MATRIX Academic International Online Journal of Engineering and Technology
ISSN: 2348–3326 © MAIOJET
Volume III Issue I, April 2015

Node cycling technique using GA

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***Abstract*— 'Wireless Sensor Network' nodes collect, process and communication data acquired from the physical environment to an external- base (BS). Its flexibility on terms of the shape of the network and mobility of the sensor nodes make it special. Sensor nodes in WSNs are normally battery- powered. Life of battery decides the life of node which is turn decides the performance as well as life of WSN. If one or couple of node id fail due to battery failure, this may collapse the entire network. As it is well know that in WSN sometime sensors are placed at such a location where it is physically impossible to replace the battery. However if somehow a dead node can be replaced by adjacent node network can de keep alive. Coverage area also plays important role in deciding the performance of the system. Here we explore multi-objective algorithm using GA and try to design an optimal network by trying to optimize the energy and connectivity parameters suing two different fitness functions. These functions include all the necessary design parameters which may affect performance of WSN.**

***Keywords*—** WSN, GA, Coverage Area, Battery Life, FF

I. INTRODUCTION

Wireless Sensor Network nodes collect, process and communication data acquired from the physical environment to an external- base (BS). Its flexibility on terms of the shape of the network and mobility of the sensor nodes make it special. Sensor nodes in WSNs are normally battery- powered. Life of battery decides the life of node which is turn decide the performance as well as life of WSN. If one or couple of node id fail due to battery failure, this may collapse the entire network. As it is well know that in WSN sometime sensors are placed at such a location where it is physically impossible to replace the battery. However if somehow a dead node can be replaced by adjacent node network can de keep alive. This process is called as deriving node cycling; which is achieved by replacing dead node by adjacent node & properly maintaining the network density. Protocol which is used to communication between nodes governs by the connectivity of the network. Generally the sink node is used to gather the information from the cluster and then transmit this information to the BS. This arrangement is called as cluster based architecture. The main issue here is the ability of sensor node to approach the sink as well as for sink node to handle the load.

Many technique ANT Colony Optimization, Swarm Optimization Artificial intelligence etc have already been deployed to handle the issue but application specific issue keeps the design optimization complexity still intact. Genetic Algorithm(GA) is one of the most powerful heuristics approach for solving optimization problems that is based on natural selection, the process that drive biological evolution. The GA repeatedly modifies a population of individual solutions. At each steps, the genetic algorithm selects individual at random from the current population to be parents and them to produce the children for the next generation. Over successive generations, the population "evolves" towards an optimal solution. GAs can be applied to solve a variety of optimization problems that are not well suited for standard optimization algorithms, including problem in which the objective function is discontinuous, non- differentiable, stochastic, or highly nonlinear. Several researchers have successfully implemented GAs in a sensor network design [2]-[8]. The GA observes the functionality of the node before deciding over the application specific issue alone with keeping the energy level within permissible limits.

II. WSN MODELLING

To implement the WSN square grid X*X length units are taken and then on complete X2 intersection sensor are placed. The single node in this entire population is represented by string of chip and sensor nodes encode in row by row fashion. The grid is applied to open field cultivation, where a length unit is an abstract parameter so that the developed system for optimal design is general enough. The length unit is defined as the distance between the positions of two neighbouring sensor nodes in the horizontal or vertical dimension.

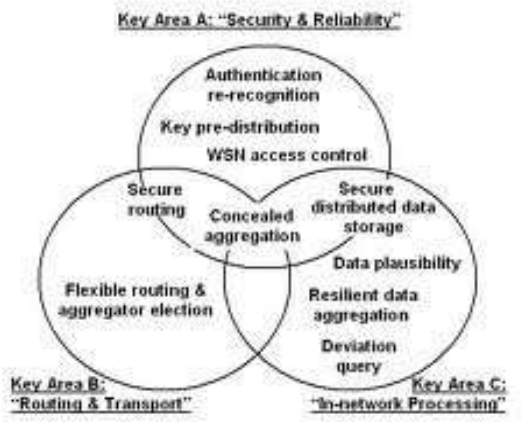

Fig. 1 shows the intersection of the grids

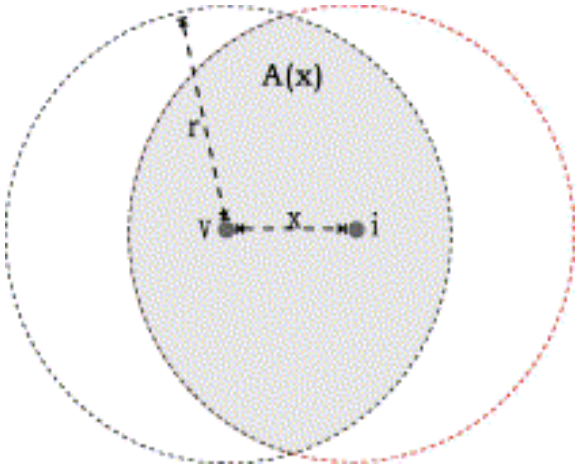

Fig. 2 shows the unit lengths between two sensors

III. Problem Defination

We need to optimize application specific connectivity and energy based parameters by using two different fitness function, which give quality measure to WSN and optimize it to best possible topology. Well known is the fact there are three broad categories in which WSN parameters can categorised [4]. We will consider only two of them, firstly the energy based such that the optimal amount of energy is used that too by live sensors and then connectivity issue to ensure none of the node remains unconnected. Constraints such as synergy consumed and unconnected sensors are to be mini missed to achieve optimal design for this the weighted sum approach is most suitable to aggregate all these constraints and optimal system design is achieved. The basic function for designing function for genetic algorithm is given by:-

$$f = \left[\sum_{n=1}^{n} \beta_n A_n\right]_{MIN} \qquad 1.1$$

Here,
A_n= Objective constraint (like unconnected node; no of node in cluster)
β_n = Corresponding weight.

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IV. Objective Parameters

Objective constrained parameters to be optimize, firstly we look on to:-.

A. *Maximum coverage of sensor*

TheMaximum coverage of sensor is given by:-

$$C_n = \frac{(n_a + n_b + n_c) - (n_{RO} + n_{dead})}{n_t} \qquad 1.2$$

n_a = 'a' mode cluster in charge, n_b = 'b' mode & n_c = 'c' mode, n_{RO} = nodes out of range, n_{dead} = dead nodes, n_t =total no. of sensor

The quality of communication delivered by the WSN is widely dependent on the fact that how the sensors are deployed, fig-3 shown the typical example of WSN nodes are deployed for specific sensing application not only for communication.

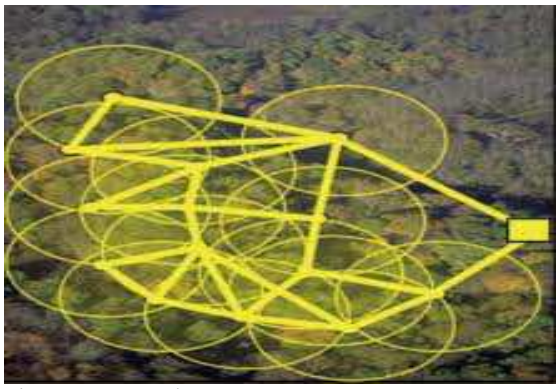

Fig. 3. WSN Nodes.

B. *Node Incharge*

Now considering node in charge of the cluster which specifies the ability of sensor to handle the load as well as its ability to communicate with other nodes in the cluster and is given as:-

$$SC_{inch} = \frac{n_b + n_c - n_{OR}}{n_{inch}} \qquad 1.3$$

Here,
n_{inch}= no. of sensors cluster in charge

C. *Out Of Range Node*

This parameter which tells about **nodes which is out of range** of cluster and is given by:-.

$$SE_{OR} = \frac{n_{OR}}{n_t - n_{dead}} \qquad 1.4$$

D. *Energy Consumption*

Energy consumption based parameter, it is the measure of the energy consumed by the WSN and it depends upon the node in which the node is operating i.e. if:-

'a' mode (In Charge node)- consumed highest power as well as data scheduling and aggregation part is perform end by it so it required high communication power,

'b' mode- consume less power as its communication range is limited as it only communicate In charge mode.

'c' mode- consume lowest power

Assuming that the power consumed by mode is α time c; b mode s β time c than:-

$$N_E = \frac{\alpha.n_a + \beta.n_b + n_c}{n_t} \quad 1.5$$

E. Fitness Function

After looking at all the design parameter now let's define the FF :-

$$f = -AC_n + BSC_{inch} + CSE_{OR} + DN_E \quad 1.6$$

Here,

(-) sign before first coefficient depicts the fact that the problem is optimized by minimizing the fitness function to maximize thier parameter related particular coefficient it is multiplied by (-) sign. Here all the coefficients are firstly set to unity and after GA optimization appropriate wieght are assigned to each coefficient. Finally weights will be set in such a manner that all the sensors should be in range of In charge node and none of in charge should be connected to more than predefined no of sensor nodes.

V. Conclusions

In this paper we implemented GA to replace the dead node with the active one foe WSN. For fixed WSN with sensors of separate operating mode it is the GA who will decide that which node shall be alive, which will act as cluster in charge and what should be transmission range of remaining alive nodes.

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