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Coverage Aware Sleep Scheduling in Wireless Sensor Networks

U. Pacharaney[1*], A. Shaikh[2], P. Jadhav[3], M. Madankar[3]

[1]Dept. of Electronics Engineering, Datta Meghe College of Engineering, Airoli, India
[2]Dept. of Electronics Engineering, Datta Meghe College of Engineering, Airoli, India
[3]Dept. of Electronics Engineering, Datta Meghe College of Engineering, Airoli, India
[4]Dept. of Electronics Engineering, Datta Meghe College of Engineering, Airoli, India

Corresponding Author: utk21pac76@gmail.com

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Abstract— In a randomly deployed wireless sensor network coverage is a fundamental issue to monitor the region of interest without leaving any area unmonitored. With limited battery of a senor node this poses a big challenge. One way to maintain good coverage and extend the network lifetime is to deploy sensors in high density and schedule them to sleep between active cycles. In this paper, we propose an algorithm to schedule the sensor sleep based on the area of overlapped coverage with neighboring sensors. First Euclidean distance of the nodes based on which the nodes placement in the intended coverage area is determined then overlap nodes are determined, multiple nodes with similar sensing range will go to sleep mode thereby keeping only one node in the active state. Simulations results show that this algorithm achieves better performance in terms of coverage efficiency than PEAS algorithm.

Keywords—Covearge; Sleep Awake; Area of Overlap

I. INTRODUCTION

Sensors link the physical with the digital world by capturing and revealing real-world phenomena and converting these into a form that can be processed, stored, and acted upon. Integrated into numerous devices, machines, and environments, wireless sensor networks (WSN) provide a tremendous societal benefit [1]. In a random WSN, number of sensors say N are deployed independently and uniformly in a bounded field of interest A with the node density $\rho = \frac{N}{A}$. Coverage is a fundamental research issue in WSN because it can be considered as the measure of Quality of Service (QoS) for a sensor network [2]. Sensing coverage characterizes the monitoring quality provided by a sensor network in a designated region. Different applications require different degrees of sensing coverage. While some applications may require that every location in a region be monitored by multiple nodes some need only few nodes to monitor the area. When multiple random nodes are deployed to cover same area, there is an overlapping of coverage between the neighboring nodes shown in the Fig.1.

The sensing range of all the sensors are usually same, consequently when one node can do a task properly, another neighbor node/ nodes will tend to be active and perform same task. This results into wastage of power, reduces the total time for which a node can cover the area it monitors and this leads to ineffective network utilization. In this work an algorithm is implemented to optimize the coverage in wireless sensor network in which scheduling is done, where a minimum number of sensor nodes are activated to satisfy the coverage requirement and the remaining nodes are set to sleep for conserving the energy.

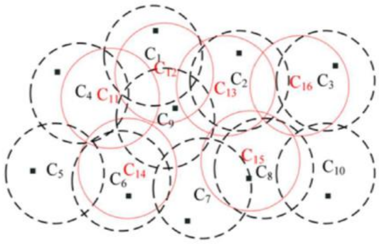

Figure 1: . Multiple random nodes covering same area [3]

The scheduling of the sensors put to sleep is done based on the area of overlap between the adjust nodes, since in a densely deployed network the sensing range of multiple nodes overlap thus creating redundancy. We propose a coverage aware sleep schedule that schedules the sleep probability based on the area of overlapped coverage by its neighboring sensors. If all the sensors follow this the network can achieve better coverage.

The rest of the paper is organized as follows section II presents the related work section III deals proposed system . Section IV is the system implementation and we conclude with section V.

II. RETALED WORK

The coverage problem in wireless sensor networks has been the subject of increasing attention in recent years [4], [5]. Meguerdichian et al. [4] proposed an optimal polynomial time algorithm that used graph theory and computational geometry for solving the best and worst case coverage. Ahmed et al. [5] proposed a distributed probabilistic coverage algorithm to evaluate the degree of confidence in detection probability provided by a randomly deployed sensor network, using a uniform circular disc for sensing coverage in the binary detection model. The coverage problem was formulated in [6] as a decision problem, whose goal was to determine whether every point in the service area of the sensor network was covered by at least k sensors, where k is a given parameter. There are various protocols for effective coverage in sensor networks: Coverage Configuration Protocol (CCP), Adaptive Self-configuring Sensor Network Topologies (ASCENT), Optimal Geographical Density Control (OGDC), Random Independent Scheduling (RIS), Light weight Dependent Aware Scheduling (LDAS) and Connected Dominating Coverage Set (CDCS) [7][8][9]. Ye et al. developed a mechanism called PEAS (Probing Environment and Adaptive Sensing) to prolong the network lifetime by maintaining a set of necessary working nodes and turning off redundant nodes .PEAS conserves energy by separating all the working nodes by a minimum distance of c. To check if there is a working neighbor nearby, each node broadcasts a message (probe) with a transmission range of c after sleeping for a random period. A node will enter the on-duty mode only if it receives no replies from working neighbors; otherwise it will stay in the off-duty mode [10]. Algorithms such as random scheduling schedules sensors sleep probability randomly as in [11]. We propose to schedule the sleep probability based on the area of overlapped coverage by its neighboring.

III. PROPOSED ALGORITHM

The Proposed algorithm is considered to be applied for randomly distributed sensor a node that tries to cover the maximum area by increasing sleep nodes and thus reducing number of active nodes. The sensing range is considered to be less than or equal to twice the communication range [12]

That is

$$R_c \geqq 2R_s \qquad (1)$$

Where R_c is the communication range and R_s is the sensing range.

A. Sensing range model

We have used the Boolean Sensing model where each sensor has a fixed sensing area and a sensor can only sense the environment or detect events within its sensing area. The Boolean sensing model assumes that sensor readings have no associated uncertainty. The coverage function of the disk model is given by

$$f(d(s,z)) = 1 \text{ if } d(s,z) \le R_s, \quad 0 \text{ otherwise.} \qquad (2)$$

where d(s, z) is the Euclidean distance between a sensor s and a space point z, and the constant $R_s > 0$ is called sensing range. Fig 2 illustrates the model.

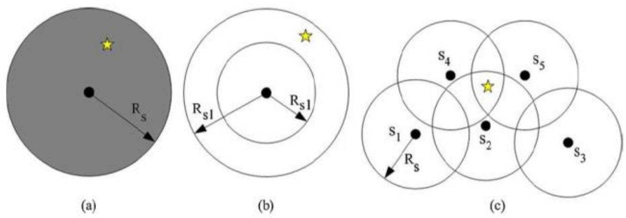

Figure 2: Illustration of
(a) an omnidirectional Boolean disk coverage model;
(b) an omnidirectional Boolean disk coverage model with variable sensing ranges; and
(c) a space point being 3-covered by three disks [3].

Fig 2 a illustrates the Omni directional coverage by the model where all space points within such a disk have the coverage measure of 1 and are said covered by this sensor. All space points outside such a disk have the coverage measure of 0 and are said not covered by this sensor. The sensing range Rs is used to characterize the sensing capability of a sensor. Figure 2(b) illustrates a sensor with two sensing ranges, $R_{s1}$and R_{s2}. The space point marked by the star is not covered if the sensor uses R_{s1} as sensing range; it is covered if the sensor uses R_{s2} as sensing range. It is generally assumed that a sensor consumes more energy when it uses a larger sensing range. Figure 2(c) is an example of space point being 3-covered, where the space point marked by the star is within the sensing disks of sensors s_2, s_4, and s_5

B. Caluculating overlap arear.

Symbols used in Fig 4 are given in table I. As the distance *d* between the two nodes decreases the overlap area increases following the limiting values of 1 at *d*=0 and of 0 for $d \geq R$. Areas $\mathbf{A^i_j}$ and $\mathbf{A^j_i}$ are same due to symmetry as shown in fig4.

$$A_j^i = A_i^j = R^2 \cos^{-1}\left(\frac{d}{2R}\right) - \frac{Ld}{4} \qquad (3)$$

Here L is the length of the chord formed by intersection of two circular disk and is given by

$$L = 2.\sqrt{\left(R^2 - \frac{d^2}{4}\right)} \qquad (4)$$

TABLE I. SYSTEM NOTATIONS

Symbols	Notations
S_i	Sensing region of node n_i of disk with radius R centered at node n_i
S_j	Sensing region of node n_j of disk with radius R centered at node n_j
A	Area of the sensing region of a node
d	Distance between nodes n_i and n_j located at S_i and S_j
P^1 and P^2	Intersection points of two disk of radius R centered at node n_i and n_j
L	Length of common chord length. It is equal to length of the line segment joining two intersection points P^1 and P^2
A^i_j and A^j_i	Area of region surrounded by arc and chord shown by shaded area.

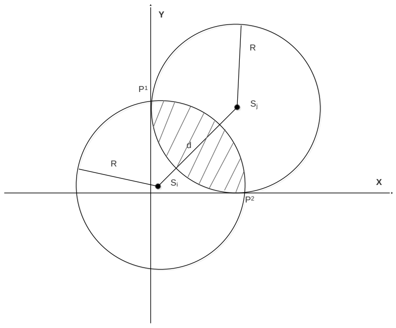

Figure 3: Overlapping model.

C. *System Implementation*

In this work, the aim of our proposed algorithm is to first optimize the coverage with minimum number of the nodes in the active state. Thus the proposed algorithm will try to improve the coverage based on the Euclidean distance of the nodes in randomly deployed wireless sensor networks. Thus the nodes can randomly wakeup at the initial period when placed in the sensing area, once confirmed with the active node, they can go back to sleep mode for a higher duration till the wear out period of that active node arrives thereby again waking up when the node enters its aging stage. Initially all the nodes are in the active mode when placed in a remote area later the sensing node will check whether any node is there in the working state, if yes it will first read the power of the active node and then decide its sleep time randomly and go back to sleep mode, if no, then it will enter into active mode and again check whether any other node with high power battery life is present in its vicinity within the same region, if yes, it will check its current remaining power and if it is less then it will continue to remain in working state until it totally fails or again go back to sleep mode thereby conserving the energy intelligently and further increasing the lifetime of the nodes.

D. *Flow chart of system*

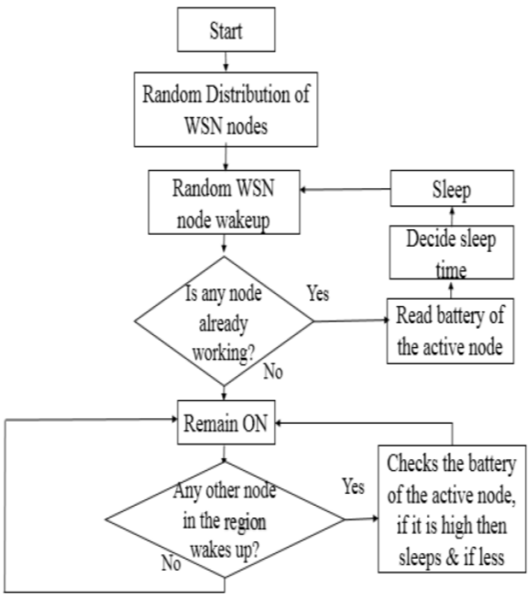

Figure 4: Flow chart of the system

Initially all the nodes are in the active mode when placed in a remote area later the sensing node will check whether any node is there in the working state, if yes it will first read the power of the active node and then decide its sleep time randomly and go back to sleep mode, if no, then it will enter into active mode and again check whether any other node with high power battery life is present in its vicinity within the same region, if yes, it will check its current remaining power and if it is less then it will continue to remain in working state until it totally fails or again go back to sleep mode thereby conserving the energy intelligently and further increasing the lifetime of the nodes.

IV. RESULT

Simulation of the proposed algorithm for coverage improvement based on overlap area of the nodes has been proposed. The algorithm has been synthesized on MATLAB simulator. MATLAB R2013a version has been used for simulation. Once the nodes are deployed in the region of interest, Euclidean distance of the nodes based on which the nodes are placed in the intended coverage area is determined. Once the overlap nodes are determined, multiple nodes with similar sensing range will go to sleep mode thereby keeping only one node in the active state. The fig 5 shown below is the stimulated output obtained on MATLAB for our proposed algorithm. It indicates the total number of nodes plotted in an area in which length & width are at Y axis and X axis respectively.

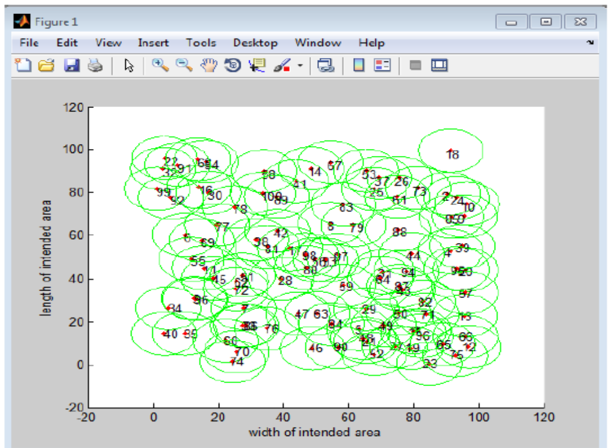

Figure 5: Node deployment in region of interest

Soon after the total number of nodes are obtained covering the given area. The program for the overlap nodes was written that finds how many nodes are covering or sensing the same area and are in the sensing range of each other. Thus our algorithm will make those nodes to enter into sleep mode and the prominent one among them will be in the active mode in order to cover the same area.

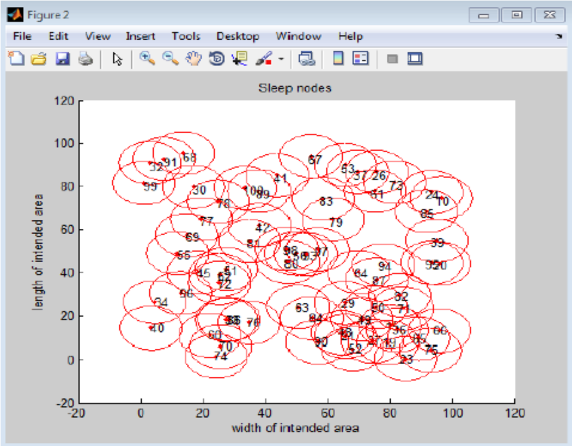

Figure 6: Sleep nodes based on area of overlap

Hence number of nodes going into sleep mode increases and thereby increasing the battery life of the nodes. The fig 6 gives the stimulated output results for the sleep node. Correspondingly Fig 7 gives the stimulated output for the total number of active nodes in the same area.

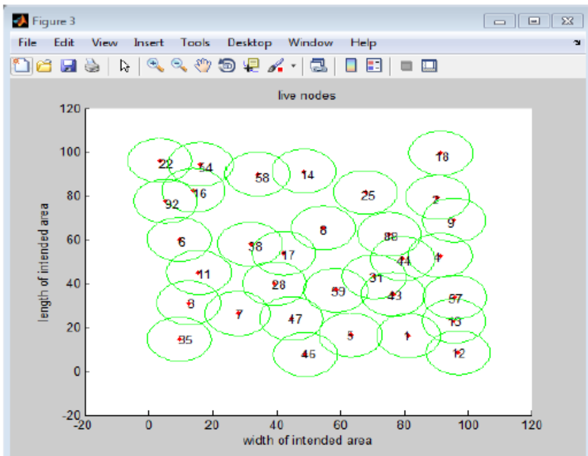

Figure 7: Active sensors in the region of interest

We compare our proposed algorithm with thePEAS algorithm . Fig 8 shows the compartive graph

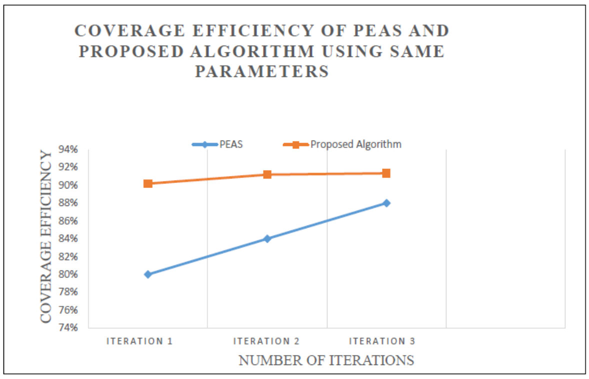

Figure 8: Comparative graph of proposed method

We investigated that the proposed algorithm provides better coverage efficiency in a large scale wireless sensor networks. In the proposed work we varied multiple parameters at every instance keeping one of the parameter same and thus achieved different area coverage for different combinations. Thus we achieved a good coverage efficiency of 91.354% for our algorithm with respect to PEAS protocol giving efficiency of almost 80% to 88% using same combinations.

V. CONCLUSION

In this paper, we propose a sleep scheduling algorithm to solve the challenges of short battery life and coverage in wireless sensor networks using a sleep probability schedule. The performance of the algorithm is studied and compared with PEAS algorithm Simulation results revealed that the proposed algorithm has a better overall coverage efficiency than PEAS algorithms.

VI. REFERENCES

[1] Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Network-Theory and Practice”, A John Wiley & Sons , Singonpure, pp.44-56, 2010. [2] I.F. Akyildiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, “Wireless Sensor Networks: A Survey,” Computer Networks, Vol.38, No.4, pp. 393–422, 2002.

[3] Bang Wang, “Coverage Control in Sensor Networks”, Springer-Verlag London Limited, London, pp.1-156, 2010.

[4] S Meguerdichian, F Koushanfar, M Potkonjak, MB Srivastava, “Coverage Problems in Wireless Adhoc Sensor Networks”, The 20th Conference Computer Communication, USA, pp.1380-1387, 2001.

[5] N. Ahmed, S.S. Kanhere, S. Jha, “Probabilistic Coverage in Wireless Sensor Networks”, The IEEE Conference on Local Computer Networks 30th Anniversary, Australia, pp.681-688, 2005.

[6] C. Huang, Y. Tseng, “The Coverage Problem in A Wireless Sensor Network”, Mobile Networks and Applications, Vol.10, No.4, pp. 519-528, 2005.

[7] Ye Fan, “Peas: A Robust Energy Conserving Protocol For Long-Lived Sensor Networks”, International Conference on Distributed computing systems, USA, pp.28-37, 2003

[8] D.G. Anand, HG. Chandrakanth, MN. Giriprasad, A. Pradesh, “Energy Efficient Coverage Problems In Wireless Ad Hoc Sensor Networks”, Advanced Computing: An International Journal, Vol.2, Issue.2, pp.42-50, 2011.

[9] G. Fan, S. Jin, D. Processing, “Coverage Problem in Wireless Sensor Network : A Survey”, Journal of Networks, Vol.5, Issue.9, pp.1033-1040, 2010.

[10] P.G. Krishna, K.V. Subrahmanyam, SC. Sekhar, “Design of High Speed Low Power Multiplier Using Reversible Logic A Vedic Mathematical Approach”, International Journal of Computer Sciences and Engineering, Vol.2, Issue.10, pp.19-25, 2014.

[11] R. Nathiya, S.G. Santhi, “Energy Efficient Routing with Mobile Collector in Wireless Sensor Networks (WSNs)”, International Journal of Computer Sciences and Engineering, Vol.2, Issue.2, pp.36-43, 2014.

[12] Z. Honghai, JC. Hou, “Maintaining sensing coverage and connectivity in large sensor networks”, Ad Hoc & Sensor Wireless Networks, Vol.1, Issue.1, pp.89-124, 2005.

