International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 10 • Issue 2 pp. 336-341 June 2018-Dec 2018 www.csjournals.com

Improved Grid based Clustering and Combinational Routing for Wireless Sensor Network

Monika Chauhan[1], Kanika Sharma[2]
[1]M.E. Scholar, [2]Assistant Professor
Department of Electronics and Communication Engineering
National Institute of Technical Teacher's Training and Research, Chandigarh, India

Abstract: Wireless Sensor Networks consists of millions of sensor nodes in a network according to its application in various real time implementations. These sensor nodes have key constraint of battery exhaustion because sensor nodes are operated by non rechargeable batteries hence to optimize the energy of the sensor nodes in wireless sensor networks is gaining more popularity by researchers. Various energy efficient clustering and routing algorithms are proposed by different authors. Among all clustering techniques, grid clustering is most preferred technique in wireless sensor networks. The key advantage of grid clustering is that it reduces the time to process the data since operations are performed on grid rather than individual data and the processing time of the aggregated data is directly proportional to the lifetime of the network. A wireless sensor network has basically two task, first one is selection of cluster head and the one is to route the aggregated data from cluster head to sink or base station. In this paper we proposed particle swarm optimization algorithm which optimize the route from cluster head node to sink or base station in grid form structure. This optimization algorithm basically improves the residual energy of the nodes and network lifetime.
Key words: wireless sensor networks, grid clustering, clustering algorithms, particle swarm optimization, network lifetime.

1) Introduction

A wireless sensor network consists of huge number of sensor nodes sometimes also known as motes are deployed randomly in the network area. Sensor nodes sense the physical phenomenon such as temperature, pressure, humidity etc depends on various applications. In perilous environment where human reach is not possible wireless sensor network is only solution. These sensor nodes can be deployed randomly or at pre determined positions in the network. In randomly deployed method, the position of sensor nodes are determined by means of global positioning system (GPS).

In wireless sensor network there is a special or dedicated node known as base station or sink node. All sensor nodes send their data to sink node or base station either directly or via multi hop communication[1]. When the network area is small sensor nodes send their data to sink directly to reduce the load in the network but when network area is large enough, multi hop routing is preferred to prevent the early exhaustion of sensor nodes as nodes need more energy to send the data to the sink at longer distance. As sensor nodes are operated by non rechargeable batteries energy efficacy is key parameter to prolong the network lifetime of wireless sensor networks[2].

Clustering is the technique which improves the network lifetime of WSN. In clustering, number of sensor nodes are grouped into clusters then all operations are performed on each cluster rather than individual node. There are many clustering techniques along with routing such as flat routing, hierarchal or cluster routing and location based routing. Among all, grid clustering is most preferred technique in wireless sensor network since it reduces the communication distance in the network. Many authors proposed various energy efficient clustering and routing protocols such as LEACH, HEED, PEGASIS, TEEN etc. Various author proposed different approaches to form the grid structure in the network such as the size of the grid and total number of grids in the network depends on the transmission range of the sensor nodes. In this paper, we applied particle swarm optimization (PSO) algorithm to optimize the route from the cluster head node to sink or base station and the selection of cluster head in each grid depends on the minimum distance of node from the centre of the grid. The role of cluster head is rotated in each round to prevent the over burdening of a single node. Optimized path improves the network lifetime and residual energy of the network.

The remaining part of the paper is organized as follows. Section 2 describes the related work to the grid clustering and Particle Swarm Optimization algorithm. The radio model is discussed in section 3. Section 4 dealt with

proposed algorithm. Experimental results and simulations are discussed in section 5. Section 6 conclude the paper and scope for future work.

2. Related Work

Jianhua Huang et al., in [3] has introduced an energy efficient multi hop routing protocol based on grid clustering in wireless sensor networks. In this algorithm cluster head selection is based on residual energy, location of nodes and levels of network area. Collected data is transferred through multi hops to the sink node. The total time is divided into number of rounds. Each round has two phases- clustering set up and steady state phase. In clustering phase, cluster head and the communication management nodes are elected which reduces the burden of cluster heads. The steady state phase involves inter clustering multi hop routing and data transmission to the sink node. . Simulation result reveals that the proposed algorithm has 17.5% more network operation period over multi hop EEBCDA algorithm. The introduced algorithm has much more energy efficient and improved network lifetime over multi hop EEBCDA algorithm.

Md Azharuddinn et al., in[4] has proposed particle swarm optimization for maximizing lifetime of wireless sensor networks. This algorithm is proposed to address the hot spot problem caused by multi hop communication in cluster based routing.PSO is famous bio inspired algorithm. In routing step the traffic load is evenly distributed over the cluster heads whereas in clustering step, this algorithm take care of those cluster head node whose energies are very fast decaying by assigning them very less number of sensor nodes.PSO has the following advantages over other optimization algorithms-it is very easy to implement, very high quality of solution, faster convergence towards an optimized solution. In clustering phase it uses unequal clustering.PSO algorithm uses a fitness value to find optimized solution which is based on approximate lifetime of gateways for routing energy consumption in inter and intra cluster transmission in unequal clustering. In proposed algorithm the routing path changes every time and hence improves network lifetime. This algorithm also provides fault tolerance. The simulation of proposed algorithm is performed in MATLAB 2012b. simulation results revealed that the proposed algorithm outperforms over PSOK,GARS,GLBC and GARA algorithms in terms of energy consumption, network lifetime ,number of data packets received by base station, number of dead gateways and inactive sensor nodes.

Jin Wang et al., in [5] has introduced Particle swarm Optimization based clustering algorithm with mobile sink for WSNs. Usually wireless sensor networks have fixed sink node and they suffers from hot spot problem that is the node which is close to the sink node oftenly over burdened. Author proposed that by using mobile sink node, the network lifetime and energy efficiency can be improved. In this paper author proposed particle swarm optimization with mobile sink node to optimize the clustering. The fitness function of optimization algorithm includes residual energy and position of a sensor node. Particle swarm optimization algorithm is belongs to artificial intelligence. In this optimization algorithm numbers of iterations are performed to update the fitness value each time. For updation pbest and gbest are used where pbest is the best local solution and gbest is the best global solution. The simulation of proposed optimization algorithm is done in MATLAB and compare the performance of proposed algorithm with LEACH ,Mobile-P and TTDD algorithms . The proposed algorithm delivers 4.6 times more packet than LEACH and 1.5 times that of TTDD at round 1800. It also prolong network lifetime over other two protocols.

3. Radio Model

Presently there is a great deal of research in the area of low energy radios. Different assumptions about the radio characteristics including energy dissipation in receive and transmit modes, will change the advantages of different protocols. For the radio hardware, transmitter dissipates energy to run the transmitter radio electronics and power amplifier and the receiver dissipates the energy to run the receive radio electronics.

In the model assumed for the work, the radio dissipates E_{elec} = 50nJ/bit to run the transmitter or receive circuitry and E_{amp}=100pJ/bit/m^2 for the transmitter amplifier to achieve an acceptable E_b. The free space (d^2 power loss) and multipath fading (d^4 power loss) channel models are used depending upon the distance between the transmitter and receiver. So, if the distance is less than the threshold value, free space model is used else the multipath fading model. In the radio model of the transmitter amplifier, β=2, for free space β=4 for multipath model. Thus if a node transmits H number of bits over a distance d using radio model, the radio expends:

$E_{TX}(H,d) = E_{elec}(H) + E_{amp}(H,d)$……..3.1

International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 10 • Issue 2 pp. 336-341 June 2018-Dec 2018 www.csjournals.com

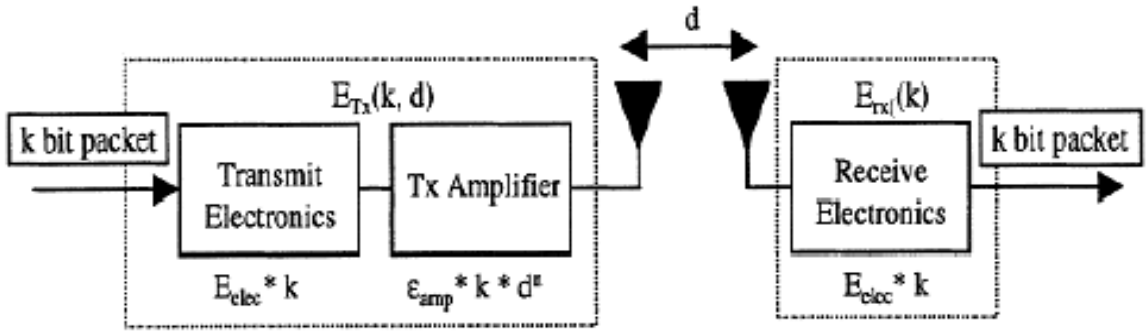

Fig 3.1 Radio model

$$E_{TX}(H,d)=\begin{cases} H.Eelec + H.\varepsilon_{fs}.d^2 \text{ if } d < do \\ H.Eelec + H.\varepsilon_{mp}.d^4 \text{ if } d \geq do \end{cases} \quad \ldots\ldots\ldots\ldots\ldots 3.2$$

Threshold $d_0 = \sqrt{\varepsilon_{fs} / \varepsilon_{mp}}$ ……..3.3

And to receive these H message bits, the radio expends:

$E_{RX}(H,d) = E_{elec}(H)$ ……..3.4

For these parameters values, receiving a message is not a low cost operation. Hence the protocols, should try to minimize not only distance but also the number of transmit and receive operations for each message. The radio channel is assumed to be symmetric such that the energy requirement to transmit a message from one node to another is same for both ways of path.

4. Particle Swarm Optimization Algorithm

The usual aim of the particle swarm optimization (PSO) algorithm is to find the optimized solution of any problem. The objective function is called the fitness function. PSO has been proposed by Eberhart and Kennedy in 1995, subsequently developed in thousands of scientific papers, and applied to many diverse problems, for instance neural networks training, data mining, signal processing, and optimal design of experiments. PSO is a swarm intelligence meta-heuristic inspired by the group behavior of animals, for example bird flocks or fish schools. it represents the state of the algorithm by a population, which is iteratively modified until a termination criterion is satisfied. In PSO algorithms, the population P={p1,…,pn} of the feasible solutions is often called a swarm. The feasible solutions p1,…,pn are called particles. Many versions of the particle speed update exist, for example:

vi (t+1) =w (t) vi (t)+ φ1u1(pi (t) -xi (t))+ φ2u2(li (t) -xi (t)) ……..4.1

The symbols u1 and u2 represent random variables with the U(0,1) distribution. The first part of the velocity formula is called “inertia”, the second one “the cognitive (personal) component”, the third one is “the social (neighborhood) component”. Position of particle i changes according to

xi (t+1) = xi (t) +vi (t+1)……...4.2

The algorithm is terminated after a given number of iterations, or once the fitness values of the particles (or the particles themselves) are close enough in some sense.

5. Experimental Result and Simulations

The proposed algorithm is simulated in MATLAB simulation software and the simulated results clearly shows that the proposed algorithm is effective in terms of network lifetime and its stability. The performance of the algorithm is also compared with other existing algorithm and it is seen that this algorithm outperforms the existing efficient grid based clustering and combinational routing in wireless sensor network (GCCR).

5.1 Residual energy of nodes vs. number of rounds (for 300 and 500 nodes)

During the execution of proposed algorithm, node with the minimum distance from the centre of the grid and also has the energy greater than the threshold energyis selected ad cluster head in each grid .Member nodes will send their data to their respective cluster head and this cluster head forward the data either to the base station or next cluster head by utilizing PSO. This process of cluster head selection and data communication is repeated for various number of rounds.

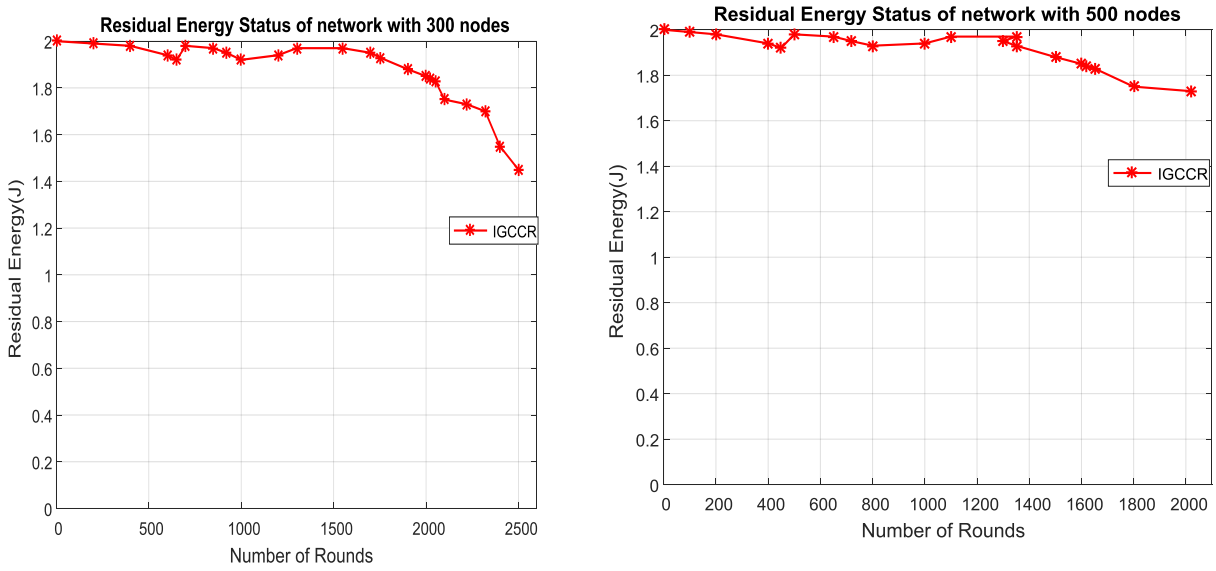

Figure 4.2 Residual Energy vs. number of rounds (for 300 nodes and 500 nodes)

5.2 Dead Nodes vs. Number of Rounds

Figure 4.3 shows the simulation results in the form of graph between the number of dead nodes vs. number of rounds. Simulation result shows that up to 1200 number of rounds, there is no dead node in the network but when number of round increases beyond 1200, percentage of dead nodes increases gradually. This simulation is also performed by considering 500 nodes which are deployed randomly in the network area.

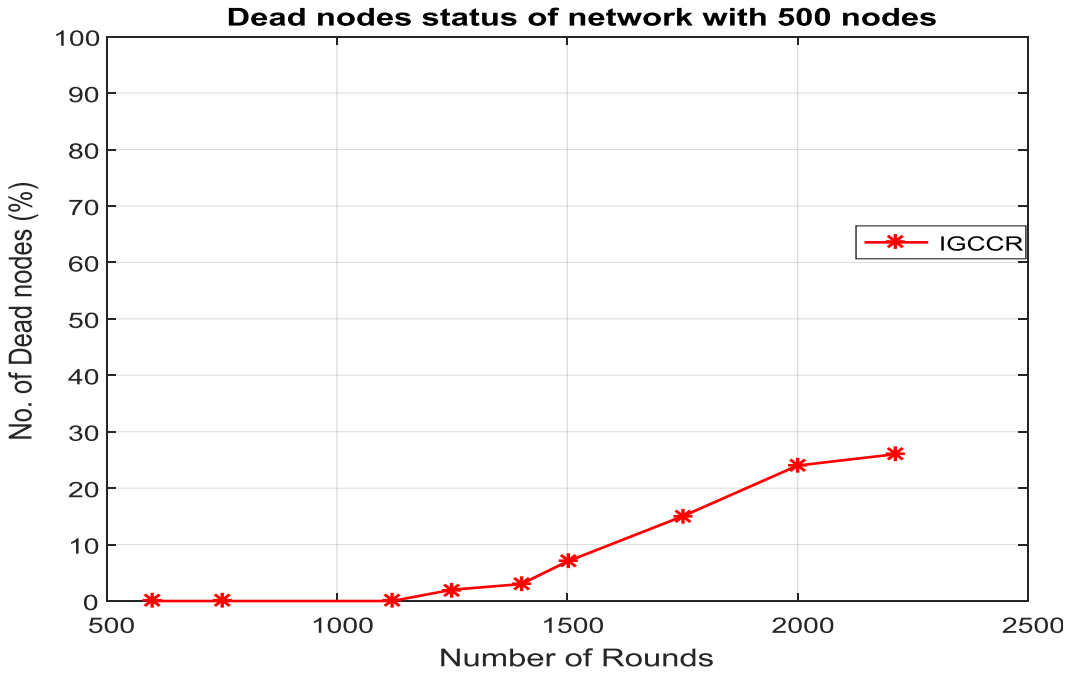

Figure 4.3 Number of dead nodes vs. number of rounds

5.3 Validation of Simulation Results

International Journal of Electronics Engineering (ISSN: 0973-7383)
Volume 10 • Issue 2 pp. 336-341 June 2018-Dec 2018 www.csjournals.com

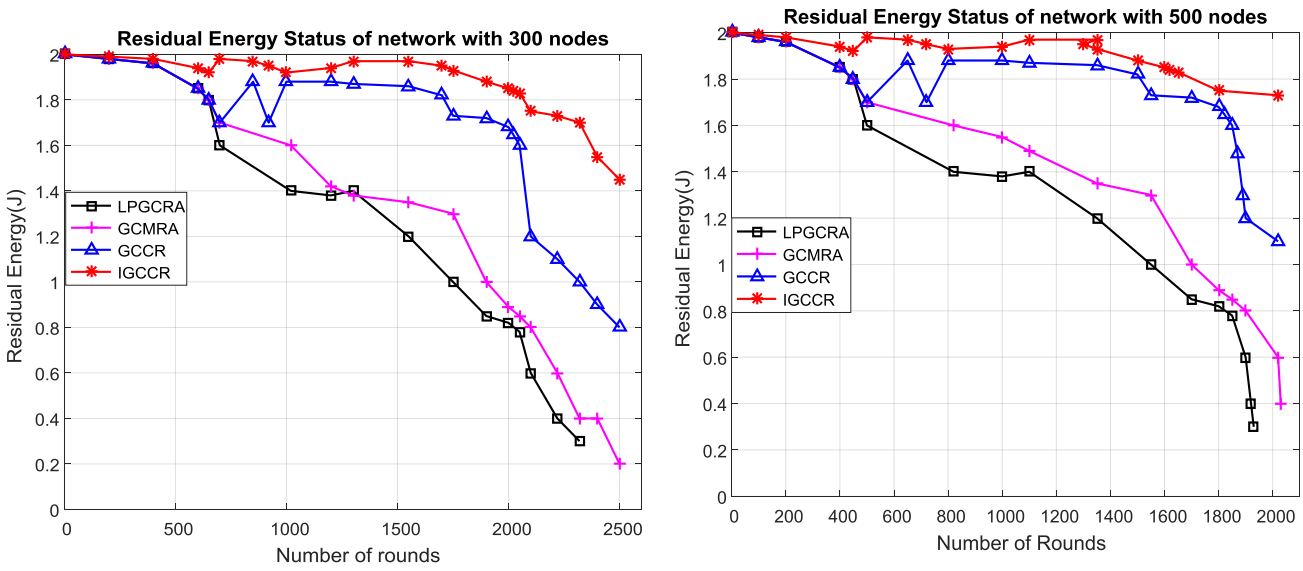

Figure 4.4 Comparison of Residual Energy (for 300 nodes and 500 nodes).

Table 4.1 Comparison of Residual Energy and % Improvement

Algorithm	Residual Energy of Nodes(in joules)	Residual Energy of Proposed Algorithm(IGCCR)(in joule)	% Improvement
LPGCRA	1.4	1.9	35
GCMRA	1.6	1.9	18
GCCR[41]	1.8	1.9	5

Simulation is also performed by considering 500 nodes randomly deployed in network area. Figure 4.4shows the comparison of residual energy of the network vs. number of round for 500 nodes in the network area. Graph reveals that the proposed algorithm outperforms over other existing algorithm in terms of residual energy of the network for 500 nodes also.

Table 4.2 Comparison of Residual Energy and % Improvement

Algorithm	Residual Energy of Nodes (in joule)	Residual Energy of Proposed Algorithm(in joule)	% improvement
LPGCRA	1.4	1.95	39
GCMRA	1.5	1.95	30
GCCR	1.9	1.95	5

In both the comparison table, comparison is made with other existing algorithm in terms of residual energy of the network after 1000 rounds.

5.3 Comparison of Network Lifetime

Figure 4.5 makes the comparison of proposed algorithm with other existing algorithms by considering 300 nodes and 500 nodes. From the graph, it is clear that the proposed algorithm has more network lifetime over other algorithms since this algorithms has less number of dead nodes hence improves network lifetime.

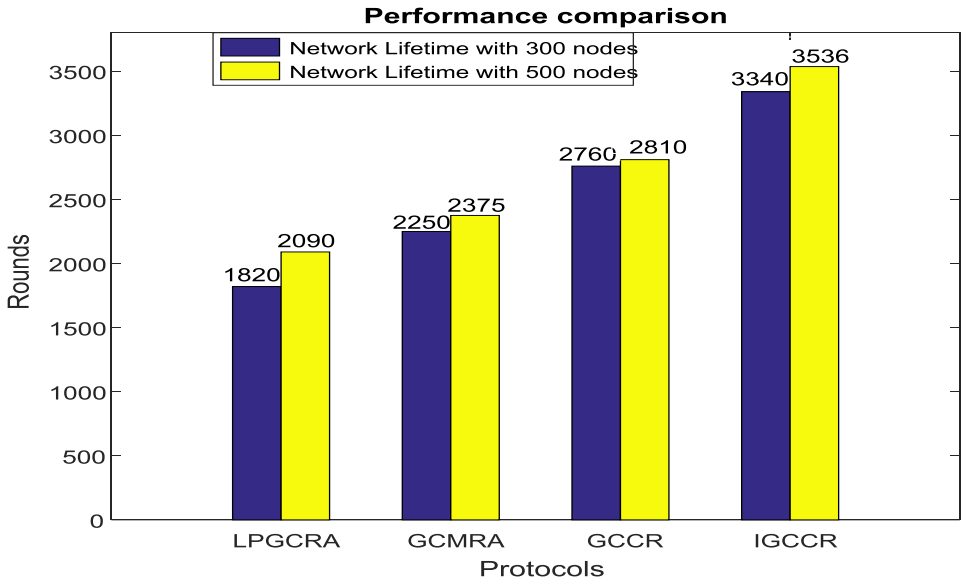

Figure 4.5 Comparison of network lifetime

6. Conclusion and Future Scope

Proposed work is simulated in MATLAB environment and validated with existing grid based energy efficient routing algorithm. Simulation shows that the proposed algorithm has given improved results in comparison to other three mentioned algorithms. The proposed algorithm worked for 300 nodes to 500 nodes randomly deployed over sensing area 500m* 500m for 500 rounds to 2500 rounds. The simulation shows that there is decrease in percentage of number of dead nodes and has more residual energy after each round for proposed algorithm. The proposed algorithm has outperformed other three namely LPGCRA, GCMRA and GCCR protocols with 39,30 and 5 percent improvement for 500 nodes and after 1000 rounds hence the proposed algorithm outperforms over other three mentioned protocol in terms of residual energy and net The future work that is closely related to this thesis work is given below:

a) This proposed work is designed for homogenous network; it can be designed for heterogeneous wireless sensor network.

b) In the proposed algorithm all the clusters are of same size. Uneven clustering can be done to solve the problem of energy hole in the network.

References

[1] Amit Rathee, Randeep Singh and Abhishilpa Nandini, "Wireless Sensor Network- Challenges and Possibilities", International Journal of Computer Applications, Vol. 140, No. 2, April 2016.

[2] Edwin Prem Kumar Gilbert, Baskaran Kaliaperumal and Elijah Blessing Rajsingh, "Research Issues in Wireless Sensor Network Applications: A Survey", International Journal of Information and Electronics Engineering, Vol. 2, No. 5, September 2012.

[3] Jianhua Huang, Yadong Hong, Ziming Zhao, Yubo Yuan, " An Energy Efficient Multi hop Routing Protocol based on Grid Clustering for Wireless Sensor Networks, Journal of Cluster Computing, Vol. 20, Issue. 4, pp. 3071-3083, December 2017.

[4] Md Azharuddin , Prasanta K.Jana, "Particle swarm optimization for maximizing lifetime of wireless sensor networks", Elsevier Journal of Computers and Electrical Engineering Vol. 51,pp. 26-42, April 2016.

[5] Jin Wang, Yiquan Cao BinLi, Hye-jinKim , SungyoungLee , "Particle swarm optimization based clustering algorithm with mobile sink for WSNs", Elsevier Journal of Future Generations Computer Systems, Vol. 76, pp. 452-457, November 2017.