Energy Efficient Routing Algorithms for Maximimizing Lifetime of WSN

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Abstract

In WSN, devices commonly known as nodes or hub are powered by battery. The device which provide power to the sensors has limited power. Therefore the nodes has to consume limited amount of power in order to fulfill the requirement of users. The lifetime of the nodes is described by its running time until it turns off due to lack of power. In this paper we propose a novel method for energy efficient routing algorithm using Genetic algorithm. The experiment results shows that the genetic algorithm with spanning tree outperforms the Exhaustive search algorithm in terms of time complexity.

Keywords—*Battery power, Lifetime of wireless sensor network, Minimum energy cost routing, Optimal flow, Linear programming problem.*

I. INTRODUCTION

In recent year, wireless sensor networks has gained rapid growth. Wireless sensor network shares lots of information between their nodes. They continuously share information with the server. If data exchange between the sensor nodes are not recorded the inconsistency of data will occur which will lead to a great disaster. If defense system, the aircraft movements of enemy are recorded. If one of the sensor cant able to detect the movement, than there will a trouble in the security of nation.

Hence proper working of sensors is very crucial. Other application areas of sensor networks are in industry, agriculture, residential and medical. These many areas are need of sensory hubs. These sensors have limited power to run. The nodes aka sensors generated data and sent to data center. The data are sent via a communication network which requires power. If one of the sensor network run out of power than it may go to dead state, going to dead state simply means it cannot further record the data.

A. Energy Efficient Routing Algorithms

A major challenge in WSN is to utilize minimum power for the sensors. To do so, sensor network must follow some protocols in order to enhance the efficiency of sensors. It is practically impossible to recharge the battery of sensor unit every time they get out of power. The efforts need to carry out to minimize the power usage rather than recharging again and again.

Why it need to prolong the power of sensor network:

- Device are generally powered by battery, as it has limited amount of energy stored.
- Failure of one device, fails the whole network or one group of network.
- One group of sensor nodes perform similar task cooperatively, so everyone has to be alive.

In wireless sensor networks the main objective is to maximize the minimum lifetime of each node. Lifetime is maximized by balancing the energy consumption of each node, using energy efficient routing. To maximize the objective function, it is appropriate for an emergency network in which every node is critical.

B. Maximum Residual Energy Path Routing (MREP):

In this algorithm, to send data from node i to node j, let p be the set of all path possible. For a path p belongs to P, define the path length lp as a vector whose elements are the reciprocal of the residual energy for each link in the path after the route has been used by a unit flow. For each unit flow routing path is calculated. Those who have minimum residual energy will be the path for optimization of routing.

C. Flow augmentation algorithm (FA):

The main objective of this algorithm is to find the best link cost function which will tends to maximize the lifetime of nodes. There may present more than 2 iterations to calculate cost function. Every time iteration called, shorted path is calculated and cost function are generated.

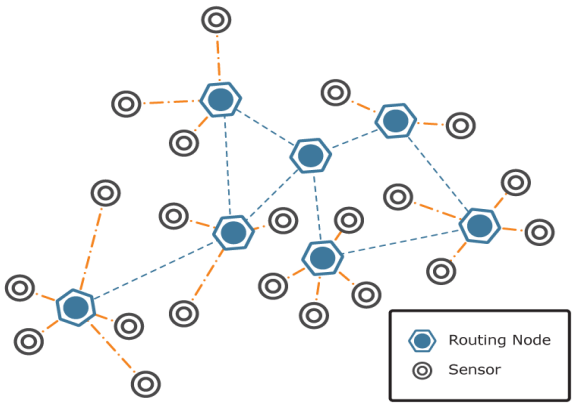

Fig.1. shows the arrangement of sensory nodes

D. Zone Based Routing (ZBR)

Zone based routing generally organizes the hubs into geographical zones. It construct a hierarchy of nodes. Each nodes contains other nodes as a container. Each zone master has a capability route packets to other zones or hubs.

E. Centralize energy efficient routing:

The objective of this routing algorithm is to determine the optimal path from each sensor node to Access Point (AP) based on the topology of the network and the packet generation rates at the sensor node. In this algorithm, author propose a routing protocol for centralized implementation of the Linear Programming solution means in this protocol LP solution is decompose in to multiple routing tree.

F. Keep connect algorithm (KC)

The keep connect algorithm finds the weight of node based on how many components are connected with this node. The weight of node can be thought as the importance of the node. Most important node is the node that results in large number of disconnected component as it dies.

II. LITERATURE SURVEY

In [7] C.K. Toh discovered that if nodes in an ad hoc wireless network expend most of their power on communication-related applications, then power aware routing protocols like minimum battery cost and min-max battery cost schemes can prevent nodes from being unwisely overused. This extends the time until the first node powers down and increases the operation time before the network is partitioned.

K. Kar et al. [8] provided routing algorithm for network capacity maximization in energy constrained ad hoc network. C. Pandana and Ray Liu proposed the Keep Connect algorithm along with flow augmentation or with Minimum Total Energy algorithm and these combine algorithm provided maximum connectivity of the network as well as maximize the lifetime of network [9]

LEACH (Low-Energy, Adaptive Clustering Hierarchy) is given by W.R.Heinzelman et al [10]. LEACH is a clustering-based protocol that utilizes randomized rotation of local cluster base stations (cluster-heads) to evenly distribute the energy load among the sensors in the network.

In [12] an energy efficient routing in ad hoc disaster recovery networks is given by Gil Zussman and Adrian Segall. Their network model is based on the model for energy conserving routing in a wireless sensor network, presented by Chang and Tassiulas [2]. Formulated as an anycast routing problem, in which the objective is to maximize the time until the first battery drains-out.

G. Anastasi, M. Conti, M. D. Francesco and A. passarella discussed various energy conservation schemes in wireless sensor network. To reduce power consumption in wireless sensor network, they identified three main enabling techniques namely duty cycling, data-driven approach and mobility [13]. Distributed energy balanced routing is proposed in [14].

III. METHODOLOGY

In this section the proposed system architecture is discussed in detail. The architecture consist of various modules.

1. Map File Creation
2. Create Populations
3. MST Algorithm
4. Genetic Algorithm

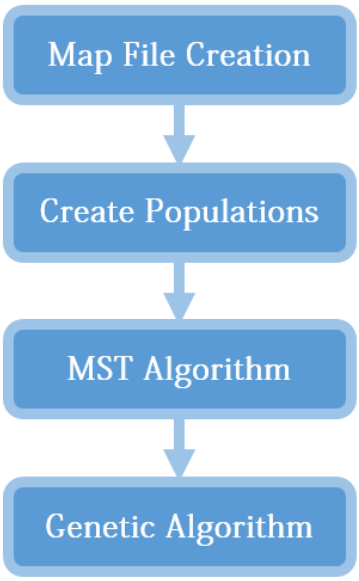

Fig.2. Proposed systema architecture workflow

A. Map File Creation

The map file is used to denote the position and distance of the sensory nodes. The map file consists of 3 major components.

a. Node Number (0 for base station)
b. X Axis
c. Y Axis

X and Y Axis points are the sensor locations.

B. Create Population, MST and Genetic Algorithm

The population are created for running the sensory nodes and transferring packets to all other nodes. The spanning tree role is to find the minimum distance from the base station. GA algorithm is sued for finding maximum lifetime of sensory nodes. Algorithm is presented below.

The GA algorithm is widely used algorithm. The GA can perform efficiently and effectively as compared to existing algorithm.

Algorithm: Core GA Procedure

- Set D = {{ x0, y0}, {x1, y1}, {x2, x3} . . . {x_N, y_N}}
- PS → are randomly generated
- Initially set

  P ← {t1, t2, t3 . . . t_{PS}}

- For loop i=1 to NG do

  FitnessValue(P)

  SelectionProbabilities(P)

  P ← NewGeneration(P)

  End for loop
- FitnessValue(P)

  Tree ranking is returned

IV. RESULTS

To evaluate the performance of GA algorithm, we have used python language for implementation and simulation. Later GA algorithm is compared with the ES (Exhaustive Search algorithm). Fig. 3. Shows the nodes location using 5 nodes.

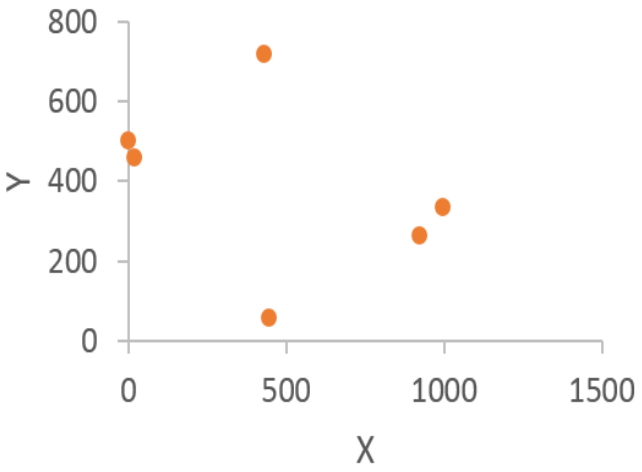

Fig. 3. Sensory Nodes Location

Some of the parameters which are used for experiments are shown below.

S.NO	Parameter	Value
1	Packet Size	125 * 8 (bits)
2	Energy Dissipated while transferring bits	50 J/bit
3	Energy Radiated to the medium to transfer 1 bit	10 J/bit/m^2
4	Cross Probability	0.8
5	Battery	15 kJ

Fig. 4. Parameters and its value for GA

Simulation results are presented below for 3 and 4 nodes.

```
=============== SOLUTION 1 ================
Node 1 should send to node 0
Node 2 should send to node 0
Node 3 should send to node 1
Network lifetime 25435.2714159 rounds
```

Fig. 5. GA with 3 Nodes

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=============== SOLUTION 1 ================
Node 1 should send to node 0
Node 2 should send to node 0
Node 3 should send to node 2
Node 4 should send to node 0
Network lifetime 67647.6352008 rounds
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Fig. 6. GA with 5 Nodes

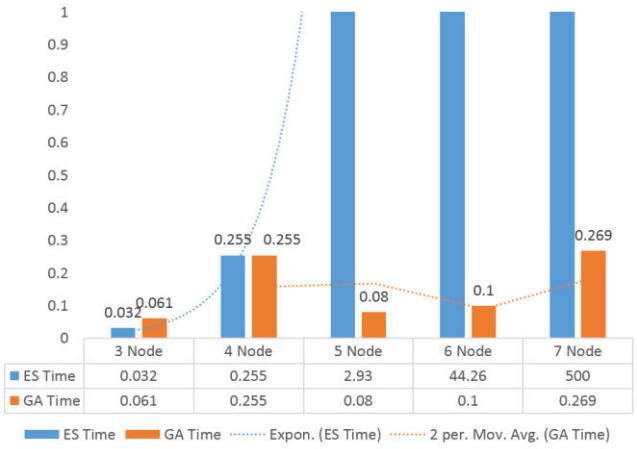

Fig. 6. Comparision chart for execution time of GA and ES

V. CONCLUSION

There are many challenges in saving energy consumption my sensory nodes. To main Quality of service, scalability, accuracy in results, fault tolerance sensory nodes has to work efficiently in order to achieve all those requirements. The routing of information from one nodes to another is very important, because it consumes lots of energy. To minimize those energy consumptions the GA algorithm outperforms the ES algorithm in terms of time complexity.

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