

SURVEY ON ENERGY OPTIMIZATION IN WIRELESS SENSOR NETWORK USING GENETIC ALGORITHM

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Abstract

Wireless sensor networks have gained more attention from researchers because their applications have significantly increased over vast areas such as smart homes, military surveillance, environment monitoring, agriculture, industrial automation, traffic management, disaster detection etc. These applications demand melioration of the currently available protocols and circumstantial parameters. Some prominent parameters are energy consumption and network lifetime which play the key role in every application. This survey paper reviews Genetic Algorithm based energy optimization in all functional stages of a wireless sensor network including node deployment, network coverage, clustering, routing and detection of attacks.

Keywords: Wireless Sensor Networks, Energy Conservation, Genetic Algorithm, Clustering Protocols, Network Lifetime.

Introduction

A wireless sensor Network (WSN) comprises the huge amount of multifunctional, low- power, low-cost, energy constrained sensor nodes. The sensor nodes have limited computational and communication capabilities. These sensor nodes sense physical parameters such as force, vibrations, sound, humidity, pressure, temperature, or chemical concentration and transmit the collected data to a base station.

The main restrictions in the development of WSNs are limited battery power, size and memory. Sensor nodes are powered by batteries which have very limited energy. Due to large numbers of sensor nodes in network and the environment complexity, it is impossible to change or recharge batteries. Thus energy preservation is an imperative issue in wireless sensor network.

In the direct transmission (DT) protocols, sensed data from sensor nodes are directly transmitted to base station. Therefore, the nodes placed far away from the base station will die faster because they utilize a lot of energy in transmitting sensed data. Thus DT protocols are incompetent as energy of sensor nodes are drained fast when the base station is placed far. But in the minimum transmission energy (MTE) protocols sensed data transmitted to the base station by multi-hop relay. Therefore, nodes placed near the base station die rapidly as they relay almost all the data on behalf of distant nodes. Therefore DT and MTE result in a unbalanced distribution of energy among the sensor nodes in the network [1]. Hence it is necessary to design an efficient multihop wireless routing technique

for WSN.

This paper is organized as follows: Section I is the introduction. Section II briefly describes Genetic algorithm. Section III is literature survey in which various protocols, algorithms and their approaches to save energy and prolonging network lifetime are summarized and finally, there is conclusion of the paper.

Genetic Algorithm

Genetic Algorithm (GA) is the most coercive technique for solving optimization problems. It is based on Darwin's principle of natural selection where in many generations the fittest natural populations are evolved. By imitating this process, genetic algorithms are used to find the solutions to realistic problems. In GAs the individuals population is a probable set of solution to a specified problem. Depending on the goodness of solution to the problem, a fitness value is assigned to each individual. The individuals are allowed to reproduce in proportion to their fitness and they generate offsprings by cross breeding with another individual. Thus the offsprings produced have characteristic contributed from each parent. The least fit individuals of the population have die out because they have less chance to be selected for reproduction. The best individuals form the current generation are selected to reproduce a new population of possible solutions and a new set of individuals are produced by mating them.

There are several other nature inspired techniques available for search and optimization that include Ant Colony Optimization, Bee Optimization and Particle Swarm Optimization etc.

Literature Survey

For increasing the lifetime of WSN, the efficient utilization of energy is very important. There are many protocols and algorithms proposed by many researchers for improving energy efficiency and prolonging the lifetime of WSN. Several researchers have successfully implemented GAs in the development of wireless sensor network. These approaches can be broadly categorized as follows.

1. Clustering And Cluster Head Selection
2. Routing
3. Data aggregation
4. Attack Detection
5. Node Placement

Clustering And Cluster Head Selection

M. Abo-Zahhad et al. [2] proposed Genetic Algorithm-based energy efficient Protocol (GAEEP). This protocol is designed to prolong the network lifetime by selecting the optimum number and positions of cluster heads due to which the energy consumption of the sensor nodes reduced. The GAEEP protocol is operating into rounds. Each round starts with a set-up phase in which optimum number of cluster heads and member nodes to each cluster head are decided by base station. The next round is a steady-state phase, where the sensed data from member nodes are transmitted to cluster head. Cluster head collect this data in frames and then it is transmitted to the base station. The simulation results show that the performance of this protocol in both homogeneous and heterogeneous cases is better than the previous protocols in terms of energy dissipation, lifetime of network and stability period.

S. K. Gupta and P. K. Jana [3] have proposed clustering and routing protocol in wireless sensor networks using genetic algorithm. In clustering the cluster heads are selected based on residual energy and distance between sensor nodes and corresponding cluster head. The routing protocol also considers the residual energy of the gateways, number of forwards and transmission distance. The results demonstrate that the proposed algorithms perform better than existing algorithms in terms of energy consumption, number of live nodes, first gateway die and number of dead gateway per round.

Amit Singh et al. [4] have proposed a Genetic algorithm based protocol in which multihop communication is used inside the cluster and cluster head to sink. In this paper each node computes its fitness function based on residual energy, probability p and distance between sink and node for selection of cluster head. These elected nodes transmit its information to sink. Genetic algorithm helps to select the best cluster head. The cluster member transmit sensed data to near cluster head and these cluster head transfer data to their near cluster head or sink which results increase in node life time. The goal of this algorithm is to select higher capable cluster heads and distribute them in the network so the total energy consumption of network is minimized. Authors compared the results of proposed algorithm with LEACH algorithm. Simulation results show that there is improvement in lifetime of network when data is sends to near CH instead of base station than the data is sends directly to base station.

M. Elhoseny et al. [5] have proposed a Genetic Algorithm based self-clustering method for heterogeneous networks that optimizes the lifetime of network. Compared with other methods, proposed method prolong the lifetime of network and the average improvement on the first and the last node die are 33.8% and 13%, respectively.

Routing

There are many researchers working on optimization of routing in wireless sensor networks. They have proposed different algorithms for optimization of

routing in wireless sensor network. Several researchers have focused their study on the use of GA for WSN routing algorithm and have proposed GA based algorithms for hierarchical routing. The results show that these algorithms can reduce energy consumption and prolong network lifetime. [6][7][8].

Balamurugan [9] explained different routing techniques and proposed Routing Protocol based on Fitness (FRP) for optimization of energy efficient data transmission. In this paper the energy consumption of sensor nodes is minimized by selection of nodes based on minimum number of hops and distance. Genetic algorithm is used as an optimization technique to search the fittest node on the basis of its fitness score. The results demonstrated that lifetime of network and throughput of FRP increases compared to the existing protocols. The protocol reduces the packet loss and delay. The result show that it is found that FRP is efficient than the AODV protocol because it reduces the packet loss. AODV protocol gives 3% packet loss and FRP protocol gives 2% packet loss. Similarly FRP provides higher throughput as compared to AODV. The results show that the throughput of FRP is 31% greater than AODV protocol.

V. K. Singh and V. Sharma [10] proposed a shortest path routing protocol based on forward address. Here Genetic algorithm with elitism is used to find energy efficient routing by reducing the path distance and in turn prolonging the lifetime of the network. The advantage of this algorithm is that it preserves the elite solutions in the next generation so as to converge faster towards the global optima. The simulation results demonstrated that GA with elitism are very efficient for searching the optimal shortest route as they can converge quicker than the conventional methods used for optimization problems. The simple GA converges in about 70 generations whereas the elitism-based GA takes about 20 generations to converge, which is much faster. It is observed that there is much improvement in the network lifetime using the proposed GA with elitism. There is 6% improvement in the network lifetime as compared to EBGA, whereas with direct method it is 208% improvement which is more significant. The average energy utilization of the network using the proposed algorithm is improved 16.8478% over the EBGA.

P. Kaushik and J. Singhai [11] presented review paper on energy efficient routing algorithms. They discussed various energy efficient routing protocols and their approaches to maximize the lifetime of wireless sensor network. Advantages, disadvantages as well as comparative study of these algorithms are also discussed in this paper.

Data Aggregation

Ali Norouzi et al. [12] investigated Genetic algorithm based energy efficient data collection spanning trees which is used to find a optimal route. This helps to balance the data load of the network throughout and which helps to balances the network residual energy. In this paper, all possible routes are calculated by the

aggregation trees through the genetic algorithm. The results demonstrated that balancing of data load of network practically maximizing the lifetime of network. K.Praveena and T.Sripriya [13] proposed a energy efficient data aggregation technique based on genetic algorithm in which mobile sink collects the data from the subsinks in network. There is reduction in energy consumption due to long distance transmissions. The subsink receives the sensed data from other sensor nodes and aggregates the collected data so no redundant data will be transmitted to mobile sink. Thus the energy is saved and can be utilized efficiently to improve the network lifetime. The mobile sink aggregates the data received from subsink and transmit it to the server which then transmit the data to destination. The results show the improvement in network lifetime. S. Sirsikar and S. Anavatti [14] focused on different issues in data aggregation process such as delay redundancy elimination, traffic load and accuracy. They have mentioned various methods to solve those issues and compared some data aggregation techniques based on delay, redundancy, energy consumption and traffic load. They have also proposed a model which uses multilevel data aggregation approach and tries to solve all the issues of data aggregation.

Detecting Attacks

Novin Makvandi et al. [15] stated that clustering can reduce energy consumption of the wireless sensor network. By reducing the communication distance significantly, it is possible to increase the lifetime of network. In this paper authors used two approaches. First one is Genetic Algorithm and second one is combination of genetic algorithm and fuzzy. The proposed method uses the genetic algorithm for clustering and performs the routing based on the fuzzy selection, which is addressed to detect the attacker nodes routing. Here the whole sensor network is not checked to detect the attacker node and only the selected route is checked by fuzzy algorithm. The simulation results demonstrated that the genetic algorithm has speed up the detection and improved the energy consumption cost. Author compared the simulation results of both the approaches and results show that the lifetime of sensor network increased with genetic algorithm plus fuzzy.

Elham Yazdankhah et al. [16] suggested a method that can be used to transfer the data securely to prevent attacks. Genetic algorithm is used to find the optimal path. The proposed optimal paths to transmit data perceived to have chosen and ensure reliable data transmission. This approach can rapidly detect compromised nodes increases to 50 percent.

Placement of Nodes

G. K. Brar and M. Kaur [17] have proposed a GA based algorithm which tackles coverage problem. The heterogeneous nodes i.e. sensor nodes having different coverage area. The results show that the Genetic Algorithm place the sensors on their best positions and

remove the intersection between the nodes therefore the area covered by the sensing nodes is maximized.

Amol Bhonekar et al. [18] demonstrated a node placement methodology using genetic algorithm for a wireless sensor network. They conclude that achieve lower energy consumption by operating large number of sensors nodes for communication purposes than less number of active sensor node which results more energy consumption for communication purposes. The results show that the algorithm maximizes the field coverage in the consecutive generations and converges at value more than the 80%.

S. Indhumathi and D. Venkatesan [19] have proposed a Genetic Algorithm based Gap Cluster technique to obtain an optimal solution for maximum coverage deployment for dynamic nodes. Simulation results show that the uncovered area get reduced after gap cluster and gives best performance in coverage and network lifetime. Results show the uncovered areas getting reduced from 165 to 65 using Gap Cluster technique.

Omar Banimelhem et al. [20] presented algorithm in which genetic algorithm finds optimal solution to the coverage problem. The proposed algorithm finds out the minimum number of additional mobile nodes and their best positions in the field. The performance of the algorithm assessed in terms of the k-coverage, coverage ratio, and additional mobile nodes count using different numbers of static nodes and sensing ranges.

Several attractive approaches like Ant Colony Optimization, Swarm Optimization, Neural Networks, Artificial Intelligence, Bacteriologic Algorithm and have been implemented to tackle problems related to the designing of WSNs[21][22][23].

Antony C. et al. [24] explores the potential of using genetic algorithm for finding the shortest path in wireless sensor network. In this review paper, author has given brief comparative study of Dijkstra's algorithm, traditional routing algorithms and the Genetic Algorithm. And conclude that the Genetic Algorithms is more advantageous than traditional routing algorithms and Dijkstra's algorithm 1. Cost as well as convergence time is very less as compared to traditional routing algorithms. 2. GA is more flexible than traditional algorithms. 3. Computation speed of the GA is less than that of Dijkstra's algorithm. As a result genetic algorithm is more efficient for optimization of the shortest path routing problem in wireless sensor networks.

4. Conclusion

The major challenges in the development of wireless sensor network are energy conservation and prolongation of network lifetime. Several key constraints in wireless sensor network have been discussed and presented survey of different algorithms and protocols and approach of these algorithm to save energy and prolonging life time of wireless sensor network. In this survey paper genetic algorithm is efficiently used to optimize the different parameter

such as shortest path, cluster formation, cluster head selection, attack detection, data aggregation and node placement.

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