Clustering in Wireless Sensor Network: A Research

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ABSTRACT

Clustering is one of the techniques in the Wireless Sensor Network that can enhance the life time of whole Network through the Cluster Head (CH) selection. Wireless Sensor Networks are mainly characterized by their limited energy supply. Hence, it is important to optimize the energy of Sensor Node for improving the life time of WSN. In this paper, I present an energy aware Clustering for Wireless Sensor Networks by using Particle Swarm Optimization (PSO) algorithm. I compare the performance of PSO with Genetic algorithm (GA) with new fitness function that has the objective minimizing the intra-cluster distance and optimize the energy consumption of network. The performance of our protocol is compared with the well known GA. Simulation result shows that the proposed protocol using PSO algorithm has higher efficiency and can attain better Network lifetime and data delivery at the Base Station (BS) over its comparatives.

Keyword:- *Clustering, Energy Efficiency, genetic algorithm, PSO, Fitness Function.*

1. INTRODUCTION

Wireless Sensor Network (WSN) is a rising field with lot-of applications such as agriculture, Security, Military, Survivalence etc. WSN usually consists of a large number of low-cost and low power of Sensor Nodes that are small in size. The nodes are varying from few to several hundreds or even thousand, because of this the energy supply of sensor Node is limited. So energy optimization should be considered when studying the overall Network problem. Clustering is one of the methods used to handle the Network energy consumption. In this the group of sensor Nodes have a Cluster Head (CH), that aggregate data from its respective Cluster and send it to the BS [1]. WSN Nodes are resource limited devices. The objective is to increase the life time of Network. In Clustering, the CH sends query to all Nodes in its Cluster, accumulate data from all the Nodes and report to the BS. The Nodes with less energy cannot become the CH. So the main concern is how to select the CH, so that the Network life time is increase.

In WSN Clustering technique plays very important role, it maintain the Network topology that efficiently the groups of Nodes. Sensor are energy constrict hence there battery cannot be recharged. So designing energy aware algorithm becomes an aspect for increasing the life time of sensors. So the evolutionary algorithm such as Particle Swarm Optimization (PSO), Genetic algorithm (GA) are generally are more suitable to solve these problem, because they are population based Stochastic approaches that can often find a global optimum solution [2].

2. RELATED WORK

Recently, lots of algorithm has been developed in WSN. The Sensor Nodes handling in WSN is very difficult as it has a limited amount of energy. For efficient use of limited energy Clustering based routing protocol are proposed. Here I am showing some Clustering based protocols.

In the year 2000 first hierarchical protocol was developed that is Low energy adapting Clustering hierarchy (LEACH). This protocol minimizes the global energy usage by distributing the load to all the Nodes at a different point in time. It uses localized coordination to enable scalability and robustness for dynamic networks. Distributing the energy with the Nodes in WSN reduces the energy dissipation and improves the life time of Network [3]. Another approach in 2002 it combine Cluster based routing and media access together and achieving better performance in term of network life time, latency, and application perceived quality [4]. Another approach is Stable Election Protocol (SEP). It depends on the weighted election probability of each Node to become CH. Based on the remaining energy it provides longer Stability and higher average throughput then another Clustering heterogeneous protocol [5].

Later in 2006, a new better approach was developed namely as distributed energy efficient clustering (DEEC) [6]. In this CH is chosen based on probability based ratio between the residual energy of every Node and the

average Network energy. The high the initial and residual energy of Nodes will have more chance to become the CH then the low energy Nodes. DEEC uses the average network energy as the reference energy. Therefore, DEEC does not require any information about energy at every round. Energy Dissipation Forecast Method (EDFM) [7] was proposed in 2009. This method considers the residual energy and consumption rate in all Nodes. This algorithm uses two types of CH for energy consumption. Two types of CH in previous round as an energy consumption and for Next round to predict CH.

In 2009 Stochastic Distributed Energy Efficient Clustering (SDEEC) [8] approach was developed for WSN. This Protocol divides the Network into dynamic Clusters and these Clusters Nodes Communicate with the CH. CH accumulate and communicate the information to the BS. Later on this Hybrid Energy Efficient Distributed (HEED) is proposed. It is a well organized Cluster based routing protocol. In this the high residual energy is compared with the members Nodes and depending on this CH is selected [9].

A new approach was developed in 2012, in this Clustering is done using K-MEANS and MAP reduce algorithm [10]. This approach divides the network in different Clusters. These Clusters have taken approx 5% of the total number of Nodes of a Network. The Nodes with have minimum distance from the CH is assign to the Cluster having maximum energy. The distance is measured by Euclidean Distance formula. The results shows that the placing of CH by using minimal distance performs well then placing them randomly.

Genetic Algorithm (GA), during the past few years, evolutionary technique such as GA is used for CH selection. It is an optimization tool for fast evolution and convergence. Any kind of real time problem that are not solve by the other technique can be solved by using evolutionary algorithm. Hence we use GA to obtain an optimize set of CHs. The GA is used in the BS, whose outcomes analyze appropriate Cluster for the Networks. The BS broadcast the full network details like query execution plan, the number of CHs, the member associated with each CH and the number of transmission to all the Nodes in the Network. All the Sensor Nodes obtain the packet that are broadcasted by the BS and Cluster are created accordingly.

In GA selection of CHs based on the Residual energy, Bandwidth and memory capacity. The Node with maximum Residual energy (RE), Bandwidth (BW) and memory capacity. The node with maximum Residual energy, maximum unused BW and maximum unused memory has become more probability to become a CH. If any two of these with maximum values and other one with minimum value then the possibility of that Node to become CH. It depends on the weight given for that parameter [11].

3. PROPOSED WORK

Particle swarm optimization (PSO) is a population based stochastic optimization technique developed by Dr. Eberhart and Dr. Kennedy in1995. This technique motivated by social behaviour of bird flocking. In PSO, there is a set of potential solution are called particles. That is initialized randomly, during each generation each particles evaluates its fitness constantly until the fitness satisfy the given threshold.

However, unlike GA, PSO has no evolution operator such as crossover and mutation, particles are update themselves with internal velocity. Compare with GA the information sharing in PSO is significantly different. In Genetic algorithm, chromosomes share information with each other so the whole population moves toward an optimal area. But in PSO, only global best (gbest) gives out the information to others. It is one way sharing mechanism of information. The evolution only looks for best solution.

3.1 The algorithm

As stated earlier PSO motivated by the behaviours of bird flocking. Assume the following scenario: a group of birds are randomly searching food in a region. There is only one piece of food in the region being searched. None of the birds knows where is the food. But they know how far the food is in each repetition. So what's the best strategy to discover the food? The helpful one is to follow the bird which is near by the food. PSO will read from the scenario and apply it to resolve the optimization problems. In PSO, every single solution is a "bird" in the search space. We call it "particle". Each particle has fitness values which are generated by the fitness function, and have velocities which through the flying of the particles. The particles fly through the problem space by following the current optimum particles.

Initialization of PSO with a group of random particles and then by updating generations search for optima. In each repetition, updation of every particle by following two best values. The first one is Pbest that is the best solution. Another best value is global best or gbest that is followed by the PSO. It has achieved so far by any particle in the population. When a particle takes part of the population as its topological neighbours, the value is a local best or lbest. After finding these two values the particles update its velocity and position with the following equation.

v[] = v[] + c1 * rand() * (pbest[] - present[]) + c2 * rand() * (gbest[] - present[])..... .....(a)

present[] = present[] + v[] ..... (b)

v[] is the velocity of particle, gbest[] and pbest[] are defined as stated before. present[] is the current particle, c1, c2 are learning factors. usually c1 = c2 = 2. rand () is a random number between (0,1)

The pseudo code is as follows:

For each particle
  Initialize particle
END
DO
  For each particle
  Calculate fitness value
  If the fitness value is superior than the best fitness value
  Set current value as the new pbest
END
Select the particle with the best fitness value of all the particle as the global best gbest
For each particle
  Calculate the particle velocity using equation (a)
  Update particle position using equation (b)
END
While maximum iteration or minimum criteria not attained

3.2. Fitness function

I have introduced the new fitness function to evaluate each individual depending on the parameters describe as follow:

Fitness = (remEnergy + (n – numCH) + (totalIC / n) + (totalBSD / n))

remEnergy:-remaining energy should be maximum. it denotes the amount of energy consumed by active nodes by optimal deployment.

n-numCH:-it denote that the number of Cluster head should be minimum, because it consume more energy.

totalIC/n:-total intra cluster distance should also be minimum, so that it consume less energy.

totalBSD/n:-All nodes have minimum distance from the Base Station because if distance is minimum then the energy consumption should also minimum.

3.3. Simulation and analysis

The proposed protocol is implemented in network simulator. I ran the simulation for 50 Nodes in 100m×100m network area. Initial energy for each node is 0.5 joules energy. The number of Cluster Head is set to be 10 percent of the total Nodes. The performance of PSO is compared with GA. Throughout the simulation the Nodes are distributed randomly to get best result. The simulation continued until all nodes in the network had consumed all their energy.

Table 1:- Parameter Values

Parameter	Value
N(no.of nodes)	50
Area	100×100m
Einit	0.5J
Eelec	10PJ/bit/m^4
Efs	0.0013PJ/bit/m^4
Eamp	5nJ/bit
Eda	5*0/00001nJ/bit
Packet size	4000

4. Simulation Result

I compared the performance of PSO and GA. Fig. 1 shows the randomly deployment of nodes. As the number of round is increases the dead node is also increase. In this blue and red nodes represent the alive nodes and dead nodes and in centre red mark show the base station (BS). Simulation is performed for 1196 round.

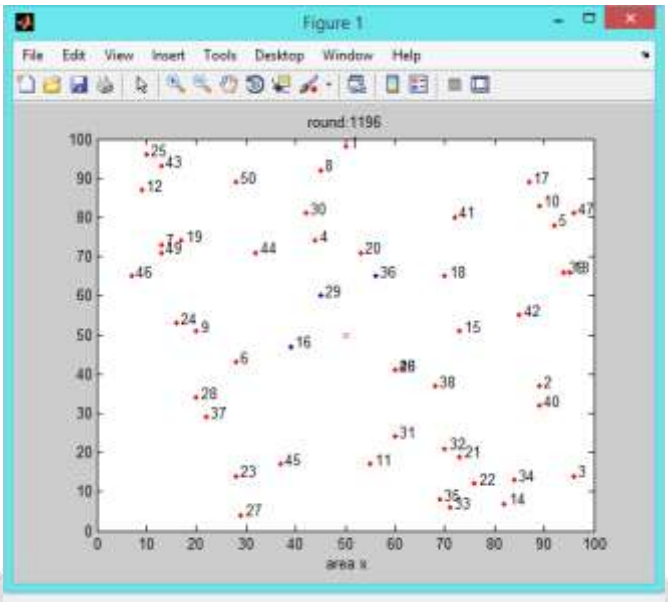

Fig. 1 Node deployment

Fig.2 shows the First Node dead in network. The first Node dead in the GA at 797 round but in PSO is at 871 round. It shows that clustering using PSO produce better result as compared to GA.

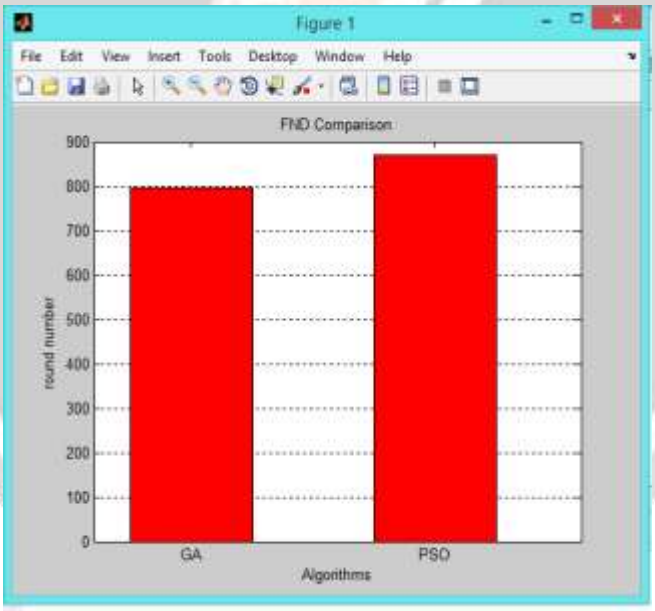

Fig. 2 First node dead

Fig.3 shows the Half Node dead in the network. As we see that in GA the half Node dead is in 961 rounds, but in PSO half nodes are dead in 1026 rounds. So it can be clearly seen that clustering using PSO algorithm make longer the network life time.

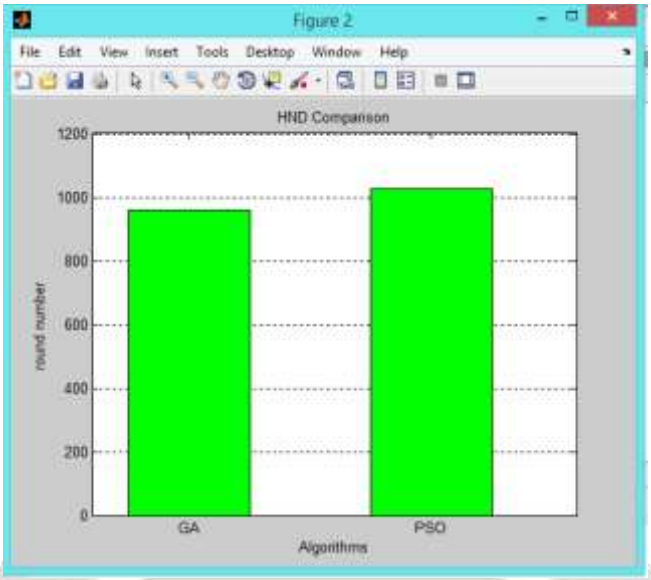

Fig. 3 Half node dead

Fig.4 shows the network energy comparison of both algorithms. Initially energy of network is 25 joules. In this we see that as the number of round increases the energy consumption of GA is more As compare to PSO. So it shows that the remaining energy of PSO is more than GA. Hence the Clustering using PSO enhance the network life time as compared to GA.

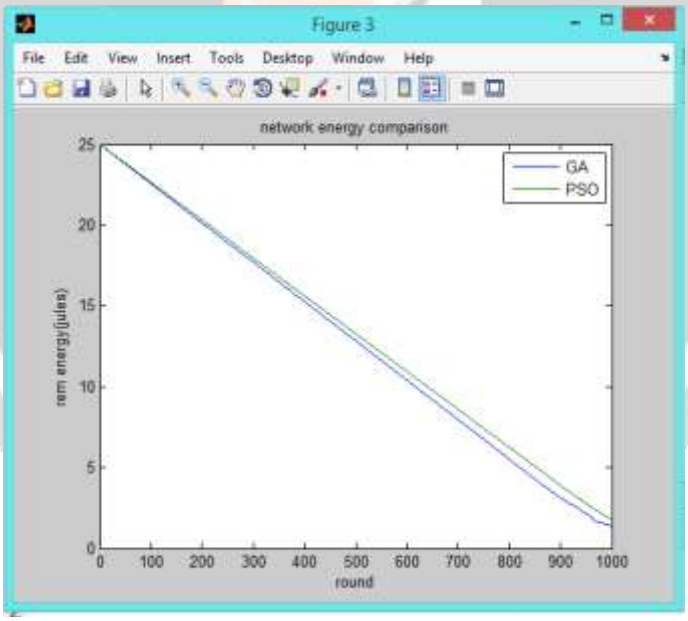

Fig. 4 Network energy comparison

Fig.5 illustrate the system's life time, defined by the number of Nodes alive over time of simulation. It can be clearly seen that the clustering using PSO algorithm prolong the network life time as compared to GA. This algorithm produce better network partitioning with minimum intra cluster distance and also Cluster Head that are efficiently distributed across the network. thus ,the energy consumed by all Nodes for communication can be reduced since the distance between member Nodes and their Cluster heads are shorter.

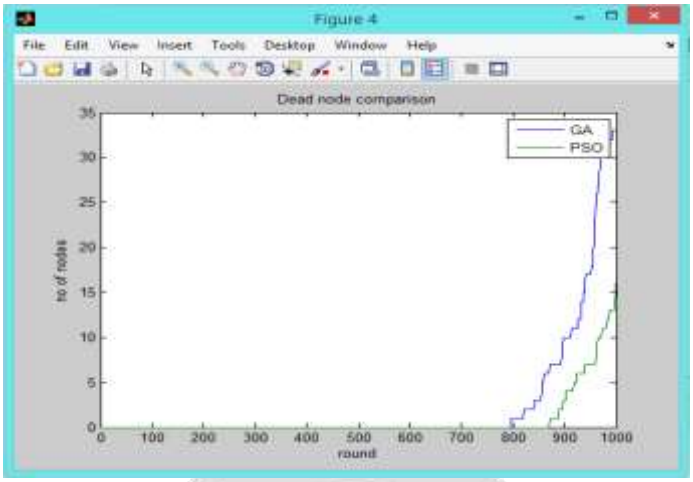

Fig.5 Dead node comparison

5. CONCLUSION

In this paper I have presented energy aware cluster based protocol for wireless sensor network using PSO technique. I have defined a new fitness function that takes into account, the remaining energy should be maximum, intracluster distance minimum, number of Cluster Head should be minimum and distance off all the nodes from the base station is minimum. I can observe from the simulation result that PSO can converge faster and achieve better global minimum when compared with GA using same size population. Furthermore PSO algorithm gives higher network life time and deliver more network data to BS as compared to GA. The result proves that the PSO improve the more network life time as compared to GA.

6. REFRENCES

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