S. et al. (April 2007). Genetic algorithm for energy efficient clusters in wireless sensor networks. In The fourth international conference on information technology (ITNG07), (pp. 147–154). Las Vegas, USA.

[9] Ait El Hadj, F. S. (2013). Approche de dtection de communauts chevauchantes dans des rseaux bipartis. Phd Thesis in computer science, Univ. Mouloud Mammeri, Tizi ouzou, Algeria.

[10] Chandrakasan, A., Balakrishnan, H., & Heinzelman, W. (2000). Energy-efficient communication protocol for wireless sensor networks. In The international conference system sciences, Hawaii.

[11] Bayrakli, S. et al. (2012). Genetic algorithm based energy efficient clusters (gabeec) in wireless sensor networks. In The 3rd international conference on ambient systems, networks and technologies, (pp. 247–254). Turkey, Istanbul.

Mohammed, A., et al. (2014). A new energy-efficient adaptive clustering protocol based on genetic algorithm for improving the lifetime and the stable period of wireless sensor networks. International Journal of Energy, Information and Communications, 5(3), 47–72.