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Energy Aware Node Deployment in Wireless Sensor Network with Straight Line Topology

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Abstract: *Wireless sensor networks are used to monitor a given field of interest for changes in the environment. Coverage and connectivity of the network are two of the most fundamental problem in WSNs. In WSN is usually defined as a with respect to how efficient in sensing an sensors are able to observe the physical ambience. Coverage in Wireless sensor network is essential are fast growing area for research. Connectivity can be defined as the ability of the sensor to reach the data sink. Finding an best deployment policy that offers high degree of coverage with network connectivity is quite difficult. In this paper we are discussing about energy efficient coverage with a straight line topology. The energy efficiency can be achieved with proper sleep wake up approach. Sensor nodes are mostly battery operated and are expected to work for a longer time without replacing the batteries. Therefore, the energy efficient coverage is achieved by new the sleep scheduling algorithm which expand lifetime of the system.*

Keywords: Coverage , Deployment, Energy Efficiency, WSN

1. INTRODUCTION

The WSNs generally is an intelligent, low power small in size and low cost solution that enables the efficiency and reliability improvement of many industrial applications such as safety and security surveillance, home and building automation, and smart grids. However, there are many challenges to bring the WSNs into real-life application [1a] Wireless sensor nodes are mainly battery powered, thus having constrained amounts of energy. Each sensor node is associated with a processor transceiver and a power source Instead of sending the raw data to the nodes or header nodes , with their processing capabilities they process the data locally. [4a]

In WSN the energy is a critical point and should be tackled sensibly. A WSN should be autonomous and self-sustainable, able to function for several years with low power. A node's lifetime is defined as the node's operating time without the need for any external intervention, like battery replacement.[3a]

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II. SENSOR DEPLOYMENT METHODS

There is extensive research in the development of new algorithms for sensor deployment, ad hoc routing, energy efficiency and distributed processing in the context of wireless sensor networks. As the algorithms for wireless sensor network are developed, they must be a low-power, highly efficient and adaptable to various hardware platform. Setting up a sensor network nodes in a real world environment is termed as Deployment[14]. Nodes may be deployed in predetermined locations or place them randomly Dropping sensors from a plane would be an example of random placement. The coverage schemes can be easly determined in deterministic placement rather in random placement . However in many deployments, it is either impractical or impossible to deploy sensor nodes in a deterministic way. Examples of deterministic and random placement are shown in Fig 1a and Fig 1b.
Other deployment approaches are dense deployment and sparse deployment. If the sensor nodes are deployed in an area in high density it is termed as dense deployment while a sparse deployment would have fewer nodes. The dense deployment model is used in situations where it is very important for every event to be detected or when it is important to have multiple sensors cover an area. The sparse deployment is cost effective and it should be properly managed and localized with maximum coverage with minimum nodes. In most of the work studying coverage it is assumed that the sensor nodes are static, they stay in the same place once they are deployed.

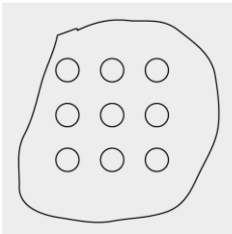

Fig.1 (a) Deterministic Deployment

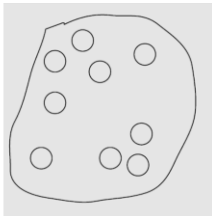

Fig 1(b) Random Deployment [2a]

A more sophisticated deterministic deployment method is given in [6]. The authors propose to arrange the sensors in a diamond pattern which would correspond with a Voronoi polygon.[5] The pattern achieves four way connectivity from each of the nodes with full coverage when the communication range divided by the sensing range is greater than the square root of two. However the pattern is too difficult to practical deployment. It assumes that the sensing and communication ranges of every node are a perfect circle.

III. CONSTRAINTS

Coverage problem is the basic problem of any type of WSN, and is the evaluation criteria of measuring sensor network quality of service (QoS). The core problem of sensor network coverage is "how strong that sensor network monitoring ability of observation in physical space?" [12]The most essential aspect to consider in the design of coverage scheme is the energy constraints. The primary challenge in WSN is energy management. Due to the limited energy the system has to limit its processing power, sensing ability, communication band width, node's form factor etc.[6]. It therefore becomes very essential to save energy and extend the battery life. Placing unwanted sensors into a low energy sleep mode is a popular method to conserve energy. Another method is to adjust the transmission range so that the sensor nodes only use enough energy to transmit to a neighbor node.[5] An hierarchical approach of network design using cluster heads reduce the amount of information sent up to the sink.
This will alleviate the load on the nodes so as to increase their lifetimes. Improving the efficiency of data manipulation and routing is also help to conserve energy. Eliminating the redundancy of data will allow the network to be more efficient by avoiding redundant data from nearby nodes. Optimizing the routing also help to find the shortest path to the sink using the least number of nodes. By using less energy for routing data, coverage is helped by having the nodes' lifetimes extended.[5]
Cardei and Wu present a summary of different approaches to energy efficient coverage problems in [7]. The authors state that most work done in this field was in the theoretical realm at the time of the survey. Chen, Kumar, and Lai extend a barrier coverage protocol to improve energy efficiency. When a node detects adequate k-coverage in the area it will put itself into sleep mode. It will enter wakeup mode after a random period of time and perform another check. If the node is not needed then it will find out from the other nodes when and factor that into its calculation as to when it should wakeup again. The authors in and [8] conserve energy by turning off groups of nodes at a time. The authors in [9] introduce a new protocol in which the nodes can be in any of five different states. When a node wakes from the sleep state it will enter the listen state and wait for a beacon. After receiving the beacon the node determines if it should go back to sleep mode or go to the join state. From this state it will wait for its timer to expire and move to the active state unless it receives a message telling it to return to the sleep state. When the node is in the active state it is providing coverage to the area, it will remain in this state until it becomes ineligible at which point it moves to the withdraw state. Once in the withdraw state the node sets a timer and returns to the sleep state unless it receives a message telling it to return to the active state.

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IV. IMPLEMENTATION OF ENERGY EFFICIENTCOVERAGE AWARE ROUTING PROTOCOL FORWIRELESS SENSOR NETWORK USING GENETIC ALGORITHM

The proposed algorithm is a new approach in wsn where nodes are assumed to be deployed in such a manner that there we could find a straight line localization of WSN nodes. The total sensor fields can be divided into number of circular cluster fields. Each circular fields have a central cluster head. The proposed topology of the nodes is in that circular fields is in straight line

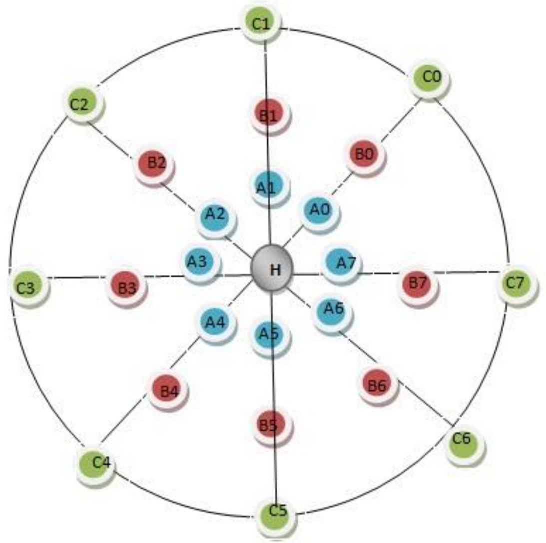

Fig 2: Node deployment in straight line

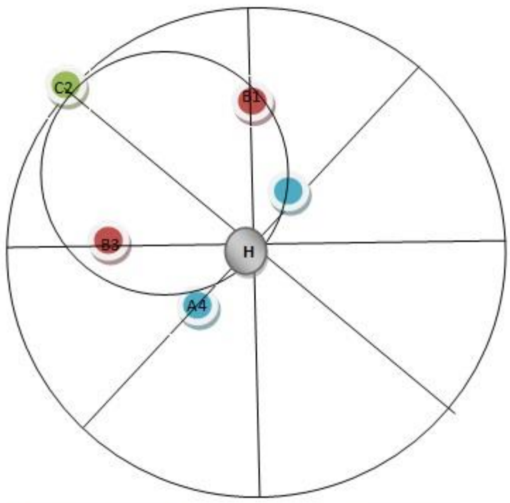

Fig 3: Active nodes in first circular sleep wake up nodes

localization. Each nodes are deployed in almost straight line and addressed in gray code sequence. The gray code sequence is one of the most effective way to address the adjacent nodes for reduced error in selecting the adjacent nodes. Here the nodes are conserve the energy by avoiding redundant data transmission using sleep wake up approach. In wireless sensor networks, sensor nodes generally switch between active and sleep modes in medium access control (MAC) layer to reduce energy consumption.[13] The most common technique for saving energy is the use of sleep mode where significant parts of the sensor's transceiver are switched off. In most cases, the radio transceiver on board sensor nodes is the main cause of energy consumption hence, it is necessary to keep the transceiver in switched off mode most of the time to reduce energy consumption.[15]

TABLE 1:

NODE DEPLOYMENT ADDRESSING

NODE NAME	GRAY CODE ADDRESS				
A0 B1 C2 B3 A4	00000	01100	11011	01110	00110
A1 B2 C3 B4 A5	00001	01101	11010	01010	00111
A2 B3 C4 B5 A6	00011	01110	11110	01011	00101
A3 B4 C5 B6 A7	00010	01010	11111	01001	00100
A4 B5 C6 B7A0	00110	01011	11101	01000	00000
A5 B6 C7 B0 A1	00111	11111	11100	01100	00001
A6 B7 C0 B1 A2	00101	11101	11000	01100	00011
A7 B0 C1 B2 A3	00100	01100	11001	01111	00010

TABLE 2:

PARAMETERS USED IN PERFORMANCE ANALYSIS

Symbol	Description	Value
Tmaxsleep	Maximum sleep Time	5 Seconds
Tsample	Sample Time	1 second
Psleep	Power dissipated during Sleep Mode	600μW

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PCS	Power dissipated when Processing	15mW
Et1	Power dissipated for sending 1 bit of data	1mW
Ed1	Power for transmission over a distance d	1mW
N	Number of nodes considered	30 and 500
A	Area of network	500X500 m2
Pinit	Initial power of each node	10W
Ttone	Time required to send the wakeup signal	Variable
PRX	Power when receiving	45mW
PTX	Power when transmitting	60mW
Pwu	Power when in wakeup mode	177W
Fwu	Frequency of the wakeup signal	862Hz
Fmsg	Frequency of sending message	Variable
Tmsg	Time needed for sending a msg+ACK	21 ms
Thdr	Time needed for sending just a header	7 ms

A sensor consumes Eelec = 50nJ/bit to run the transmitter or receiver circuitry and Eamp = 100pJ/bit/m2 [11] for the transmitter amplifier [10]. Thus, the energy consumed by a sensor i in receiving a k-bit data packet is given by, Eelec* k (1) While the energy consumed in transmitting a data packet to sensor j is given by the equation 1

Txij = Eelec*k + Eamp * d2ij * k --------------- (1)

Where dij is the distance between nodes i and j. [3] So main requirement is to minimize the transmission of data, for this it is thought that if redundant data is not transmitted then a lot of energy saving is possible. [10] The energy spent in transmission of a single bit is given by[9] etx(d)= et1+ed1*dn------------------ (2)

The average power consumed by a node , is calculated using the equation 3, depends on the frequency at which messages are sent through the network, denoted by Tmsg. Each message transfer adds energy to the basic costs of the wakeup circuitry (Pwu). Receiving the message also takes Tmsg time. The Table 2 describes the parameters used for the sensor node for the implementation of the proposed algorithm

Pwu=Pwu+Fmsg x ((Ttone +Tmsg) x PTX +Tmsgx PRX+ (N-1) x Thdr x PRX --------------- (3)

The average power consumed for the sensor circle with a time interval of sec is given in graph fig. 4

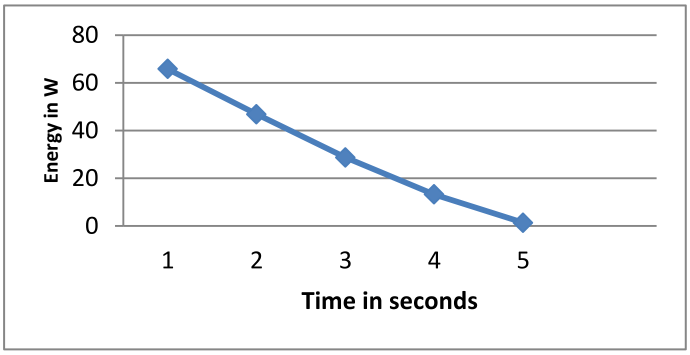

Fig 4: Total energy consumed for ideal one coverage of entire field

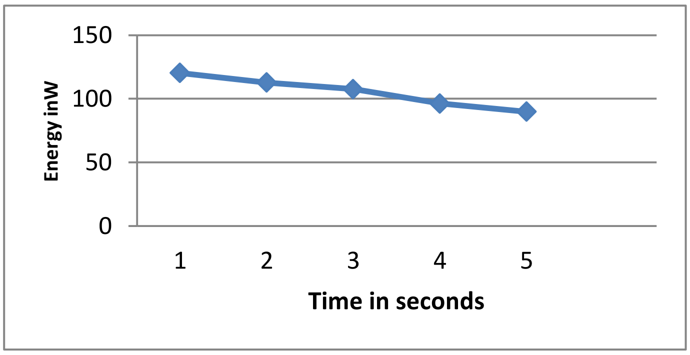

Fig 5: Energy consumed for coverage of a circular coverage approach

From the graph Fig 4 and Fig5 it is clear that the total energy consumed in the proposed algorithm is very less compared to normal sleep wake up mode. With the proposed algorithm circular coverage approach the energy of the nodes is conserved effectively

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V. CONCLUSION

WSN is exclusively used for monitoring the given environment with out any interference. But continuous coverage of a field is quiet challenging as it consumes large amount of energy. The energy aware coverage mechanism with a deterministic topology is quiet acceptable. Here we are proposing a new algorithm where the deployment of sensor node made the sensing effectively without affecting the coverage. Here the sensing field is considered as number of circular node deployment by taking the nodes in straight line and each circle has a central node act as the header node. Within the circle the nodes are made sleep and wakeup mode with another circular formation. From the results it is evident that the proposed algorithm is very efficient in power saving without the affecting of the coverage of the sensing field. For the error avoidance in the node addressing the nodes are addressed in gray code.

REFERENCES

[1] Sneha M. Patil, Archana B. Kanwade "Energy Conservation through Sleep Scheduling in Wireless Sensor Network". International Journal of Application or Innovation in Engineering & Management (IJAIEM) Volume 4, Issue 4, April 2015 ISSN 2319 – 4847

[2] "Nidhi Chaudhary , Sahil Gupta" A Survey on Coverage Problem in Wireless Sensor Network International Journal Of Engineering And Computer Science ISSN:2319-7242 Volume 4 Issue 5 May 2015, Page No. 11952-11955

[3] SEEMd -Security enabled Energy Efficient Middlewarefor WSN Linoy A Tharakan , R Dhanasekar ISBN No. 978-1-4799-3914-5/14/$31.00 ©2014 IEEE

[4] Energy Aware Data Compression in Wireless Sensor Network using an advanced RLE method – Matrix RLE (M-RLE) Linoy A Tharakan, Dr.R Dhanasekaran International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 17 (2015)

[5] Raymond Mulligan, Habib M. Ammari Coverage in Wireless Sensor Networks: A Survey Network Protocols and Algorithms ISSN 1943-3581 2010, Vol. 2, No. 2

[6] Linoy A Tharakan , Dr. R Dhanasekaran Data compression in Wireless Sensor Network associated with a noble Encryption method using Quine-Mc Cluskey Boolean function reduction method International Journal of Applied Engineering Research, ISSN 0973-4562 Vol. 10 No.55 (2015)

[7] M. Cardei and J. Wu, "Energy-efficient coverage problems in wireless ad-hoc sensor networks", Computer Communications Volume 29 Issue 4 pp. 413-420, February 2006.

[8] M. Cardei and D. Du, "Improving Wireless Sensor Network Lifetime through Power Aware Organization", Wireless Networks , Volume 11 Issue 3, May 2005

[9] Guoliang Xing , Xiaorui Wang , Yuanfang Zhang , Chenyang Lu , Robert Pless , Christopher Gill, "Integrated coverage and connectivity configuration for energy conservation in sensor networks", ACM Transactions on Sensor Networks (TOSN), v.1 n.1, p.36-72, August 2005

[10] Dr. K.K Paliwal, Israna, Panipat Rohit Anand , Priyanka Garg "Energy efficient data collection in Wireless sensor network – a survey" International conference on Advanced Computing, Communication and Networks'11

[11] Radhika and S.Malarvizhi "Middleware approaches for Wireless Sensor Networks: An Overview" IJCSI International Journal of Computer Science Issues, Vol. 9, Issue 6, No 3, November 2012

[12] Ajit Singh Negi, Neha Garg, Akhand Pratap Singh Role of Clustering in Achieving Energy Efficient Coverage in Wireless Sensor Network : A Short Review International Research Journal of Engineering and Technology Volume: 02 Issue: 02 | May-2015

[13] Ms. Priyanka Bhoyar, Mr. Sunil Gupta, Ms. Bharti Masram Progressive Sleep Scheduling for Energy Efficient Wireless Sensor Network International Journal on Recent and Innovation Trends in Computing and Communication March 2015

[14] Linoy A Tharakan, Dr.R Dhanasekaran Web Enabled Temperature Sensing Using Energy Aware WSN Node With Zigbee For Critical Sensing Environments ARPN Journal of Engineering and Applied Sciences VOL. 10, NO. 7, APRIL 2015

[15] Ranjeet S. Pisal Implementation of Data Compression Algorithm for Wireless Sensor Network using K-RLE International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 3, Issue 11, November 2014

Cite this article as: Linoy A Tharakan,Dr. R Dhanasekaran. "Energy Aware Node Deployment in Wireless Sensor Network with Straight Line Topology." *International Conference on Interdisciplinary Research in Electronics and Instrumentation Engineering (2015)*: 61-65. Print.