Designing a Low Power MAC Protocol for Wireless Sensor Networks in NS2

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Abstract— In recent years, Wireless Sensor Networks (WSN) have attracted the researchers due to its wide applications. The advancements in WSN have enabled a wide range of environmental monitoring and object tracking system.WSN consists of small low cost sensor nodes and their transmission range, storage capabilities and energy resources are limited. This paper examines Particle Swarm Optimization algorithm (PSO) based routing in which we have taken energy efficiency as the main criteria for performing routing and deriving optimized path for data forwarding and processing to the base node. A sensor network is deployed over a region and the main task of such a network is to gather information from the node and transmit it to the base station for further processing. Therefore if the transmission range is long, then the energy dissipated will be more and if the range is short then energy will be saved. The PSO generates a path of routing by taking energy as fitness value to judge different path and to choose the best optimized path which consumes less energy as compared to other routing paths. The simulations are carried out in ns2 and are compared with the results of Genetic Algorithm (GA) showing that the results of PSO are better than the GA. [4]

Key words: Wireless Sensor Network, Particle Swarm Optimization, Routing, Optimization, Fitness value

I. INTRODUCTION

In recent years, wireless sensor networks have attracted a considerable amount of attention to researchers. Today, several WSNs are deployed in fields such as smart electric grids, home care systems for elderly people, factory automation, environmental monitoring systems and security systems. A WSN consists of numerous nodes. A sensor node is a small device consisting of a sensing unit, a data processing unit, a wireless communication unit and a battery.

Energy waste in WSNs can be caused by several major sources. The first source is collision caused by simultaneous packet transmissions. The power spent on transmitting these collided packets is waste and retransmission causes extra packet delay. The second source is overhearing caused by receiving packets which are meant to receive at other nodes. The third source is control packet overhead caused by transmitting or receiving control packets generated by the MAC layer for exchanging information between nodes. The fourth source is overemitting caused by transmitting a packet to a node in sleep mode. The final source is idle listening caused by listening to the wireless channel. [7]

II. PARTICLE SWARM OPTIMIZATION

The PSO was originally developed in terms of social and cognitive behavior by James Kennedy and Russell Eberhart in 1995 as a representation of the movement of organisms in a bird flock or fish school. [1] PSO algorithm works by having a population called a swarm of candidate solutions called particles. These particles are moved around in a search space. The movement of the particles is influenced by two factors using information from iteration-to-iteration and particle-to-particle. As a result of iteration-to-iteration information, the particle stores in its memory the best solution visited so far, called pbest, and experiences an attraction towards this solution as it traverses through the solution search space. As a result of particle-to-particle information, the particle stores in its memory the best solution visited by any particle, and experiences an attraction towards this solution, called gbest. After iteration, the pbest and gbest are updated for each particle if a better solution is found. This process continues until either desired solution is achieved, or it is determined that an acceptable solution cannot be found within computational limits.

For an n-dimensional search space, the ith particle of the swarm is represented by an n-dimensional vector,

Xi = (xi1, xi2,…, xin)

The velocity of the ith particle is represented by another n dimensional vector,

Vi = (vi1, vi2,…, vin)T

The previously best visited position of the ith particle is denoted as Pi = (pi1, pi2,…, pin) T

The velocity of the ith particle is updated using the velocity-update equation given by

Vid = Vid + c1r1 (pid – xid) + c2r2 (pgd – xid) (3.1)

Where g is the index of the best particle of the swarm

And the position is updated using

Xid = xid + vid (3.2)

Where d = 1,2,…,n; i = 1,2,..,S, where S is the size of the swarm; c1 and c2 are constants

Equations (3.1) and (3.2) are the initial version of the PSO algorithm. A constant Vmax is used to limit the velocities of the particles and improve the resolution of the search. The concept of inertia weight was developed to better control exploration. After inclusion of inertia in PSO, the resulting velocity update equation becomes

Vid = w * vid + c1r1 (pid – xid) + c2r2 (pgd – xid) (3.3)

PSO is a computational method that optimizes a problem by iteratively trying to improve a candidate solution with regards to given measure of quality. The main point in this is that we have to choose the best path according to fitness value which is according to minimum distance to be travelled by a date up to base node. Now since we are dealing with energy efficient routing, more the distance more the energy will be lost in sending data. So we are generating optimum path taking consideration all sensor nodes.

III. FITNESS FUNCTION

To find the optimum path using PSO, we have to find the fitness value of each path. This fitness value will be used to select the local best and global best for PSO. The formula to calculate fitness value is

Fitness value = dist (i,j) + dist (j,base) (3.4)

Where i and j are node distance.

We set an initial solution by selecting a random number of solutions from the set of x solutions. After getting initial random solutions we calculate fitness value of each solution, according to equation (3.4).

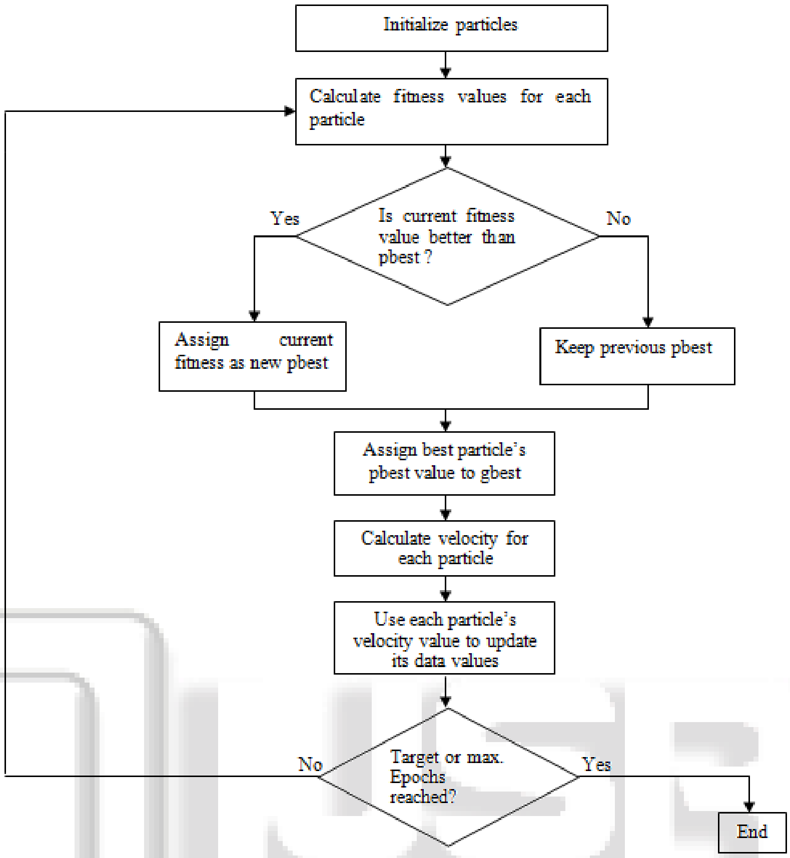

Fig. 1: PSO algorithm

IV. RESULTS

The simulations were carried out in network simulator (NS2) and the Particle swarm optimization was carried out under ns2 and the program is written in OTcl programming language.[6]

After that we calculate best among the entire solution and set it as initial global and local best. PSO update equation is used to update old solution and generate new solutions and their nodes are calculated. These solutions along with their nodes are then used to find the fitness value of each solution. The process will be repeated till the given iteration is satisfied. Based on this continuous iteration and fitness value, the solution which is better is replaced than its other solutions.

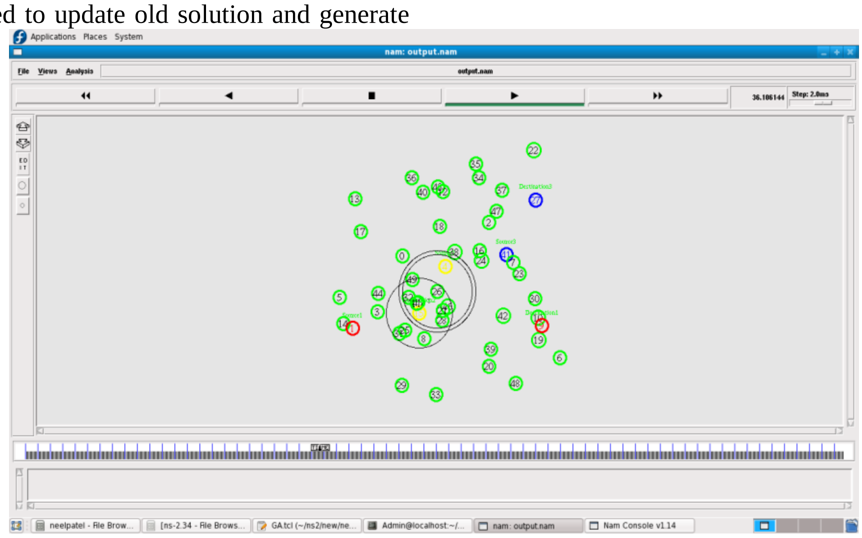

Fig. 2: NAM File

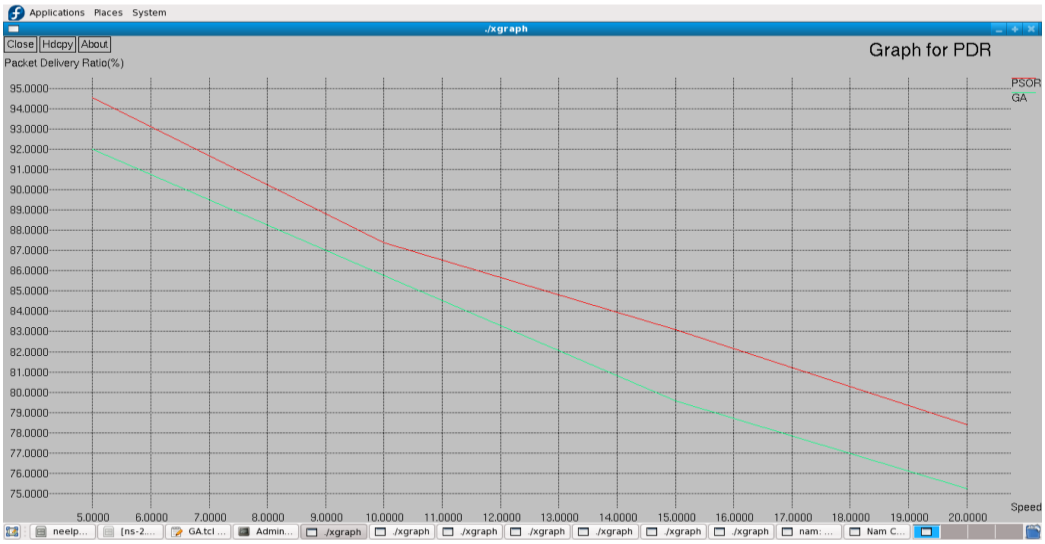

Fig. 3: Packet Delievery Ratio

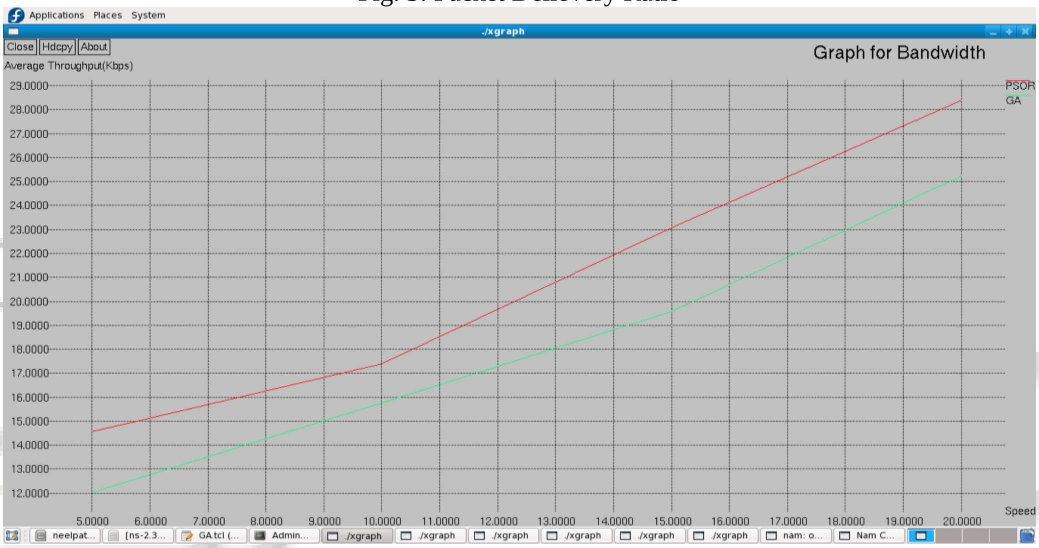

Fig. 4: Average Throughput

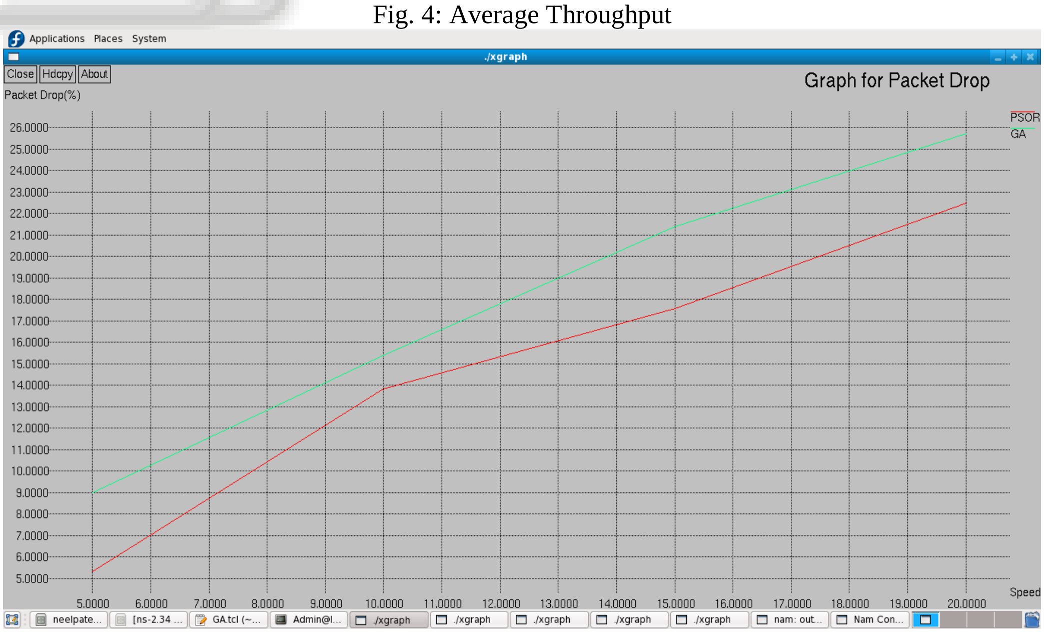

Fig. 5: Packet Drop

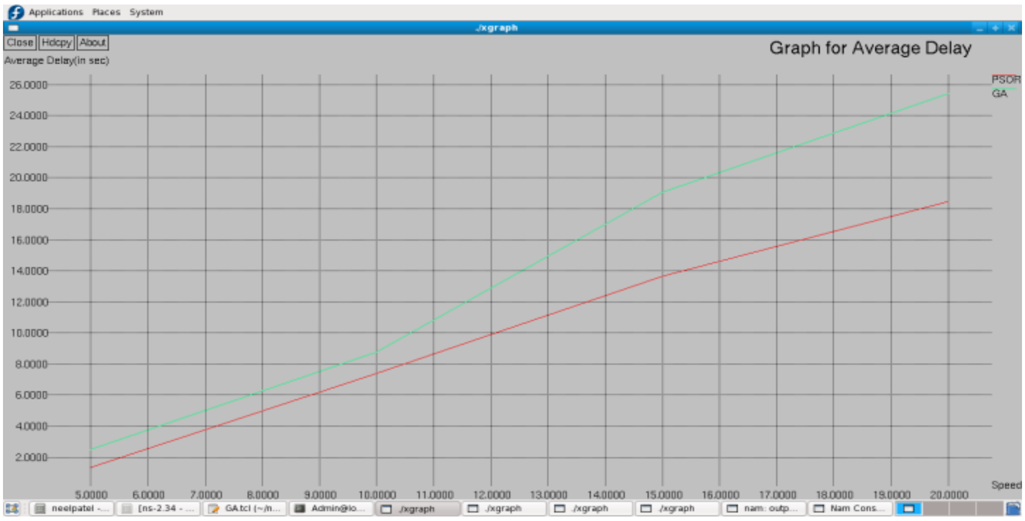

Fig. 6: Average Delay

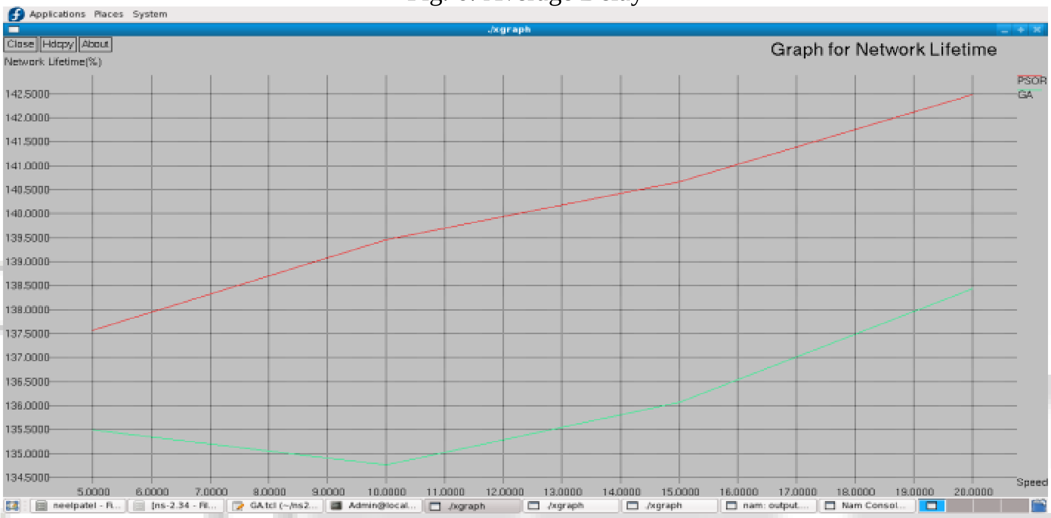

Fig. 7: Network Lifetime

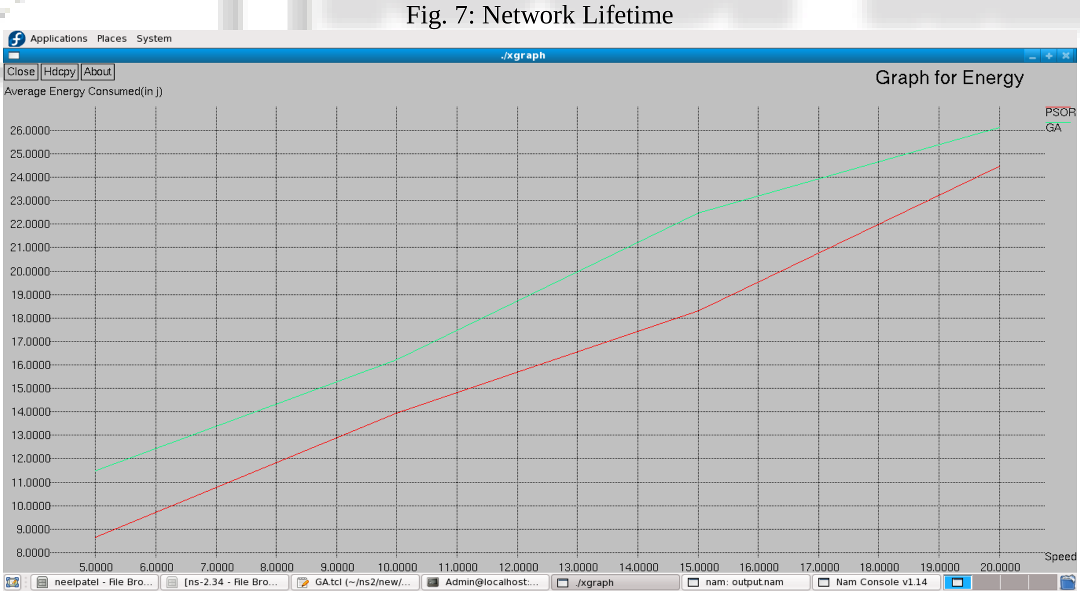

Fig. 8: Average Energy Consumption

From the results above, it is concluded that the PSO gives better result than Genetic Algorithm (GA). PSO has outcomed GA in all aspects.

V. CONCLUSIONS AND FUTURE ENHANCEMENT

In this paper, a novel routing based algorithm named Particle Swarm Optimization has been examined which results in energy efficient routing across the network. The concept of this algorithm is based on the fact is greater the distance travelled to send data more is the consumption of sensor energy. Our results show optimum path can be calculated using PSO which shows better result than GA giving us the best routing path. In the future work, PSO can be modified and it may perform better than the existing.

REFERENCES

[1] James Kennedy, Russell Eberhart, "Particle Swarm Optimization", IEEE, 1942-1948, 1995.
[2] Tzung-Pei Hong, Guo-Neng Shiu, "Allocating multiple base stations under general power consumption by the Particle Swarm Optimization", IEEE Swarm Intelligence Symposium (SIS 2007), 2007.
[3] Snehal Sarangi, Biju Thankchan, "A Novel Routing Algorithm for Wireless Sensor Network using Particle Swarm Optimization", IOSR, ISSN: 2278-0661 Vol 4, Issue 1, pp 26-30, Sep-Oct 2012.
[4] Mohammad Abo-Zahhad, Sabah M. Ahmed, Nabil Sabor, Shigenobu Sasaki, "A New Energy-Efficient Clustering Protocol Based on Genetic Algorithm for Improving the Lifetime and the Stable period of Wireless Sensor Networks", IJEIC, Vol. 5 Issue 3, pp 47-72, 2014.
[5] Raghavendra V. Kulkarni, Ganesh Kumar Venayagamoorthy, "Particle Swarm Optimization in Wireless Sensor Networks: A Brief Survey", IEEE Vol. 41 No.2, pp 262-267, 2011.
[6] Yunjiao Xue, Ho Sung Lee, Ming Yang, Priyantha Kumarawadu, Hamada H. Ghenniwa, Weiming Shen, "Performance Evaluation of NS-2 Simulator for Wireless Sensor Networks", IEEE, pp 1372-1375, 2007.
[7] Yaw-Wen Kuo, Kwuang-Jyz Liu, "Enhanced Sensor Medium Access Control Protocol for Wireless Sensor Networks in the ns-2 simulator", IEEE pp 1-11, 2014.