Optimizing Energy in WSN using Evolutionary Algorithm

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ABSTRACT
Wireless sensor network (WSN) open up new application area such as intelligent environmental and structural monitoring. One of the major challenges in WSN lies in the constraint energy and computation resource available in the sensor nodes. This paper deals with minimizing the energy resource of the wireless sensor nodes and maximizing its life time. When an event is detected in a particular area, all the nodes around the sensing range will collect the data and forward it to the upstream nodes. This makes wastage of energy because all the nodes are involved in sensing, processing and transmitting the same data.. WSN should be energy efficient in term of energy consumption and quality of path that are used to route the packets, towards the data collecting point called sink. Next node selection is based on minimum cost value. The cost depends on link quality residual energy and number of successive transmission. Genetic algorithm is used to optimize the minimum cost function. By using evolutionary optimization method minimum number of nodes is selected to obtain the optimal route.

Keywords: Energy, routing, Genetic Algorithm, PSO, WSN.

1. INTRODUCTION
A wireless sensor network (WSN) consists of spatially distributed autonomous sensors to cooperatively monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants. The development of wireless sensor networks was motivated by military applications such as battlefield surveillance. They are now used in many industrial and civilian application areas, including industrial process monitoring and control, machine health monitoring, environment and habitat monitoring, healthcare applications, home automation, and traffic control.

In the last decade, several advances in embedded systems and wireless communication have made possible the arising of a new kind of ad-hoc network, the Wireless Sensor Network (WSN).[11] The WSN is composed of sensor nodes, which are built with a sensor board, a processor, a radio and a battery. These components allow the sensor to perform sensing, processing and communication tasks inside a coverage radius. When the network is in operation, the sensors collect data from a phenomenon which is being analyzed, and disseminate them toward the sink node, using multi-hop communication. In the literature, several works show the importance of WSNs and their applications for monitoring of: wild life [1], structural health [2], [3], mine tunnels [4], toxic organic compounds in the environment [5], etc.

When a node becomes unavailable, due to out-of-power condition, a rearrangement of the network layout (without this node) must be performed, in order to reestablish the communication without significant reduction in the network coverage. Each time this operation is performed, there are usually several alternatives for reconfiguration. Each different choice of the network configuration, in each stage, determines in which time a further reconfiguration will be necessary and, consequently, the lifetime of the network.[6] The optimal design of the WSNs can be useful to extend the network lifetime, ensuring adequate network coverage and connectivity. Recent works show that an efficient density control in high density sensor networks can save significant amounts of energy and can improve the data dissemination, since it decreases packet collisions and radio interference [7]. In a density control scheme some nodes are scheduled to sleep (or change to energy-saving state), while other ones continue to collect and disseminate data to sink nodes [8]. Therefore, a fundamental problem in high density WSNs is to minimize the number of active nodes to save energy, while keeping the area coverage and the connectivity of nodes.

This paper is basically, we focus on optimization of sensor network.Selecting the optimized path between the source and sink. Calculating the cost function of a path between two nodes depends upon both the activation energy and the maintenance power. By using genetic algorithm the optimized path between source and sink has been selected. Many path will be available between source and the sink .

2. RELATED WORKS
Different power conservation model were used in wireless sensor network. [2] J.Podpora, L.Reznik and G.Von Pless "Intelligent real time adaption for power efficiency in sensor networks" IEEE sensor journal, 2008, proposed method based on intelligent, dynamic power conservation scheme for sensor networks in which the sensor network operation is adaptive to both changes in the objects under measurement and the network itself. An active regime when a node actively performs measurement of the signals sensed from the environment and transmits them to the base station and A sleep regime when measurement and/or transmission take place less frequently or not at all. It is assumed that the transformation should occur when some meaningful change in the object under measurement and/or environment has been detected. If a meaningful event has occurred, more sensors should be awakened in order to capture interesting event data with

a greater degree of granularity. On the other hand, if no change is occurring, the nodes may be put back into a sleep state and the sampling time between measurements increased.[3] M.Vieira,L Vieira and L.Ruiz "Scheduling nodes in wireless sensor network : A Voronoi Approach"IEEE International conference on computer network,2003.Propose a method to set up which nodes should be turned off or on. The management may take the sensor node out of service temporally. Our design uses a Voronoi Diagram, which decomposes the space into regions around each node. That schema could be used in management architecture for a wireless sensor network In case of a network with a high density of sensor nodes, some problems may arise such as the intersection of sensing area, redundant data, communication interference, and energy waste. A management application is necessary to make the most of network resources. On the other hand, a high density network can introduce a fault-tolerant mechanism, increase precision, and provide multi-resolution data. The network density control depends on the application. solution is based on the Voronoi Diagram, which decomposes the space into regions around each node, to determine which sensor node should be turned off or on. To evaluate our design, we perform a simulation comparison. We evaluate the scheduling of nodes varying the network density. [4] Q.Wu, N.Rao,S .Iyengar and V. Vaishnavi "On computing mobile agent routs for data fusion in distributed sensor network" IEEE transaction on knowledge and engineering,2004 The problem of computing a route for a mobile agent that incrementally fuses the data as it visits the nodes in a distributed sensor network is considered. The order of nodes visited along the route has a significant impact on the quality and cost of fused data, which, in turn, impacts the main objective of the sensor network, such as target classification or tracking. We present a simplified analytical model for a distributed sensor network and formulate the route computation problem in terms of maximizing an objective function, which is directly proportional to the received signal strength and inversely proportional to the path loss and energy consumption. To meet these new challenges, the concept of mobile agent-based distributed sensor networks (MADSNs) has been proposed by Qi and S.S. Iyengar. Wherein a mobile agent selectively visits the sensors and incrementally fuses the appropriate measurement data. Mobile agents are special programs that can be dispatched from a source node to be executed at remote nodes. Upon arrival at a remote node, a mobile agent presents its credentials, obtains access to local services and data to collect needed information or perform certain actions, and then departs with the results. Learning algorithms such as genetic algorithms (GAs) use prior network knowledge to reduce energy consumption.[13].GA is used for reduce energy consumption problem. [14].GA is used to determine the number of cluster and cluster head in the wireless sensor networks.[12],[15].We propose an optimization model using Genetic Algorithm and Particle Swarm Optimization to maximize the lifetime of the network.

3. PROBLEM DEFINITION

3.1 MINIMIZING COST FUNCTION

A scenario has been created with a set of sensor nodes and a sink node. Establishing at least one path between sensor nodes and a sink node. Finding a network which compiles with coverage and connectivity constraints at each period of time and minimizing the energy consumed in the system. We use GA to compared the results. Here the energy of sensor node will be optimized and life time of sensor will be increased.

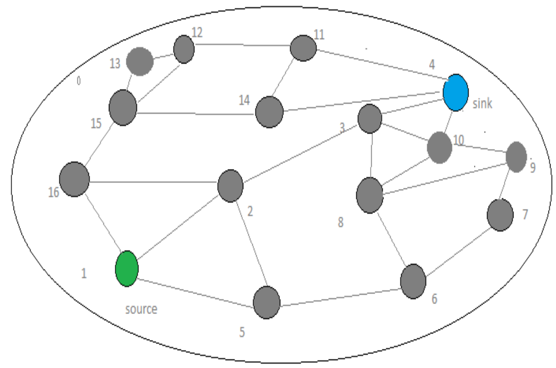

Figure 1. Node and Sink SCENARIO

The optimal solution can be found by solving the equations given below

$$F=\min[C(P)] \quad (1)$$

$$C(P) = C(S,R1) + C(Rx,Ry) + C(Ry+D) \quad (2)$$

$$C(S,R) = WE*PE + WT*PT \quad (3)$$

$$G=(M,A) \quad (4)$$

The network is modeled as a weighted graph G = (M,A) where M is the set of nodes and A be the set of links between nodes. is the set of order pair (i,j) is referred to as the link connecting node i to the node j. The core area of the research is towards the minimizing the cost function c(p). We try to keep the communication and connectivity model as general as possible, without making any specific assumption on physical channel model, modulation and coding techniques. For this reason , any further specification will not affect the validity of the set. C(S,R) refer to the calculation of Cost function between source and a node. When some event happened sensor around the particular area will detect the event and send the information to the sink. As sensor nodes are densely populated the information need to pass through the relay nodes. By determining the optimized path between the source and sink, we can able to minimize the number to sensor to be in active state. Able to minimize the energy consumption we can be prolong the life time of sensor node. C(S, R) refers to calculation of cost function between source and a relay node. C(Rx,Ry) refers to the calculation of cost function between two relay node C(Ry,D) refer to the calculation of Cost function between last relay node and sink. All nodes are transmitted. Cost function of each link (i,j) is depends on the resource that are needed to transmit a message from node I to node j. The factor we consider only energy required to transmit a single information bit. Other factor such as quality associated with the link, congestion level at node j, the node failure probability or the residual energy of the node can also be considered. In order to keep the framework as general as possible, we do not propose a specific model to determine such cost. In our analysis, we only consider all loop-free oriented paths connecting node s to node d

3.2 Connectivity Parameter.

PE refers to energy required to send information from one node to another node energy required will be between(0.00 to 100.00). PT refers to Transmission success rate of PT will be in between (0.0 to 1.0). WE refer to Assigned weight of PE (0.0 to 1.0). WT refer to the Assigned weight of PT (0.0 to 1.0).

3.3 CALCULATING COST FUNCTION:

1. Consider WE = 0.7, WT = 0.3, PE = 100 and PT = 3.
2. PE and PT are the energy level of next hop node and transmission success rate respectively,
3. Sixteen active path is selected between source and the sink.
4. C(S,R) used to calculate the cost function between two nodes. C(P) used to calculate the total cost function between the source and sink.
5. By using the equation 2 and 3 calculation has been carried out between source and destination for the entire available sixteen path.
6. Energy will be randomly decreasing from the source node and the power will be randomly increasing from the source to the sink. All the cost function has been calculated.

3.4 GENETIC ALGORITHM

The genetic algorithm (GA) is a search heuristic that mimics the process of natural evolution. This heuristic is routinely used to generate useful solutions to optimization and search problems. Genetic algorithms belong to the larger class of evolutionary algorithms (EA), which generate solutions to optimization problems using techniques inspired by natural evolution, such as inheritance, mutation, selection, and crossover. By using genetic algorithm the minimum distance between the source and destination will be calculated and further optimized.

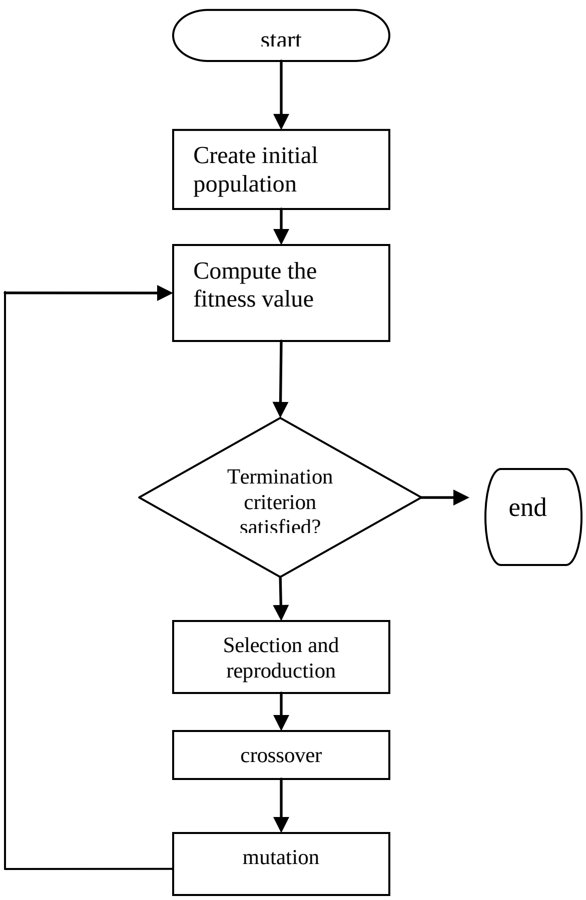

Figure 2. Flow Chart.

A Genetic Algorithm performs fitness tests on new structures to select the best population. Fitness determines the quality of the individual on the basis of the defined criteria. In nature, an individual's fitness is its ability to pass on its genetic material. Anything that contributes to this ability contributes to the organism's overall fitness. This ability includes traits that enable it to survive and further reproduce. In a GA, fitness is evaluated by the function defining the problem. The fate of an individual chromosome depends on the fitness value; the better the fitness value, the better the chance of survival. This is the concept of survival of the fittest. The genetic algorithm repeatedly modifies a population of individual solutions. Genetic Algorithm performs fitness tests on new structures to select the best population. Fitness determines the quality of the individual on the basis of the defined criteria. At each step, the genetic algorithm selects individuals at random from the current population to be parents and uses them produce the children for the next generation. This is done by three rules – selection, crossover and mutation. Over successive generations, the population "evolves" toward an optimal solution. Genetic algorithms are robust and provide better optimization.

.4. SIMULATION RESULT

4.1 FOR GENETIC ALGORITHM

No of variables – 1
Population – 16
Generations – 1000

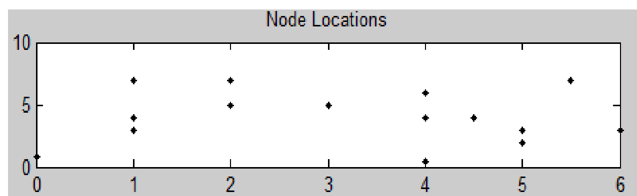

Figure 3. Node Location

In above fig.3 the population of the sixteen nodes is displayed. The position of the nodes is given in the matrix format. The Fixed Start is taken to be the first XY point and the Fixed End is taken to be the last XY point.

- **XY** is an Nx2 matrix of nodes, where N is the number of nodes
- **DMAT** is an NxN matrix of node to node distances
- **MIN_TOUR** is the minimum length NOT including the start point or end point
- **POP_SIZE** is the size of the population (should be divisible by 8)
- **NUM_ITER** is the number of desired iterations for the algorithm to run

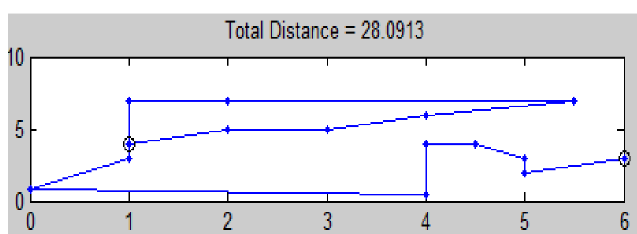

Figure 4. Total Distance

At the end of the simulation about 16 active path are obtained between source and the destination. Among which the shortest path between source and sink is displayed in the fig.4 .

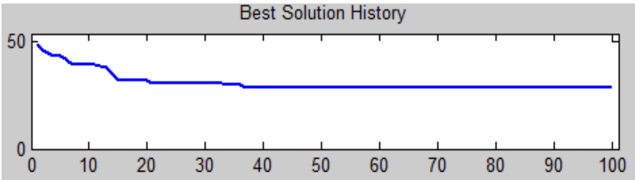

Figure 5. Best Solution

Elapsed time 2.370412 seconds

The optimized path is calculated and display in the figure 5.

6. CONCLUSION

Lifetime depends on energy consumption of the node .By selecting optimized path between source and the sink able to increase the life time of the node. In this paper we discuss about cost function of path between source and the sink has been calculated. By using genetic algorithm able to find the optimized path between nodes. In future development particle swarm optimization method is used to determine the shortest path and compare with the genetic algorithm.

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