Improvement of Coverage Algorithm in WSN in Terms of Sensor Numbers and Power Amount

Iman Khandani, Reza Sabbaghi-Nadooshan, Fardad Farokhi

Electrical Engineering Department, Islamic Azad University, Central Tehran Branch, Tehran, Iran
Email: *iman.persian@gmail.com*, *r_sabbaghi@iauctb.ac.ir*, f_farokhi@iauctb.ac.ir

Abstract

Wireless sensor networks(WSN) have unique properties that distinguished them from other wireless networks and have special challenges. Not-chargeable, not-changeable and limited power supplies of sensor nodes is the most important challenge of this networks, and if the power supply of node expired, a part of data maybe lost. Because of the importance of covers in wireless sensors, in this work we have presented approaches that in their designs nodes are in special and different areas so that the hole of environment be covered and for saving power consumption, in each active period only one node is active and others are in inactive. For implementing the task cycle and avoiding from over-load of one node, the active node which have the task of sensing and maintaining the cover of area, in the next period, another node will replace it. It seems that by zoning the environment and cycle of tasks, the overall cover of wireless network improves.

Keywords: wireless sensor network, coverage, zoning, cycle of tasks.

1. Introduction

Wireless sensor networks composed of hundreds and thousands small nods, which are called sensor nodes, and these nodes cooperate with each other to do their tasks or special tasks. The wireless sensor networks are based in technical sensors, wireless relations, small embedded equipment and distributed computations. This networks exchange data to environment by sensors and gather and analyze them. Wireless sensor networks are extensively used in environment control, tracking the target, military usage, management of natural disasters and etc. (Borges et al, Prasad 2015, Manikandan et al, 2015). Wireless sensor networks have unique features that separate them from other wireless networks. Some of this features includes large number of nodes, limited use of hardware because of reducing the costs, being in inaccessible environments continuously by humans, being disposed to disrepair and etc. there are many challenges in wireless sensor networks but Not-chargeable, not-changeable and limited power supplies of sensor nodes is the most important one. So, the technique of power saving is the most important ones. If in wireless sensor networks an area isn't covered, in the other word, the data of a section of environment isn't sensing, the efficient of network in at risk. Therefore, in wireless sensor networks, coverage is one of the most important challenges (Wang et al 2015).

Proposed method for controlling over the wireless sensor networks in a way that, besides having coverage, the power consumption be at desirable level, is controllable usage of task cycle in a manner that some of nodes which have less energy and their operation doesn't have any risk for coverage, be inactive during in a defined period. For having a global coverage, the network is divided to different sections and in each sections of area, one node is active and other are inactive. The

active node must have either most energy and also fewer times have been active.

2. Related work

Different method has been proposed for wireless sensor networks that reviewing all of them is impossible. From current methods, some of them are more reliable and famous. In this text, some of them are presented briefly (Fan and Jin 2010).

Random Independent Scheduling (RIS) (Kumar et al 2012): the objective of RIS is to determine the best number of nodes that are sufficient for covering an area in a period that the nodes can be inactive to increase the life-time of network. It assumes that, based on the synchronizing method, the time is divided to cycles. In RIS, inactive method is independent and the power is efficient and low-weight, because each sensing node doesn't need to have bilateral cooperation with its neighbours, so that, the probability of a node being active is p and being inactive is 1-p. RIS method doesn't need the data of place and table of neighbours, but in confronting with unpredicted risks which destroy sensors before finish of their energy, isn't so stretch, therefore sensor nodes can't analyze their position dynamically.

In research of Nudurupati and Singh 2013, a method for increasing the cover of wireless sensor network is presented, in which the assumption is the move of sensor nodes. By mobility of sensor nodes, the coverage of networks will be improved. In this method, the network is assumed heterogeneous, that means some of nodes of network have more hardware capacity than other nodes. In this plan, the networks are divided to different areas and in each area, one node is active and others are inactive, so that the power consumption minimized. The main disadvantage of this method is heterogeneously and mobility of nodes.

The concept of Connected Dominating Set (CDS) has recently emerged as an effective method of covering areas of wireless sensor networks. The main objective of CDS methods is to maximize the number of inactive nodes and reducing power consumption. Fast inactivation of active sensors may decrease the efficiency of network. In article of AkbariTorkestan 2013, CDS is developed by name of DCDS (Degree Connected Dominating Set) for modeling the cover of wireless sensor networks. In this article, a training method for covering the network is presented which is based on LAEEC (Learning Automata-Based Energy-Efficient Coverage).

Random Backoff Sleep Protocol (RBSP) (More at al. 2014) is a research based protocol which uses the data of power consumption. Moreover, RBSP doesn't use exponential function for activation time, but most of research methods doesn't use the energy data and use exponential functions. This exponential function increases the period between continuous activation of inactive nodes. When the active node be inactive, the cover of network will be lost. For avoiding this, More at al 2014 have proposed another bachoff algorithm for computing the period of inactivation.

3. Proposed methods

In this plan, the assumption is N sensing node are randomly distributed in a two-dimensional environment by xm*ym dimension. This network is homogeneous, that means the sensing nodes have similar characteristics of hardware, no one is better. An example of this plan is presented in Figure 1. In this example, there are 200 sensor nodes and the dimension of environment is 100*100. The blue circles are sensing nodes and the black plots are stations. The first technique for covering hole of wireless sensing networks is dividing the area as figure 1. After random distribution of nodes, the environment of the node distribution will be divided to different areas. In these areas, a node is selected as the active node, which has the role of connecting with base station.

The length and width of this area would be in a manner that each node can have easy connection with other nodes of the area. In proposed plan, the diameter of each area would be the same as connecting radius of node (R_c), by this we can avoid nodes from being too small that can more complicate the plan. Connecting radius of node, is the space which node can send its signal. In this plan it is assumed that connecting radius of nodes can be increased or decrease based on the interval of target.

The process of dividing the environment is done with the base station. The design lines of figure 1 are completely hypothetical and just used for better perception of readers. Before dividing the areas, it isn't clear that which node is in which area and so we should use the interval {1, 2,…, 25} of one of the areas as its own area. After the dividing process, it will be clear that each node exactly is in which area.

At first, the base station and by this assumption that it has the capacity of mobility, will go to (40, 40) point, and send a signal. In this situation, the nodes of this area knows that they are in {1,2,3,4,5,6,7,8,9,10} areas. According to the angle of income signal and its interval from the base station, the coordinate of nodes under the base station will be separated from above ones. So one node knows that if it be above the base station is in

{1,2,3,6,7,8} areas and if it is under the base station, is in {4,5,9,10} areas. In next step, the base station will go to (40, 20) point and will send a signal. As so, the nodes in {1…5} and {2…6} areas will be separated. According to previous step, the nodes in {1,2,3,6,7,8} will divide to {1,2,3} and {6,7,8} areas and nodes in {4,5,9,10} to {4,5} and {9,10}.

After this process, each node knows its exact area. Dividing the environment to the fixed size areas is useful for equalizing the load, cover and the cycle of tasks. In each area, the node that has the most energy would be selected as the active node and the others will be inactive, so that we can save the energy consumption. Because of high load of active node in area, the process of selecting active node will repeat in defined period and in each time, may the active node be changed.

This process also named the cycle of tasks. The main goal of wireless sensing network is reading the information and sending them to the central station, which name is base station. In this plan, based on the remote station, we can solve the problem of sending data from active nodes to this station. So that, until the base station isn't in the area of active node, it wouldn't send the package, and as soon as the base station become close to active node, this node will send the package.

The base station will determine the main road in a regular period, so each node can find its place. This case solves the problem of sending signal from the base station to the node and improves its efficiency. The way of station would be as easy as possible, and like one of the base geometric shapes. In this plan, the road of base station mobility is the same as figure 2. This plan is designed in a way that the base station will pass each area.

In the course of this network, we will confront with conditions that each node of one area is completely inactive and others of this area will be uncovered. For this goal, the technical method of voting is proposed, that we will use it in this study. This plan is based on the similar data of nodes in neighbouring areas of covered areas. So we can get the null areas by averaging the data of neighbouring areas. The following formula is an estimation of data in the areas without nodes that are computed in base station.

$$Estimated\ \_Data = \frac{\sum_{area=1}^{k} Sensed\ \_Data_{area} \times Dist_{\text{area\_node,center of empty area}}}{\sum_{area=1}^{k} Dist_{\text{area\_node,center of empty area}}}$$

In this formula, the interval between the active nodes in the areas that have nodes to null areas is named as $Dist_{\text{area\_node, centre of empty area}}$ and the sensed data of this area is named as $Sensed\_Data_{area}$ and the number of active nodes is presented by k.

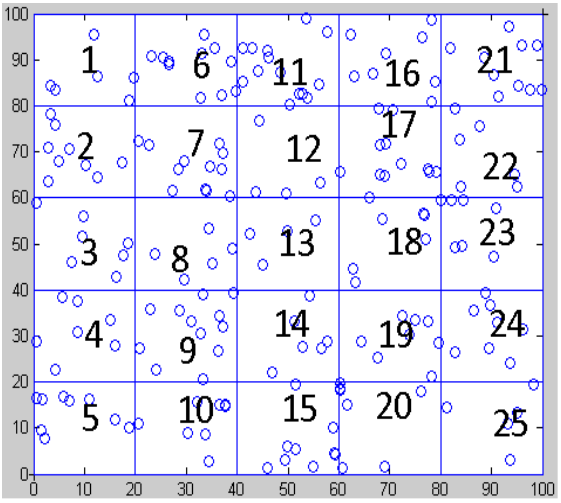

Fig. 1. Configuration of wireless sensing network

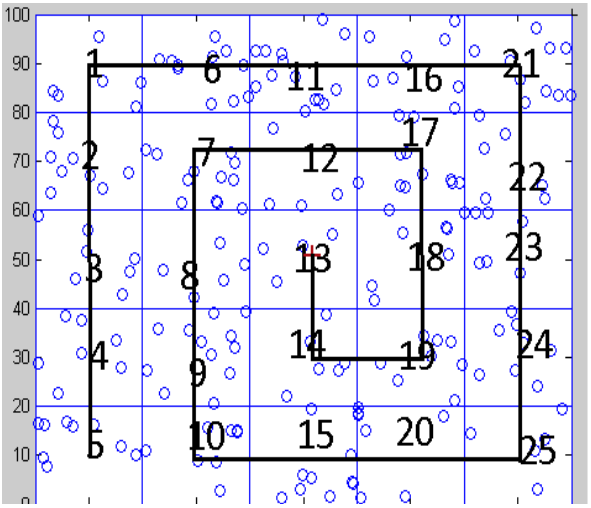

Fig. 2. The passing ways of base station.

4. Analyzing

In this section, proposed method reviewed and its operation is compared with methods of Efficient Coverage Ratio using Mobility (ECRM) (Nadarapy and sink 2013) and LEACH algorithm which is the most famous methods of clustering. The parameters of simulation are presented in table 1.

In three figures (3, 4, 5), the outcome of simulation is presented. Based on the results, the proposed method in all courses of network have better energy consumption compared to LEACH and ECRM, and in different courses, its inactive nodes were lesser than LEACH and ECRM.

Other parameters that compare to different method will be analyzed in wireless sensing networks includes First Node Die (FND),

Half Nodes Die (HND) and Last Node Die (LND). FND, HND and LND of simulation are presented in figure 5. It's clear that the first node die in proposed method is occurred later than LEACH and ECRM and this shows the efficiency of proposed method. HND and LND of proposed method are later than LEACH and ECRM and this point also shows the advantage of proposed method.

5. Conclusion

Our main objective is to improve the wireless sensing network by using the process of task cycles, in a way that the efficiency of network increases. In proposed plan, the environment of network is divided to different areas and in each area,a node is selected as the active node. Based on the results of simulation, the proposed method can significantly increase the coverage of wireless network by dividing area, cycle of tasks, mobility of base and estimation of consensus.

This improvement, that is measured by MATLAB software, compared to LEACH and ECRM, are about 60% and 20% respectively. The proposed method is compared to LEACH and ECRM, because of their similarity.

Table.1.
The parameters of simulation

Parameter	Amount
Number of nodes	200
Length of environment	100
Width of environment	100
Primary energy	0.05 J
Length of data package	4000 bit
Length of controlling package	32 bit

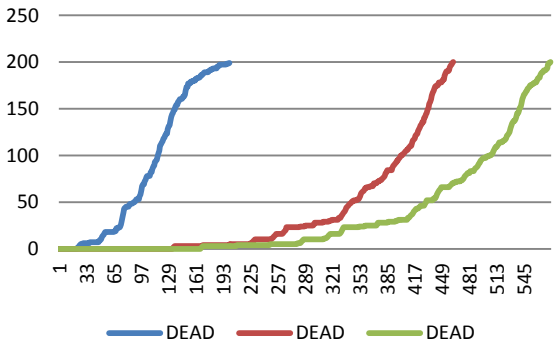

Fig. 3. Inactive nodes.

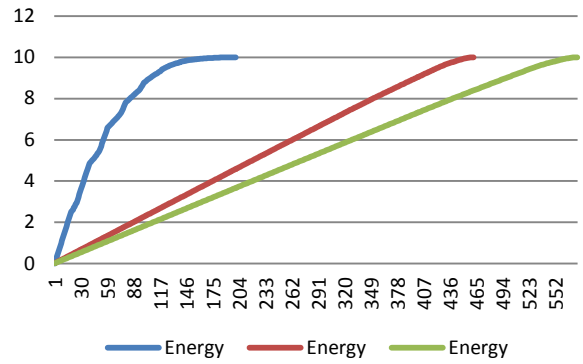

Fig. 4. Energy consumption

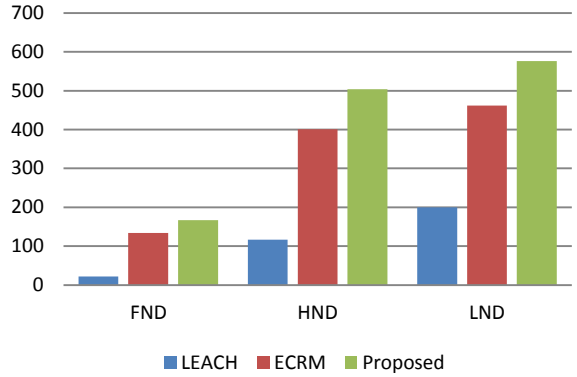

Fig. 5. FND, LND and LND

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