IARJSET

ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 10, October 2016

Improvement in Network lifetime using Ant Colony Optimization for k- Coverage in WSN

Swati Sharma[1], Kanika Sharma[2]

Scholar, ECE Department, NITTTR, Chandigarh, India[1]

Assistant Professor, ECE Department, NITTTR, Chandigarh, India[2]

Abstract: Wireless sensor network has large number of potential applications. It faces many challenging optimization problems in which one of them is coverage problem that reflect the quality of service provided by a sensor network as well as how well sensors monitored the sensor network. In this paper, we propose a optimization technique to improve network lifetime for k-coverage. In proposed algorithm firstly sensor nodes are trained by support vector machine and then apply ant colony optimization technique for target coverage and find the optimal path between source node to destination node. The objective of this paper is to find optimal path from source to destination and improve network lifetime for k-coverage. The proposed work compared with Artificial Bee Colony (ABC) and Particle Swarm Optimization algorithm (PSO) at different nodes.

Keywords: Target coverage, k- coverage, ant colony optimization, wireless sensor network.

I. INTRODUCTION

Wireless sensor network used in many applications like target coverage, military, traffic control, industry, video surveillance etc. The network lifetime is the critical parameter to adamant the efficiency of sensor network. Network lifetime can be defined as it is the time duration between the network start functioning to desired coverage criterion. To achieve high network lifetime the energy usage by network should be restrain because of the battery has limited energy which cannot be recharged and replaced easily. Coverage of sensor network needs to ensure that the region of interest should be monitored by required degree of reliability.

Coverage problem is classified in two parts one is area coverage and second is target coverage. Area coverage used to monitored whole region of interest whereas target coverage concern to monitor only particular specify point in the region of interest. Target coverage classify in three categories these are simple coverage, Q coverage and k-coverage. In case of simple coverage each sensor node monitored each target. In case of Q-coverage a target is monitored by at least some number of sensor nodes. Since in k-coverage, each target in region of interest has to be monitored by at least k sensor nodes. It is higher level of coverage used in accurate target tracking, battle field and chemical polluted areas.

In this paper we propose an optimization technique i.e. Ant colony algorithm to improve network lifetime for k-coverage in WSN. The proposed algorithm is the hybridization of support vector machine and ant colony optimization. Support vector machine trained the sensor nodes and classify them into dead node and alive node. ACO algorithm used to cover target and find shortest path between source node to destination node.

The proposed algorithm gives maximum network lifetime as compared to ABC and PSO. In this paper we have given a set of i targets and j sensor nodes. The sensor nodes are initially placed in such a way that each target should be monitored by at least k- sensor nodes and gives maximum network lifetime. The optimal deployment location computed by proposed algorithm to achieve maximum network lifetime.

This paper organized as: Section I gives introduction about proposed technique and explain, section II gives a brief review on previous work done on support vector machine and ant colony optimization techniques used for maximize network lifetime, section III explain the proposed algorithm and section IV provides simulation result and section V and VI gives conclusion and future scope of the proposed work.

II. RELATED WORK

Many optimization techniques have done in order to maximize network lifetime and detect failure nodes in wireless sensor network.

Some of them are discussed here:

In [7] proposed that the network lifetime is the essential parameter of WSN. The network lifetime is improved by deployment of sensor nodes at optimal location. In this paper they calculate the theoretical upper bound.

Upper bound is the maximum network lifetime for some configurations. The scheduling is done to achieve required level of upper bound. The overall objective of this paper is to discover optimal deployment location for a

 DOI 10.17148/IARJSET.2016.31015

deterministic deployment technique. In this paper they use ABC and PSO for sensor deployment. In [8] proposed the practical algorithm which moves the sensor node toward k-surface coverage known as Autonomous deployment for load balancing k-surface coverage. It aims to reduce the required sensing range. This algorithm needs only localized computations. They gives prove of optimal output and termination of the proposed algorithm. The proposed algorithm contributes to 2-D area coverage problem.

In [9] presented that the coverage and connectivity of network are main challenging and important issues of WSN. Many techniques have been developed to improve connectivity and quality of service of WSN by mobility of sensor nodes. But it consumes more energy and shortens the network lifetime.

In this paper they propose Hungarian method and Voronoi partition of deployment region. Hungarian used for optimal solution of target coverage and Voronoi used to reduce total movement distance.

The Steiner minimum tree with limited edge length is proposed for network connectivity. The combination of these two solutions solve MSD (Mobile sensor deployment) problem and prolong network lifetime.

In [10] presented WSN faces many challenging optimization issues. In which one of them is coverage problem it affect the quality of service of sensor network. The coverage problem means how efficiently sensor network monitored and track by sensor nodes.

In this paper they determine the degree of coverage of a sensor network. The sensor network is covered by k-sensor nodes. The degree of coverage determine within short period of time. So they get minimum energy consumptions by sensor nodes.

III. PROPOSED ALGORITHM

The effective self-positioning of sensor nodes in estimated geographical area can determine by Support Vector Machine. SVM based on supervised learning algorithm in which first step to train the support vector machine and then use this trained machine to classify new data[11].

To train the support vector machine (or support vector network) we consider the matrix of data points (test set) in which each row corresponds to observation and each column corresponds to a variable.

Apply this test set to the training sets (group of sensor nodes) of wireless sensor network. After that, the sets of support vector make a group of these new-trained data points and classify them into dead nodes and alive nodes. So using this procedure, we can identify the failure nodes in wireless sensor network [12].

We have given an set of i targets T= {T_1, T_2, …. T_i} and j sensor nodes S = {S_1,S_2,…..S_j} randomly deployed in given region. We determine the optimal deployment location by ACO technique to cover all targets and achieve maximum network lifetime.

The initial pheromones quantity is generated in such a way to cover targets. The Ant colony optimization technique is an inspired by the real ant behavior. Ants randomly start to search and discover food from their nest.

While returning towards its nest, it drop pheromones trail on the way [13]. An extensive pheromone trail indicates the food source.

Other ants select the path according to the quantity of pheromones. However, the pheromone vanishes over a short period so pheromones accumulated in the shortest path between nests to food source [14].

In this approach ants tries to discover the minimum distance to cover from nest to food source in the network. Before path searching we have taken some initialization parameters as follows.

The 'n' is the environmental phenomenon that shows the least amount of pheromones in the transmission path. The transition probability is use for an ant r to move from source node x to Destination node y, which represent the routing information. The probability decision rule

$$P_{xy}^{r} = \left| \frac{[\tau_{xy}]^{\alpha}[\eta_{xy}]^{\beta}}{\Sigma[\tau_{xy}]^{\alpha}[\eta_{xy}]^{\beta}} \quad \text{if } y \in L^{r} \right| \quad (1)$$

Where τ_{xy} the amount of pheromone and η_{xy} is the heuristic function. The α and β are the constant parameter use to control the influence of the τ_{xy} and η_{xy}.

In ACO algorithm ants contain the memory L^r which has the information about nodes that already visited or not.

The heuristic function (η_{xy}) is the reciprocal of Euclidean distance (d_{xy}) between x and y sensor node [15][16]. After completion of ant tours the amount of pheromones updated accordingly to the

$$\tau_{xy}(t+N) = (1-\delta).\tau_{xy}(t) + \Delta\tau_{xy} \qquad (2)$$

where δ is the local pheromone spoil parameter. Pheromone updates after completion of ants tour so above equation shows that pheromone updates at time of t+N, where t is the previous pheromone update time. $\Delta\tau_{xy}$ Represent the additional pheromone quantity at the t + N point [17].

This iteration process repeated until ants discover the best possible path from source node to destination node as well as coverage of all targets.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 10, October 2016

The lifetime of the sensor network, calculated by the energy consumption of the sensor node at optimal path and whole energy consumption of the ant r.

$$Energy\ cost = \frac{E_c{}^2}{\sum_{x=1}^{n}\sum_{y=1}^{n} e_{xy}^{\alpha}\, W_y^{\beta}\, P_{xy}^{r}} \qquad (3)$$

Here n is the sum of the network node and e_{xy}^{α} is the energy consumption between source node to destination node. W_y^{β} is the available power destination node.

If ant r has travel edge (x,y) then the value of P_{xy}^{r} is one otherwise zero.

IV. SIMULATION RESULT

The simulation performed in MATLAB 2013b. The proposed algorithm is the hybridization of support vector machine (SVM) and ant colony optimization (ACO). In proposed algorithm, we have considers a 500×500m region of experiment and 25 targets. The number of sensor nodes are varies from 100-250. The sensing range of each node is 75 and 100 units of battery power.

In proposed algorithm we firstly apply SVM algorithm trained all defined number of sensor nodes which classified them into failure node and alive nodes as shown in table 1 at different value of k-coverage. After that we apply ACO algorithm in which ants discover the optimum path from source node to destination node through alive nodes.
As shown in figure 1 we have taken 100 sensor nodes and deploy them using ACO in given region of interest. We have taken the node 5 and 30 select as a source node and destination node.

Table.1. No of failure nodes and alive nodes for different values of k-coverage.

k-coverage	No of Failure nodes	No of Alive nodes
K=1	45	55
K=2	39	61
K=3	43	57
K=4	40	60

Figure.2. shows the network lifetime for various deployment techniques for k coverage problem. The proposed technique gives maximum network lifetime compared to other deployment technique. The network lifetime increases with increasing the no. of nodes.

As we increases the k coverage value then network lifetime decreases because in this condition one target covered by more than one sensor node. The proposed algorithm network lifetime are compared with ABC and PSO. It has been shows that the proposed algorithm having larger network lifetime comparison to existing algorithm.

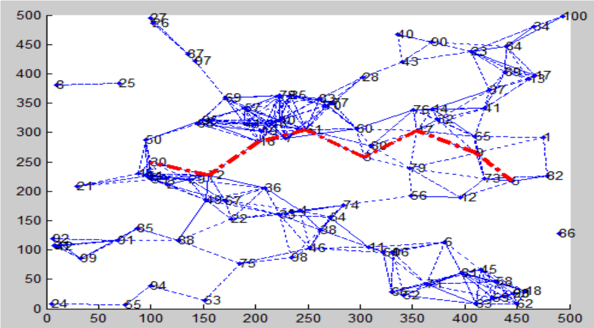

Figure.1.Shortest path from source node to destination node.

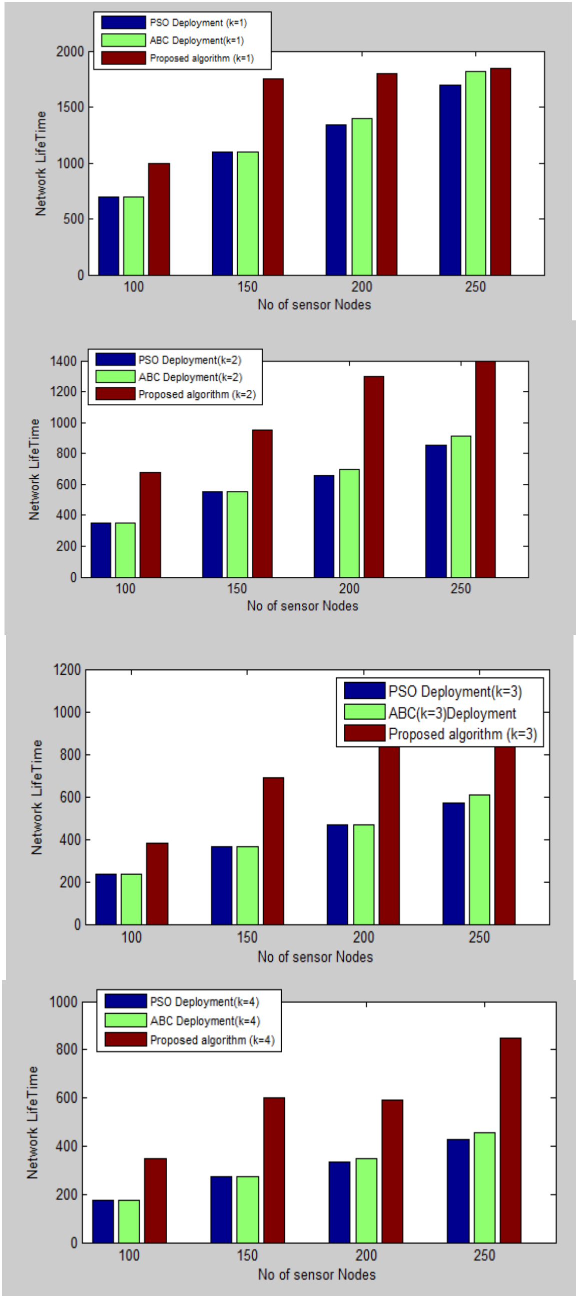

Figure.2.Network lifetime for k coverage problem at various number of nodes for Proposed, ABC and PSO algorithm.

IARJSET
ISSN (Online) 2393-8021
ISSN (Print) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified
Vol. 3, Issue 10, October 2016

Table. 2. Network Lifetime comparison of proposed algorithm with existing algorithms.

No of Nodes	Network Lifetime at k=1			Network Lifetime at k=2			Network Lifetime at k=3			Network lifetime at k=4		
	PSO	ABC	Proposed algorithm	PSO	ABC	Proposed algorithm	PSO	ABC	Proposed algorithm	PSO	ABC	Proposed algorithm
100	700	700	1000	350	350	680	233	233	380	175	175	345
150	1100	1100	1750	550	550	950	366.66	366.66	688	275	275	599
200	1340	1400	1800	660	700	1300	466.66	466.66	875	335	350	590
250	1700	1820	1850	854	910	1400	568.96	606.66	1100	427	455	850

Table 2 shows the network lifetime at different values of k-coverage and sensor nodes. The network lifetime of proposed algorithm is improved by 42.87% by the ABC and PSO algorithm Table 3 shows the comparison of the proposed algorithm and ABC. Our proposed algorithm achieve better network lifetime for simple coverage (k=1) as well as for higher value of k-coverage.

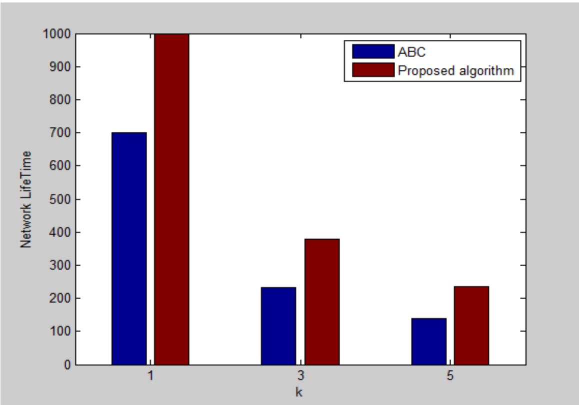

Figure.4.Comparison of proposed approach and ABC

The performance analysis of proposed algorithm with ABC for target coverage is shown in table 4.3. Here we taken the 100 sensor nodes deployed in $500 \times 500m$ region so the network lifetime for k-coverage at k=1,3 and 5 the proposed algorithm gives 42.87%, 63.09 and 67.14% better result than ABC.

Table 3 performance analysis of proposed algorithm by ABC for target coverage

K-coverage	% age improvement in k-coverage by ABC	%age improvement in k-coverage by proposed algorithm
K=1	12.90%	42.87%
K=3	21.05%	63.09%
K=5	40%	67.14%

V. CONCLUSION

In this paper, we compute locations for sensor nodes using ant colony optimization, it gives maximum network lifetime. It is the hybridization of SVM and ACO. The proposed routing algorithm is use for target coverage and finds the shortest path between nodes. This algorithm gives longer network lifetime and reliable communication between sources to destination node even when some nodes are dead. We get maximum network lifetime by using proposed algorithm in compare to existing optimization technique. The proposed optimization algorithm performs better than artificial bee colony and particle swarm optimization algorithm.

VI. FUTURE WORK

Our proposed optimization technique is simple and energy efficient. Target coverage reflects the quality of service. Network lifetime is the essential parameter in WSN. Therefore, this technique has proposed to detect dead nodes and discover the shortest path between nodes. Future work can be done to enhance network lifetime for higher value of k- coverage using mobile sink.

REFERENCES

[1] Pankaj Chauhan, Tarun Kumar, "Power Optimization in Wireless Sensor Network: A Perspective," International Journal of Engineering and Technical Research, ISSN: 2321-0869, Volume-3, Issue-5, pp.273-277, May 2015.

[2] Mihaela Cardei My T. Thai Yingshu Li Weili WuEnergy -Efficient Target Coverage in Wireless Sensor Networks," IEEE conference , pp.1976 - 1984 vol. 3, ISSN :0743-166X, 2005.

[3] Pedro A. Forero, Alfonso Cano, Georgios B. Giannakis, "Consensus-Based Distributed Support Vector Machines," Journal of Machine Learning Research, pp. 1663-1707, 2010.

[4] Sanqing Hu, Yu-dong Yao, "Mac protocol identification using support vector machines for cognitive radio networks," IEEE Wireless Communications, Vol. 21 , Issue: 1, pp.52 – 60, ISSN :1536-1284, February 2014.

[5] Rana Haber, Adrian Peter, Carlos E. Otero , "A Support Vector Machine for Terrain Classification in On-Demand Deployments of Wireless Sensor Networks," IEEE International Conference, pp. 841 – 846, April 2013.

[6] Zhao Cheng, Mark Perillo, and Wendi B. Heinzelman, "General Network Lifetime and Cost Models for Evaluating Sensor Network Deployment Strategies", IEEE Transaction on mobile computing, Vol. 7, NO. 4, pp.484-497, April 2008.

[7] S. Mini, Siba K. Udgata, and Samrat L. Sabat, "Sensor Deployment and Scheduling for Target Coverage Problem in Wireless Sensor Networks," IEEE Sensor Journal, Vol. 14, No. 3, pp. 636-644, March 2014.

[8] Feng Li, Jun Luo, Wenping Wang, and Ying He, "Autonomous Deployment for Load Balancing k-Surface Coverage in Sensor Networks," IEEE Transactions on wireless communications, Vol. 14, No. 1, pp. 279-293, January 2015.

[9] Zhuofan Liao, Jianxin Wang, Shigeng Zhang, Jiannong Cao," Minimizing Movement for Target Coverage and Network

Connectivity in Mobile Sensor Networks," IEEE Transactions on parallel and distributed systems, Vol. 26, No. 7,pp. 1971- 1983, July 2015.

[10] Rasmi Ranjan Patra, Prashanta Kumar Patra, " Analysis of k-Coverage in Wireless Sensor Networks," International Journal of Advanced Computer Science and Applications, Vol. 2, No. 9, pp. 91-96, 2011.

[11] Duc A. Tran,Thinh Nguyen, "Localization In Wireless Sensor Networks based on Support Vector Machines," IEEE Transactions on Parallel and Distributed Systems , Vol.19, Issue: 7, pp. 981 – 994, ISSN :1045-9219, May 2008.

[12] Reza Samadian, Majid Noorhosseini, "Improvements in Support Vector Machine Based Localization in Wireless Sensor Networks," IEEE international conference, pp. 237 – 242, 2010.

[13] Selcuk Okdem Dervis Karaboga , "Routing in Wireless Sensor Networks Using Ant Colony Optimization,"IEEE Conference on Adaptive Hardware and System, pp. 401-404, 2006.

[14] PANG Yi, SUN Qing-lin, CHEN Zeng-qiang, ZHANG Huiying, "Power Control in Non-uniform Wireless Sensor Networks Based on the Parallel Ant Colony Algorithm," International Conference on Computational Intelligence & Communication Technology, IEEE international conference, pp.252 – 256, 2015..

[15] Hong-Chi Shih, Shu-Chuan Chu, John F. Roddick, "Power Reduction of Wireless Sensor Networks Using Ant Colony Optimization," IEEE International Conference on Computational Aspects of Social Networks, pp. 464-467. 2010.

[16] Jun Xiao, Lili Sun, Shi Zhang, "Distance Optimization Based Coverage Control Algorithm in Mobile Sensor Network," IEEE International Conference, pp. 3321 – 3325, ISSN No. 1062-922X, 2008.

[17] Songzhu Xia, Su Wu, Jun Ni, "A New Energy-Efficient Routing Algorithm based on Ant Colony System for Wireless Sensor Networks," IEEE International Conference on Internet Computing for Science and Engineering, pp. 176-180, 2009.