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LIFETIME AND COVERAGE ENHANCEMENT USING HYBRID APPROACH IN WIRELESS SENSOR NETWORK

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ABSTRACT

This paper present a hybrid approach to improving the network lifetime and coverage/connectivity of wireless sensor network. Here we apply a new deployment scheme with GA based routing to improve network lifetime and coverage. GA based clustering on routing is used in this paper to select the path for data transfer in such a way that total energy consumption along the path is minimized. Coverage is another important factor in wireless sensor network. The position of sensor nodes must also be provide maximum coverage. In this paper, we also introduce a zonal approach for deployment which provide maximum coverage. Experiments shows the accuracy of genetic algorithm is better than LEACH, and provide better energy efficiency or improve network lifetime. The simulation result also shows the uniform placement of sensor nodes provide better coverage and connectivity as compare to random placement of sensor nodes.

KEYWORDS: Wireless Sensor Network, Deployment, Coverage,Connectivity, Network lifetime, Genetic Algorithm.

INTRODUCTION

In Wireless Sensor Network (WSN) fixed number of sensor nodes are deployed in a given region to detecting intented event or object, store the detected data, process them and then transmit it to the required destination. Each sensor node has limited communication range and low power [1]. So, coverage and energy consumption are two fundamental issue which are discuss in this paper.

The coverage of wireless sensor network reflects how well the event or object in the entire monitored area is detected by sensors. Coverage in wireless sensor network depend upon a number of factor such as communication range of sensor node, sensing range of sensor node and deployment technique etc. One sensor node in WSN communicate to another when it lies within a communication range of the neighbor sesor node. Sensing are is an area in which a sensor node can sense environmental changes. To increase the coverage and connectivity it is very important to planned the position of sensor node before the deployment process. If the number of sensor node that can be placed in given region is limited, it is very important to determine the exact location for these sensor node which affect the coverage and operational lifetime of network [2].

Each sensor node in wireless sensor network containes a limited energy source. So, it is very important to keep minimum energy consumption because it is difficult to change the battery especially when the WSN installed in remote areas. The data transmission will be affected if the sensor node is running out of energy. Therefore, retransmission of data will be needed which might cause packet drop or delay [3].

This paper is organised as follows. Section 2 represents maximum coverage sensor deployment problem. In this paper a zonel approach is used for sensor node placement to cover the target area. Section 3 describes the energy efficient communication protocol. In this section proposed genetic algorithm is defined. Section 4 will define the

simulation parameter and simulation result. Finally, conclusion of our research are given in section 5.

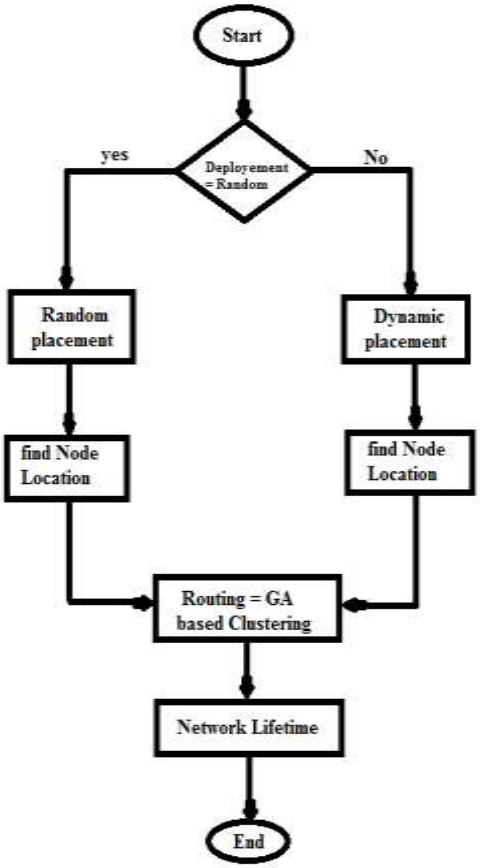

Fig 1. Proposed Model

MAXIMUM COVERAGE SENSOR DEPLOYMENT

Sensor coverage and connectivity are two fundamental issue in wireless sensor network. Network connectivity of alive sensor in complete coverage is guaranteed by having the communication range or sensing range of each sensor is twice the distance between two sensor nodes [4].

A wireless sensor network cover a wide range of a target area with a minimum number of sensors, which can be done by efficient deployment of the sensors. There are two ways for deplyoing sensor nodes to completely cover a target area, i.e. random deployment and dynamic deployment [5].

Random Deployment:

In random deployment sensor nodes are distributed independently in a given region to collect the information or data from their surroundings [6]. The random scheme can be gaussian, or poisson, uniform, or may follow other distribution depending upon the application under consideration. Random deployment of sensor node increase network connectivity which is an important issue in wireless sensor netwrok [7].

Random deployment become a problem when distance between some sensor node is too large and other sensor nodes are placed very close to each other. So due to this there is a problem comes is known as coverage hole. Coverage hole is uncovered area of a given region in between the covered area [8].

Dynamic Deployment:

Dynamic deployment is a preplanned deployment technique of sensor node in a given region. Sensor node are deployed in a given area by placing them in predetermined location. This placement technique can be applied to a

small to medium sensor network such as building monitoring or indoor survilliance because it is not possible to determine the exact position of sensor node when network size is large [9].

THE PROPOSED PLACEMENT

This paper proposed a dynamic deployment technique to improve the network coverage. The proposed scheme is based on a design objective such as maximum coverage and maximum connectivity. Coverage can be improved by placing the sensor node in an uniform manner in a target region. A zonnel approach is used in this paper. Whole area is divided into a number of sub-area or a no.of zone. Each zone is containes at least more than one sensor node to cover the target or event. For example, in a node deployment problem, when there are 50 nodes. These 50 node will be placed in 100×100 m^2 target area. Assume that target area is divided into 5×5 zones. Each zone size is 20×20 m^2. Each zone is contains two sensor nodes to cover the event.

Optimization Objectives

Coverage: The target area is divided into X×Y zone.

K = n/ total zone

K = no. of node in each zone.

n = total no. of sensor node.

Connectivity: Connectivity represent how the sensor nodes communicate to other node via a single hop or multi-hop communications. Each sensor node has at least one data transmission route to transmit their sensing data to base station. Disatance between each sensor node is always less than its transmisssion range. Connectivity in the proposed approach is based upon the set of member between transmission range of sensor node.

connectivity = count (dmat < transrange)

dmat = distance between two sensor node

transrange = transmission range of sensor node

ENERGY-EFFICIENT COMMUNICATION PROTOCOL

LEACH

LEACH (Low Energy Adaptive Clustering Hierarchy) , is a distributed clustering protocol that use randomized rotation of cluster head to evenly distribute the energy load between the sensor node in the sensor network. The whole operation of leach protocol are divided into fixed length round. Where each rount consist of set-up phase and steady state phase [10].

a. Set-up phase:
   Cluster head election.
   Cluster formation.
b. Steady State phase:
   Time slot scheduling.
   Data transmission.

working of LEACH algorithm is as follows [11] :

1. LEACH is a self organizing protocol, so each sensor nodes elect themselves to be a cluster head, by selecting a random number k with threshold T(n). if k is less than T(n) then the node become a cluster head of current round.

$$T(n) = \begin{cases} \dfrac{p}{1 - p * (r \bmod 1/p)} & \text{if } n \in G, \\ 0 & \text{otherwise,} \end{cases}$$

Where P is the desired percentage of cluster head, r is the current round and G is the set of node that have not been cluster head in the last 1/P round.

2. After selection of cluster head, each non cluster node decided to join a cluster, it inform cluster head node that it will be a member of particular cluster.

3. Cluster head nodereceive all the messages for node that would like to be a member of the cluster. Depending upon the number of memberninthe cluster, the cluster haed node allocate the time slot to each node when it can transmit.

4. After cluster formation and TDMA scheduling, node start transmitting the data in their allocated transmission slot.
Drawback of LEACH protocol [12]:

1. In LEACH protocol cluster haed is selected randomly in each round. Therefore, some node is selected as cluster head many times so they exhaust their energy too quickly.
2. There is a direct communiction between cluster head and sink in LEACH protocol. So, energy consumption between cluster head and sink are greater than energy consumption among other node, so cluster head will exhaust energy soon.
3. It can not be applied to a larger sensor network.

PROPOSED GENETIC ALGORITHM

Genetic algorithm is the most effective tool which provide the optimal solution of problem. In this paper GA based clustering are proposed to achieve good performance in terms of network lifetime. In the proposed algorithm closest sensor node are selected as a member of cluster.

Encoding:

Binary encoding is most common in genetic algorithm. Proposed GA used binary encoding. In binary encoding every chromosome is a string of bit, 0 or 1. Encoding in genetic algorithm is based upon boolean array. Where binary 1 represent cluster head node and binary 0 represent non cluster head node.

Population:

Population is collection of individual known as chromosome that represent a complete solution to a defined problem.

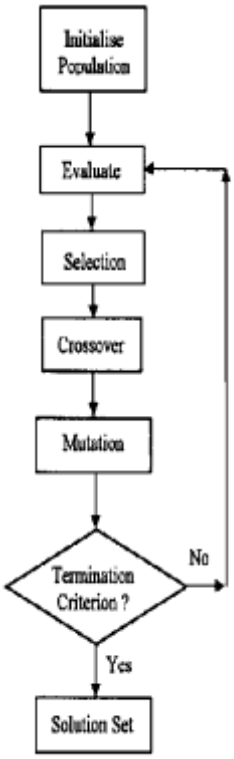

Fig 2 flow chart of genetic algorithm operation

Fitness:

An individual fitness is its ability to pass on its genetic material. Fitness function of proposed algorithm is based on residual energy of sensor.

Selection:
The selection process determines which of the chromosomes from the current population will mate to crate new population. The probability of chromosome to be selected is propotional to its fitness. A tournament selection is used in this paper to select the parent nodes to produce a child solution.

Crossover:
Crossover is a genetic operator to generate childern chromosome in which more than one parent solution are used to produce child solution from them. In proposed algorithm uniform crossover are used in which bits are randomly select from the first or from the second parent.

Mutation:
Two members are selected and exchanged. A uniform mutation is used in the proposed algorithm.

SIMULATION AND RESULT

The basic simulation parameter and simulation result are discussed in this section. Simulation study has been done by using MATLAB.

Simulation Parameter:
The simulation parameter of our model are shown in table no.1 and parameter of genetic algorithm are given in table no. 2.

Table1. Simulation Parameter

Parameter	**Description**	**value**
xy	Network Area	100*100m
n	Node Number	50
k	Packet Length	4000bits
bs	Base Station Position	50,50
E_{int}	Initial Energy	0.5J/node
E_{elec}	Energy dissipation to run the radio	50nJ/bit
E_{mp}	Multipath Model of transmitter amplifier	0.013pJ/bit/m4
E_{da}	Data Aggregation Energy	5nJ/bit/signal
$r_{\max}$	No. of round	1700

Table2. Genetic algorithm parameter

Parameter	Value
Initial population	10
Crossover rate	0.5
Mutation rate	0.015
Tournament size	4
Maximum iteration	10

Simulation Result

We have selected a reactangle area of 100×100 m^2 and 50 nodes are placed in an uniform manner in the given area. And base station are located at position (50,50). The transmission range of each sensor node is 35m. and length of transmitted packet us 4000 bit.

COVERAGE

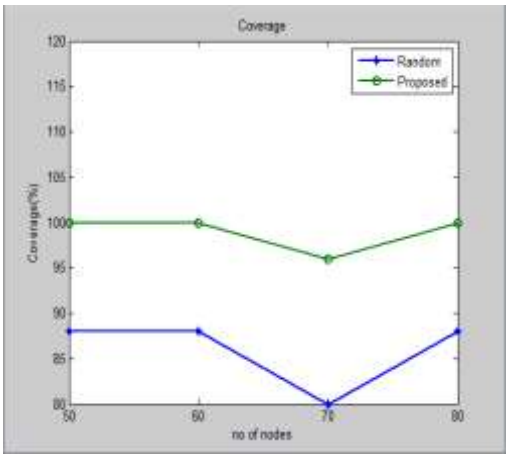

Fig 3. Compare coverage percentage of existing and proposed algorithm

Fig 3. Compare the coverage percentage of existing (random) and proposed algorithm at different number of nodes.

CONNECTIVITY

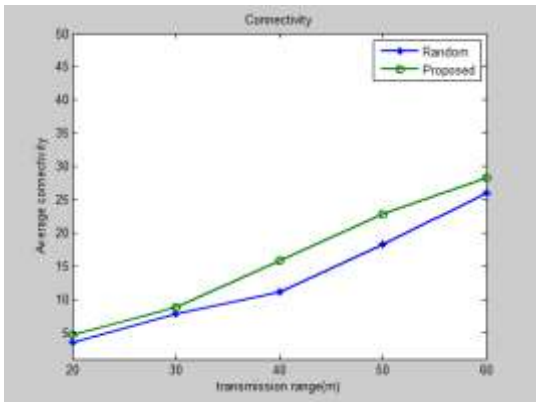

Fig 4. Compare the connectivity of existing and proposed algorithm

Fig 4 compare the connectivity of existing (random) and proposed algorithm at different value of transmission range.

NETWORK LIFETIME

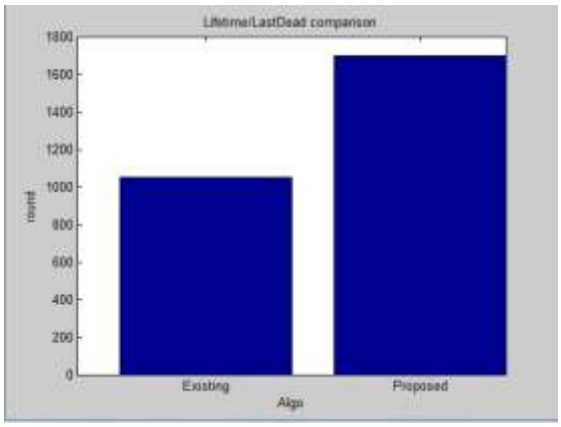

Fig.5 compare the network lifetime of existing and proposed algorithm

Fig 5. Comapre the network lifetime of existing and proposed algorithm. In both existing and proposed algorithm there are equal number of sensor nodes. And operation performed for equal round.

CONCLUSION

This paper proposed a dynamic deployment approach to arrange sensor node in a wireless sensor network to ensure that coverage and connectivity will be maximized and GA-based clustering algorithm for energy efficient data transfer in wireless sensor network. Based on simulation result, sensor node deployed with proposed deployment algorithm provides a considerably higer coverage and connectivity and proposed genetic algorithm provides the more efficient solution than previous one.

The work will be further extended with the other objective function to address other issue that are related to WSN.

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