LAIC – An Approach to Improve the Efficiency of Wireless Sensor Network

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***Abstract*-Wireless sensor network (WSN) consists of many sensors to monitor physical or environmental conditions, such as health condition monitoring, military applications temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass the data through network to a main location. The main characteristics of nodes in wireless sensor network are low power and minimal processing, so it is essential to optimize the consumption of energy in WSN application. In this paper we introduce a new algorithm to increase life time of the sensor nodes in the network. Only few sensors are in active state in the covered regions and the remaining are in ideal. All the nodes change their status from active to ideal and ideal to active state periodically. Meantime the nodes which are in the ideal state enable for a short period to check whether the active nodes are still active or not. If there is any failure nodes in the region ideal sensor get active and sense the data. As all the nodes change their status periodically, few nodes only in active state and start to sense the data using its energy. So the energy of ideal nodes will be saved and it will be used when only when it get active. The proposed algorithm provides close to optimal enhancement in the network lifetime and the output performs six times better than the existing algorithm.**

***Index Terms*-Wireless Sensor Networks (WSNs), topology control, Start Active algorithm, Life Time, Efficiency of WSN.**

I. INTRODUCTION

A wireless sensor network (WSN) consists of devices equipped with radio transceivers that cooperate from and maintain a fully connected network of sensor nodes. The devices can be stationary or mobile. WSNs do not have fixed infrastructure and do not use centralizedmethods for organization. This flexibility enables them to be used whenever a fixed infrastructure is inconvenient, hence making them attractive for numerous application ranging from military, civil, industrial or health.

The main components of a sensor node shown in the figure.1 are transceiver, microcontroller, external memory, power source and the sensors. Microcontroller only processes the data and controls the functionalities of other components in the sensor node. General purpose desktop, Microprocessor, Digital Signal Processors, Field Programmable Gate Array and Application-specific integrated circuit can be used as a controller. Microcontrollers are the most suitable choice for sensor node and embedded system.

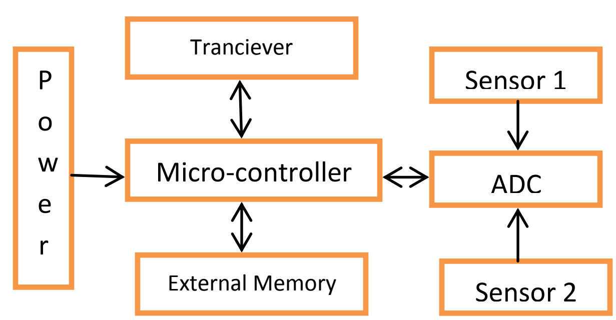

Figure 1. Sensor node Architecture

There are two major policies used for power saving. They are Dynamic Power Management (DPM) and Dynamic Voltage Scaling. DPM shuts down parts of sensor node which are active. DVS varies the power levels depending on the nondeterministic work load by varying the voltage along with the frequency; it is used to get quadratic reduction in power consumption. Sensors produce measurable response to changes in physical conditions like temperature and pressure. One of the major challenges of Wireless Sensor Network designers is to use such resource-constrained sensors to guarantee certain network requirements, such as network lifetime, sensing coverage, and end-to-end delay.

The cheap sensors are scattered densely to increase the amount of resources deployed per unit area. For example, when deploy sensors are several times denser than required, then design a scheduling scheme to make them work in batches, so that the total network lifetime can be extended [1]. However, dense deployment brings many problems, such as difficulties in network management and severe medium access control connections. Barrier coverage has several advantages over full coverage and all the points in the deployment region to be covered. But the barrier coverage needs much few sensors than full coverage [2]. The sleep wakeup problem, determines sensor's sleeping time to increase the network lifetime, is polynomial-time solvable for barrier coverage even when nodes lifetimes are not equal [3]. The sleep-wake up problem in NP-hard-even if sensor life times are identical [4] in full coverage.

II. RELATED WORK

Many researchers [8], [9], [10] , [13], [14],[15],[16], [17],[21], have addressed various methods for reducing energy consumption and increasing network lifetime during the coverage in wireless sensor networks. In [13] devise a heuristic algorithm to find the maximum number of disjoint covers a subset of nodes which can completely cover the entire surveillance region. Heuristic tries to cover fields that are covered by a small number of sensors and tries to avoid excessive use of those sensors which cover sparsely covered fields.

L.F.Wolsey delivered the mathematical programming model which was based on a decomposition of the overall problem. It consists of routing and scheduling issues, by a column generation scheme [29, Chapter 11]. The greedy approach is devised to exploit sensor spatial redundancy; even if this approach is simplistic, it better scales to very large networks and is proved to be effective in terms of performance in some scenarios.

Keith Hellman and MichealColgrosso 's study [18] focuses on the major energy efficiency issues in wireless sensor networks. Infrastructure less networks that requires multiple hops for connecting all the nodes with each other. Integration of vertical layer and criticality of energy consumption are the two main characteristics of wireless sensor networks that drive their design. The separation of network functions into layers is characterized as the original sin in networking.

A survey on coverage problems in wireless sensor networksis given in [21]. They classified coverage problems area coverage [22] to cover an area and point coverage [20], [19], [23], to cover a set of targets, and coverage problems to determine the maximal support/breach path that traverses a sensor field.

III. NETWORK SETUP

Assume the sensors deploys in a two dimensional area i.e A2DM Strip = [0,n] x [o,w(n)] where w is width and n is a node. As the set up consists of static sensor, the sensors do not move after deployment. Based on the position point process of density λ the sensor nodes are distributed randomly. So the total expected no of nodes are $\lambda n w(n)$.

All sensor nodes are assumed to have certain sensing range and every sensors can identify the environment and detect intruders with in its sensing region. The regions are partitioned into two regions. If the region covered by at least one sensor that is said to be covered region and another one is compliment to covered region. Consider that two sensor at location Li and Lj. If the sensing area of two sensors is equivalent or over laped, it is connected. If $|Li - Lj| <= 2r$ Then $|Li - Lj|$ is the distance between two sensors theconnected component of sensors intersect the left and right boundaries of the rectangle area.

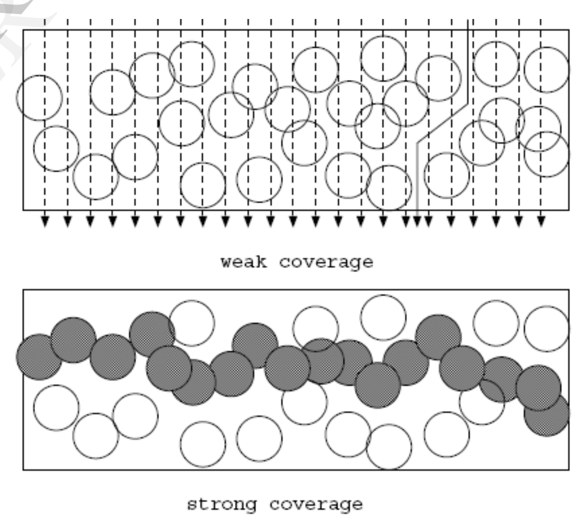

Figure 2. Weak and strong coverage

The crossing path connects one side of the region to the opposite side, where entry point and the exit point reside on the two opposite sides of the region. For a 2D rectangular area, we assume that the intruders attempt to cross the width of the stripe. The strength of coverage of a WSN can be measured by the number of times that an intruder is detected when traversing along a crossing path. If a path intercepts at least k distinct sensor then the path is said to be kcovered. If its probability tends to 1 as n->α the event occurs with high probability. Weak coverage guarantees to detect intruders on congruent crossing paths. Strong barrier coverage guarantees to detect intruders without any constraint on crossing path.

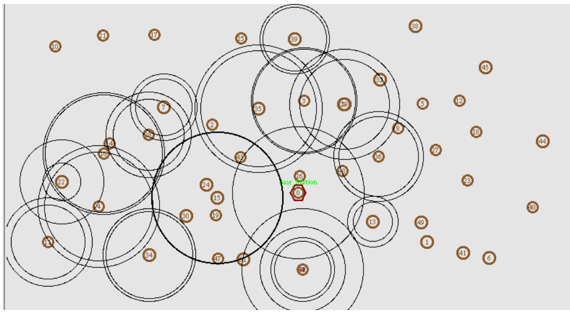

Figure 3. Network setup in simulation

Based on the proposed algorithm, all the sensors are in active state initially and it broadcasts information packet containing node id, location and life time. Node which transmits the information packet is u and the neighbor node is said to be v from the network setup Nu. Coverage area of rectangle path is A. The proposed algorithm consists of a main program and four procedures. That is LEARN, ACTIVE, IDEAL and CHECK.

Proposed Algorithm:

Step 1: According to the deployment of sensornetwork all the nodes are in active state and it calls aprocedure LEARN only once.

Step 2: After executing LEARN, every active invokesa procedure called Active in a particular timeinterval. The active nodes decide whether to stateactive or go ideal state.

Step 3: All the ideal node gets active in a particulartime interval to check whether its region is coveredby any other node. If it's covered by any other nodeagain it goes to Ideal state. Otherwise it goes toactive state to cover the region

Hence, every node u initializes a set A(u)= Φ used inActive procedure , computes and identifies the region RIu). If the procedure cannot find the region nformation R, it meansthe current sensor deployment is not sufficient to provide thecoverage, so node u sends a message indicating about this. Ifthe procedure finds the region in the network node, u sends aninformation packet to all other nodes with node Id, Positionand its life time of u. If computed region is different fromactual region for all two nodes a,b, the condition aεR(b) doesnot necessarily imply yέ R(x). Hence after all nodes have sentan information packet and the packets have reached itsdestination, all nodes u will have information about a subset ofNu Therefore Nu={v:uέR(v)}. In order for u to collectinformation about nodes in Nu – N'u = {v:i Φ R(v) and vέR(u). All nodes u in Nu – N'u reply with anacknowledgement packet.

After executing LEARN procedure, the entire node executesthe procedure Active as shown in figure 5. It decides whetherto stay in active state or to go to ideal state. The node u can goto ideal state if for every active node v such that U ε R(v), theregion will be covered without u. Some time if two nodes areeligible to go to ideal state it causes damage. To avoid thisevery node u maintains a set A(u), for all u A(i) = Φ. As timeelapses u allow the nodes to go to the ideal state but they havenot made their decisions. That will be indicated by the set ofnodes A(u). From the first step node I checks all node in A(u)including u to go to ideal state to find any coverage problem isthere. If there is no coverage problem, u then consults the nodein the network setup Nu and sends query packet to go to idealstate. After getting inquiry form node u, v sends "not required"information for u to go to ideal state again. It does if and only ifu and A(u)s going to ideal state will not the jeopardize coveredregion.

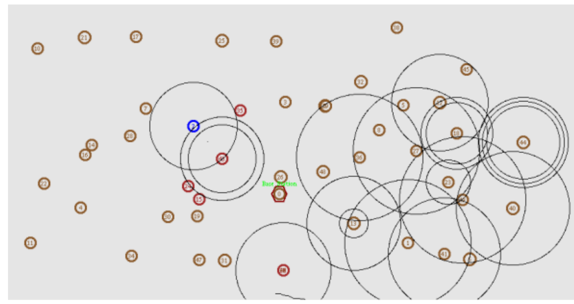

Figure 5. Broadcast information packet from u to v

In step 3 u go to ideal state if and only if it has received a"Not required" information packet from all active nodes within that region. Whether node u is in ideal or active state, itbroadcasts all nodes in Nu about its decision, so that they knowthe status. When u decides to go to ideal state it changes toideal state till time T later or until the first active sensor node inthe network is expected to failure which ever occurs earlier.

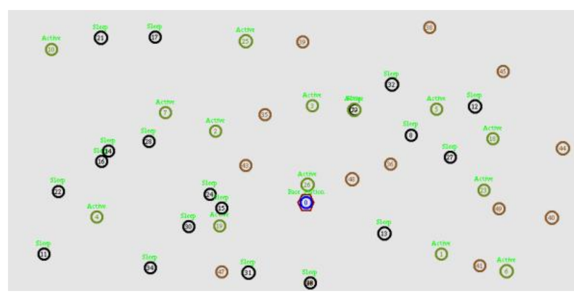

Figure 6. Active and Ideal states of Nodes

When an ideal node gets active, it executes the procedure CHECK to decide to become active or to go toideal due to failure of nodes. Firstly, u clears all records ofother nodes from the table and updates the status. Then u sendsa query packet to other nodes in the network Nu to find if theyare necessary to cover the region. Secondly node v ε Nu repliesto u mentioned whether or not it requires u to be active. Whenu is in Ideal state some nodes in the network may change theirstatus whether V replies "not required" or "required" packetcontaining its node Id, Position and life time. This will enablenode u to keep updated record of active nodes in the network. Thirdly, indicates if u received a "not required" packet and it cango to ideal state again. In case of any failure node in thenetwork, there is no reply from v and u to go to active state. Fourthly,Ideal nodes gets active in a particular time interval and updates the record and get permission to stay as ideal or active.U informs all active nodes in the network Nu if it decides tobecome active. Then V updates its record.

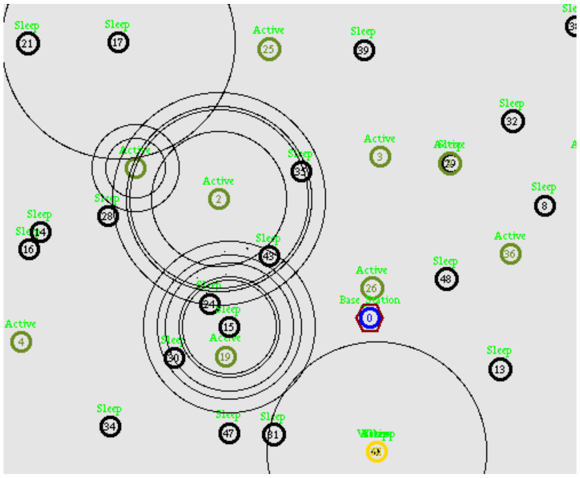

Figure 7. Simulation result of Check Procedure

IV. PERFORMANCE EVALUATION

We have simulated proposed algorithm using NS2 with 100 nodes. We define the network lifetime as the total time when the network is local or global barrier covered. We found the level of life time improvement is achieved using proposed algorithm and the global barrier coverage algorithm. To determine the improvement in life time, we compare the performance of proposed algorithm with RIS algorithm [5] [6] and vary the number of nodes from 50 to 100. The simulation result of remaining life time is based on time T shown in the graphically in Figure8 with existing and proposed algorithm. The energy exhausted during the simulation shown on the simulation result in Figure9

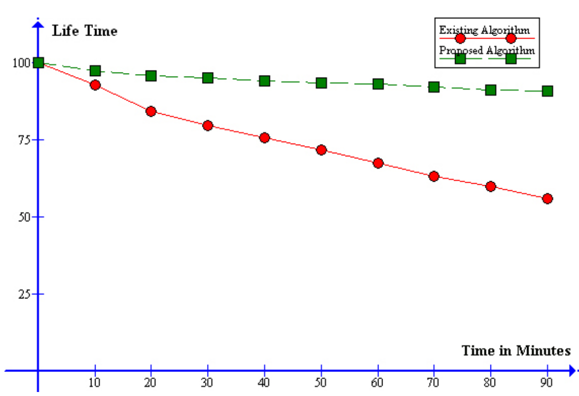

Figure 8. Simulation Graph results shows remaining life time

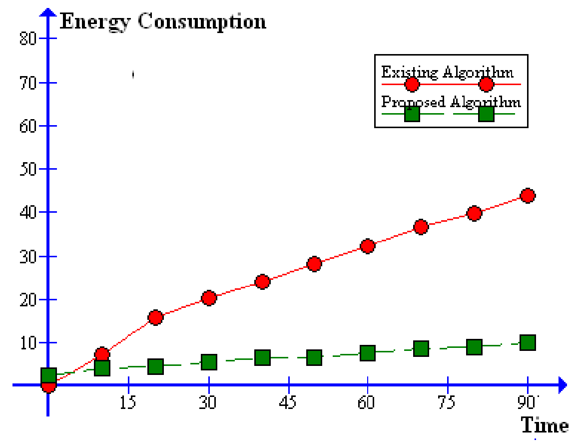

Figure 9. Simulation Result shows Energy Consumption

V. CONCLUSION

We proposed a new algorithm to improve the efficiency and increasing life time in wireless sensor network. In simulation we observe that the proposed algorithm is six time better than existing algorithm. By enabling the development of algorithms for coverage, our work might have opened up many research problems.

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