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Improving Energy and Network Lifetime using PSO based Apriori in Wireless Sensor Networks

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Abstract

In WSN, the sensor nodes can be placed in any area in the environment. The main work of sensor node is to sense and collect data for forwarding data to a base station or sink. The Cluster formation with load balanced and Effective routing is the key issue in WSN. In this study the problem is to be overcome the cluster formation by using the SEARCH (Sustainability, Energy Aware Cluster Head) protocol, then routing is done by using the PSO (Particle Swarm Optimization) Multi-objective Fitness Function with Apriori Algorithm and its Association rules. The SEARCH protocol helps to detect the energy level of each node in the WSN and helps to form Energy based Clustering to balance the load. The PSO Fitness Function and Apriori Association rules, helps to route the sensed data using efficient routing, by taking the amount of data transfer and the energy efficiency of all routes in order to maintain the energy for long term transmission. As a result, here we implemented this work in java platform. This will shows the better performance of nodes in the network. It will increase the lifetime of network and energy efficiency of the node.

Keywords: Apriori Association Rules, Energy Efficiency, Network Lifetime, PSO (Particle Swarm Optimization) Algorithm, SEARCH (Sustainability, Energy Aware Cluster Head) Protocol, WSN (Wireless Sensor Networks)

1. Introduction

In WSN's generally used for sensing, collecting and forwarding the data. Wireless sensor networks grouping a large amount of smaller sensor nodes. The sensor nodes are placed randomly or manually into the specified area. Power consumption of the sensor nodes and lifetime of networks is the most challenging issues in the WSN environment.

In WSN, clustering is one of the most challenging issues and it can be mainly focused on improving scalability and to enlarge the lifetime of the network. Initially heuristic approaches are used. The main drawback of this approach is it will select a node with a very low energy. After that meta heuristics approaches are used, it will selects it can deal directly with the gateways and it manages the gateways to maximum energy nodes.

Sensor nodes are energy constrained. Once the node is deployed it cannot be recharged further. The characteristics of WSN's are Battery operated nodes, short range communication, mobility of nodes and no limited central manager.

In Recent years, sensor nodes are operated on low battery power and these leads to quick node failure. Normally a WSN needs a required energy constrained node with limited power supply. Instead of using cluster heads to connect the nodes, here they use gateways. Gateways are some special type of nodes which are operated in battery. It is also energy constrained but it has more power than a cluster head.

Clustering is designed for several effective energy protocols in WSN. Previously LEACH protocol is used to appropriate the load balancing among several clusters in the network. Many clustering algorithms are used for

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load-balancing. The main drawback of these algorithms is selected cluster heads with low energy nodes.

In order to improve the nodes energy and controls the node fails, we are going for nature based algorithm called as PSO (Particle Swarm Optimization) algorithm. PSO algorithm mainly focuses on two phases like Cluster selection and Cluster Formation.

For clustering, PSO based SEARCH protocol is used. The SEARCH (Sustainable Energy Aware Routing and Clustering Hierarchy) will find out the higher nodes for data transmission. It will calculate the node energy and will discard the low energy nodes in the cluster.

For routing, we have to find out the maximum shortest distance between the nodes and to minimize the distance using multi-objective fitness function. Next, apply Apriori Association rules to those nodes and select the maximum energy nodes and forward data through the selected nodes. This will reduce the node failures.

2. Related Works

Many clustering algorithms are used for developing WSN. Focuses WSN in terms of node to node packet delivery and lifetime of network[1]. The main aim of this approach is to reduce the traffic delay of the data forwarding.

Uses dynamic clustering inorder to achieve better energy efficiency of the nodes and monitor the power resources of the network[2]. Focuses the PSO approach inorder to achieve the optimal solution[3,4]. This will discusses so many approaches inorder to attain the better solutions.

For the design of WSN[9], Clustering algorithm is to be used for selecting a Cluster head with maximum energy. Both energy consumption and battery level can be used to calculate minimum path cost. The minimum path cost can be used for providing the lifetime of nodes to be more.

For improving the lifetime of the network[5,14], ILP (Integer Liner Programming) formulations are used. It is used for load balanced clustering. Using ILP formulations, we can form cluster using sensor nodes as two tired networks. Here the sensor node will act as a cluster head. The first tier is used for routing and the Multi hop routing function is used in the second tier.

For overcoming the energy efficiency and network lifetime problem, we have to focus other problems such as coverage area, delaying the nodes, Packet loss ratio, etc. EEQR addresses power consumption and high end delay problem[12]. Comparing to the static and mobile sinks, EEQR provides energy efficient, more and less end to end delay. It will serve the lifetime of the network as well as satisfying the other problems such as coverage area, delay, packet loss ratio etc.

For design a Routing in an energy savings is a most challenged issue in the WSN. Proposed energy aware routing algorithm for clustering[13]. It mainly focuses on a strategy of clustering technique. This algorithm uses linear time complexity to improve the energy of the cluster head and also achieved a satisfied load balancing.

Some mathematical models are used for routing protocols. Here two types of rules are used[11]. The first one calculates the distance between the nodes and the second nodes can be used to check the energy available in the network. The main aim of this approach is path can be used effectively and to reduce the energy used by the network.

For improving network lifetime[6] addressed maximum disjoint cover set problems. This paper is focused to increase the disjoint cover sets, that would help to increase the energy of the suitable sensors and those sensors from the sets are further responsible transmitting and maintaining the data, and the remaining sensors are assumed as weak sensors, it can be discarded. For balancing the loads into a gateway is a challenging issue for a long operation in WSN. Proposed NP-Hard problem for WSN long term Operation[7]. In this it will show the performance of both equal and unequal balanced sensor nodes.

Proposed CEBCRA (Cost-based Energy Balanced Clustering and Routing Algorithm)[19] for reducing the energy and to increase the lifetime of the network in WSN. Here the algorithm mainly focuses on three stages, namely, selection of cluster head, set up the cluster and forwarding the data. It mainly used for single hop communication.

3. Proposed System

3.1 Network Model

Assuming the WSN model, the sensor nodes are placed randomly along with the Gateways. The nodes become stationary once they deployed. Then we have to find the distance between each node and to assign those nodes to the Gateways. After that to find out the distance between each node and calculate the distance between the nodes and the base station. Assume energy for each node.

3.2 Energy Model

After initializing WSN, the next step is to calculate Gateway energy. This calculation is used to check the Lifetime of the network.

$$L(n) = \left\lfloor \frac{E_{residual\ g(n)}}{E_{Gateway\ g(n)}} \right\rfloor \ldots\ldots\ldots\ldots\ldots (1)$$

Let g_n denotes the gateways with n nodes. L(n) denotes the lifetime of gateway g_n. If gn has residual energy Eresidual (g_n) and energy consumption per round $E_{Gateway}$ (g_n).

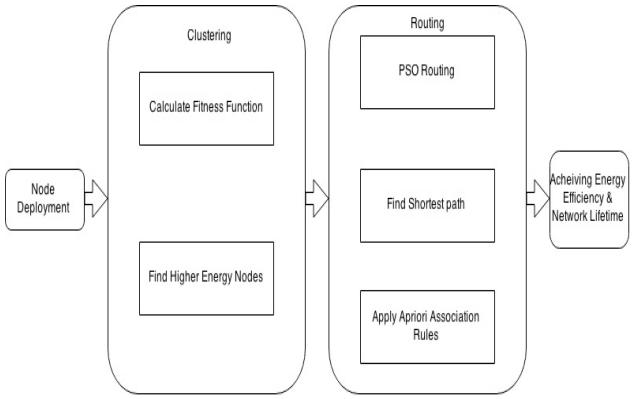

Figure 1. System Architecture.

3.3 Particle Swarm Optimization (PSO) Approach

PSO (Particle Swarm Optimization) approach is a meta-heuristic approach and also a non-straight function optimization technique. PSO is developed by the inspiration of the natural life of birds flocking. It can observe from the nature of birds always travels in a group without colliding.

The Particles can be present inside the swarm and those particles are assumed for the specified problem. Particles are traveling for searching the best path for the given problem. Memory is available in each and every particle in order to find out the best path visited by the specific particle.

PSO techniques taken by the real number of particles. Mainly there are two key steps followed in PSO optimization techniques.

- Representation of solution.
- Fitness function.

For clustering, particles are cleverly encoded to produce a complete clustering solution. A different fitness function is also used by taking care of those gateways which inevitably consumes more energy by acting as a relay node in packet forwarding. We perform extensive simulation on the proposed methods and evaluate them with several performance metrics, including a lifetime of network, active sensor nodes, energy consumption, total number of packets delivery and so on.

Each Particle can be computed by a fitness function to check the quality of the solution to the given problem.

$$F = \sqrt{\frac{(S_h + S_g) - E(Tx + Rx + Ix)}{T_t}} \ldots\ldots\ldots\ldots\ldots (2)$$

S_h - Stability of cluster leads (distance between the cluster lead + distance between cluster lead and cluster node + amount of energy dissipated in each transmission)/total no of transmission.

S_g - Stability of Gateway (distance between the gateway + distance between gateways and the cluster node + amount of energy dissipated in each transmission)/total no of transmission.

T_x - Transmission energy.

R_x - Receiver energy.

I_x - Energy dissipation in Idle State.

T_t - Total no of transmission.

3.4 SEARCH Protocol

In WSN Several Clustering and Routing Protocols are used. Many Energy Aware protocols can be challenged as the energy constraints of the sensor nodes. In this paper, we are concentrating SEARCH (Sustainable Energy Aware Cluster Head) protocol. This protocol mainly used to sustain the energy of the nodes for long transmission. Here the main aim of this protocol is, to calculate the higher energy nodes for further transmission and discard the lower energy nodes.

3.5 Apriori Algorithm

Apriori algorithm is the optimized approach to mine association rules. It's a level-wise search technique such as hash function techniques and breadth-first search. Association rule generation is broadly split up into two separate steps:

- First, minimum support is performed for finding all frequent item set in a database.

- Second, these collected frequent item sets and the minimum confidence constraint are required to form rules.

3.6 PSO-Apriori

In WSN the data is transferred using energy efficient routing, with the selected nodes of PSO multi objective fitness function. In this, the routing is not considered for the long data transfer transaction, even though the node is satisfied with energy, it supports the average data transmission and failed during the causes of Long Transmission. The Apriori association rule is used to detect the interesting relationship and form the strong rules. So the Association rules are used for avoiding Long transmission failure. This helps to enhance energy and performance in case of long transmission.

4. Performance Results

In this section, we examined our proposed approach for increasing the lifetime of a network and energy efficiency. Our simulation results obtained in Java Net beans IDE. Initially we assigned the network shown in Figure 2. The PSO routing approach is used for determining the energy of the entire network.

Figure 3 Shows that the existing route path between the sources to the destination. Existing approaches provide the best path occasionally. Here we calculate the maximum hop count and fitness for the overall area. The number of iterations will be more; the main reason is that it tries the path for all possible combinations. This leads more time and the accuracy is to be less. Table 1 show the Next Hop of each Gateways and it also shows the Hop Count of Gateways to the base station.

In our proposed method, Figure 4 shows the best path by using PSO with Apriori association rules. This method reduces the number of iterations. Here we calculate the fitness for the combined paths; in our existing method we calculate fitness for the overall area. This will reduce the performance time and the data can be forwarded quickly.

In the above Table 2 shows the comparison between the existing and our proposed system. In existing each

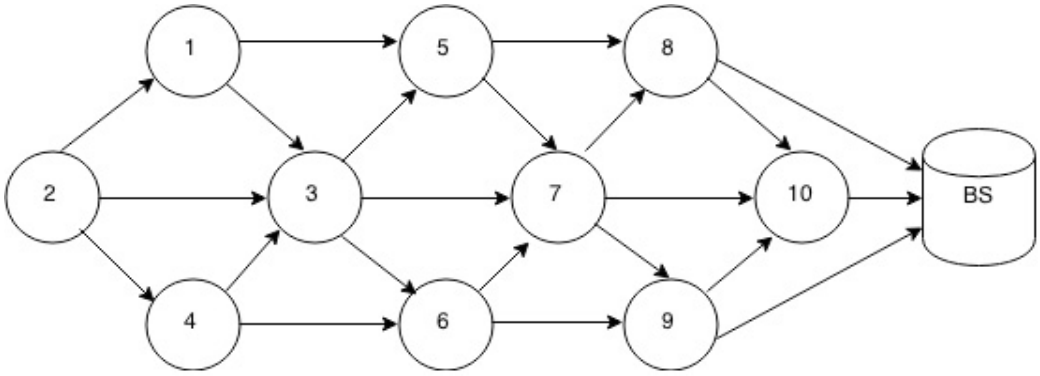

Figure 2. Routing Path for WSN.

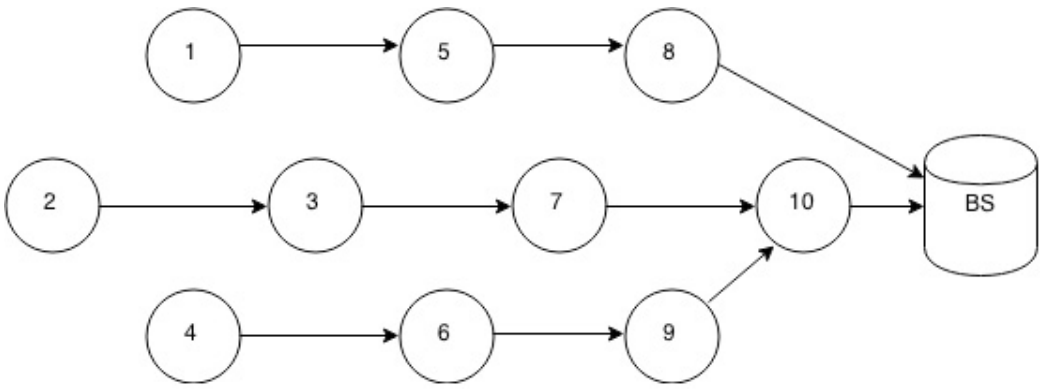

Figure 3. PSO Routing.

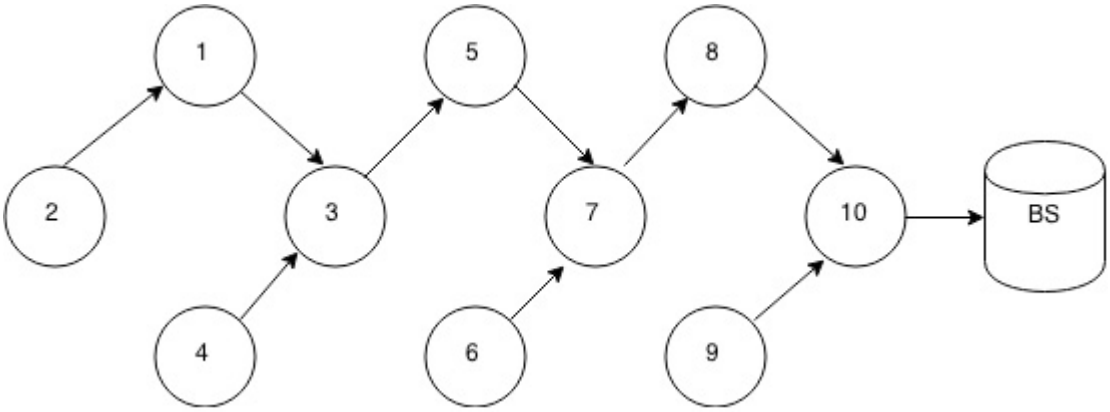

Figure 4. PSO-Apriori Routing.

Table 1. Gateways and their Hops

Gateways	NextHops	NextHops Count
1	{3,5}	2
2	{1,3,4}	3
3	{5,6,7}	3
4	{3,6}	2
5	{8,7}	2
6	{7,9}	2
7	{8,9,10}	3
8	{10, BS}	2
9	{10, BS}	2
10	{BS}	1

best path is found. Thus, it is an efficient system for finding the shortest path of the network.

5. Conclusion

In this paper, we proposed a new approach called PSO based Apriori for an increasing network lifetime and energy in wireless sensor networks. For using Apriori algorithm we get alternative paths for forwarding the data to the base station, which balances the energy. In Figure 4, the performance improvement of our proposed approach is shown. The final graph shows the best path, reduced

Table 2. Routing comparison between Existing and Proposed Method

Existing PSO Routing		Proposed PSO with Apriori	
Gateways	NextHop	Gateways	NextHop
1	{5}	1	{3}
2	{3}	2	-
3	{7}	3	-
4	{6}	4	{3}
5	{8}	5	{7}
6	{9}	6	{7}
7	{10}	7	-
8	{BS}	8	{10}
9	{10}	9	{10}
10	{BS}	10	{BS}

and every gateways has NextHop counts. In our proposed system only a few of the gateways NextHop counts. In previous work, the best path is found in any one of the rounds. But in our method, on each and every round, the path cost and thus increases the energy level of the node in the network.

In our Future work, the number of gateways is reduced as the number of nodes increases in order to increase the

network lifetime. It improves the energy efficiency of the network in the WSN Environment.

6. References

1. Varma GA, Reddy GAK, Theja YR, Arunkumar T. Cluster Based Multipath Dynamic Routing (CBDR) Protocol for Wireless Sensor Networks. Indian Journal of Science and Technology. 2015; 8(S2):17–22.
2. Kumar SA, Ilango P. Data funnelling in wireless sensor networks: A comparative study. Indian Journal of Science and Technology. 2015; 8(5):472–80.
3. Mohana R. A position balanced parallel particle swarm optimization method for resource allocation in cloud. Indian Journal of Science and Technology. 2015; 8(S3):182–8.
4. Rahmati M, Effatnejad R, Safari A. Comprehensive Learning Particle Swarm Optimization (CLPSO) for Multi-objective Optimal Power Flow. Indian Journal of Science and Technology. 2014; 7(3):262–70.
5. Kuila P, Jana PK. Energy efficient clustering and routing algorithms for wireless sensor networks: Particle swarm optimization approach. Engineering Applications of Artificial Intelligence. 2014; 33:127–40.
6. Cardei M, Du DZ. Improving wireless sensor network lifetime through power aware organization. Wireless Networks. 2005; 11(3):333–40.
7. Kuila P, Gupta SK, Jana PK. A novel evolutionary approach for load balanced clustering problem for wireless sensor networks. Swarm and Evolutionary Computation. 2013; 12:48–56.
8. Yigitel MA, Incel OD, Ersoy C. QoS-aware MAC protocols for wireless sensor networks: A survey. Computer Networks. 2011; 55(8):1982–2004.
9. Abbasi AA, Younis M. A survey on clustering algorithms for wireless sensor networks. Computer Communications. 2007; 30(14):2826–41.
10. Naruephiphat W, Charnsripinyo C. An energy-aware clustering technique for Wireless Sensor Networks. INTECH Open Access Publisher; 2010.
11. Lee JH, Moon I. Modeling and optimization of energy efficient routing in wireless sensor networks. Applied Mathematical Modelling. 2014; 38(7):2280–9.
12. Nazir B, Hasbullah H. Energy efficient and QoS aware routing protocol for clustered wireless sensor network. Computers and Electrical Engineering. 2013; 39(8):2425–41.
13. Amgoth T, Ghosh N, Jana PK. Energy-aware multi-level routing algorithm for two-tier wireless sensor networks. Distributed Computing and Internet Technology: Springer; 2014. p. 111–21.
14. Bari A, Jaekel A, Bandyopadhyay S. Clustering strategies for improving the lifetime of two-tiered sensor networks. Computer Communications. 2008; 31(14):3451–9.
15. Lim WH, Isa NAM. Particle swarm optimization with increasing topology connectivity. Engineering Applications of Artificial Intelligence. 2014; 27:80–102.
16. Chanak P, Banerjee I. Energy efficient fault-tolerant multipath routing scheme for wireless sensor networks. The Journal of China Universities of Posts and Telecommunications. 2013; 20(6):42–61.
17. Tyagi S, Kumar N. A systematic review on clustering and routing techniques based upon LEACH protocol for wireless sensor networks. Journal of Network and Computer Applications. 2013; 36(2):623–45.
18. Salazar-Lechuga M, Rowe JE, editors. Particle swarm optimization and fitness sharing to solve multi-objective optimization problems. Congress on Evolutionary Computation (CEC'2005); 2005.
19. Kuila P, Jana PK. An energy balanced distributed clustering and routing algorithm for wireless sensor networks. IEEE 2nd International Conference on Parallel Distributed and Grid Computing (PDGC); IEEE; 2012.
20. Kuila P, Jana PK. Approximation schemes for load balanced clustering in wireless sensor networks. Springer; 2014.
21. Lindsey S, Raghavendra CS. PEGASIS: Power-Efficient Gathering in Sensor Information Systems. IEEE Proceedings Conference on Aerospace; 2002. p. 3.