International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

Enhancement in Divide and Conquer Scheme with Relay Nodes to Solve the Energy Hole Problem in WSN

JagpreetSingh[1] & Satish Arora[2]
Computer and Science Engineering, Punjab Technical University Jalandhar, Punjab, India
[1]p_randhawa@rocketmail.com; [2]arora3683@gmail.com

Abstract-
In wireless sensor network, sensor nodes have the limited battery power, so in order to utilize the energy in a more efficient way several author's developed some techniques, but still there is need to reduce the energy consumption of nodes. In this paper, we introduced a new technique called as 'Divide and Rule technique' to solve the coverage hole by dividing the network field into subfield and next avoid the energy hole problem with the help of static clustering. Basically, in divide and rule scheme network area is divided into three regions namely inner, middle and outer to overcome the problem of energy consumption. We implement this work in NS-2 and our simulation results show that our technique is far better than old techniques.

Keywords- Wireless Sensor Networks (WSNs); Related Work; Protocol Design; Simulation Results

1. INTRODUCTION

Wireless Sensor Networks (WSNs) have been widely considered as one of the most important technologies for the twenty-first century. A wireless sensor network is a type of wireless network. A wireless sensor network is a wireless network that made up of a number of sensors node and at least with one base station. There are different role of Sensors in different applications. These can sense different environmental (temperature, humidity, light, etc.), underwater (water salinity, seismic monitoring, oil pollution monitoring, etc.), and human body parameters (human vital signs), etc., [2]. In wireless network a collection of nodes organized in a cooperative network. Energy saving is the crucial issue in designing the wireless sensor networks. In order to maximize the lifetime of sensor nodes, it is preferable to distribute the energy dissipated throughout the wireless sensor network. Wireless sensor network has two types-structured and unstructured. In structured wireless sensor network, the all sensor nodes are deployed in pre designed manner. In unstructured a collection of sensor nodes deployed in ad-hoc manner into a region. Once deployed, the network is absent unattended perform monitoring and reporting functions. The benefit of structure wireless sensor network is that some nodes can be deployed with lower network maintenance and management cost. Fewer nodes can be deployed at specific locations to provide coverage while ad hoc deployment can have uncovered regions. Sensor nodes are collecting data about environment, after collecting it they process it and then transmit to the base station. Many author's try to reduce the energy consumption of sensor nodes, but the demand is still there [1]. Basic characteristic of the wireless sensor network are limited energy, dynamic network topology, lower power, node failure, mobility of the nodes, short-range broadcast communication, multi-hop routing and large scale of deployment. Energy consumption and network life time has been considered as the

major issues in wireless sensor network (WSN). Firstly, placing the nodes in network is an important step, also beneficial for avoiding energy hole and coverage hole problems. Because if the first node degrade their battery then it put impact on whole area [8]. What is next, clustering is the best method to enhance the network lifetime and creating the optimum number of CH also play an crucial role, which enhance the network stability and lifetime [6].Wireless sensor networks follow some approaches for improving the lifetime of network like energy-aware technique, multi-hop routing and density control technique but these approaches still need to be improved. On the basis of network structure, routing protocol is divided into three parts: flat routing protocol, Hierarchical routing protocol and location aware [7] . In flat all the nodes have same rules i.e. nodes can sense the environment and sending the data to the base station. So it has very low network lifetime. In hierarchical the low energy nodes sense the environment and high energy nodes used to send the data to the base station. Location based routing can be used in networks where sensor nodes are able to determine their position using a variety of localization system and algorithm.

In this research work, we introduce a new clustering technique at routing layer named as Enhanced Divide-and-Conquer relay technique (EDCR). In this research we focus on two main objectives first is coverage hole and another one is energy hole [4].

2. RELATED WORK

H. Dhawan et al., describe the clustering based routing protocol Low Energy Adaptive Clustering Hierarchy (LEACH) [12]; the most effective and useful protocol in WSN. It achieves efficient energy consumption results by distributing the energy equally among nodes. But because of this random selection of nodes, sometime the node which has lower power select as a CH, which further is a negative point of this technique because it may result in network failure.

W.R. Hienzelman, et al., proposed LEACH-Centralized (LEACH-C) is an extension of LEACH, which is propose by[13]. The Leach-C basically use the combined concept of routing protocol and media access to enhance the lifetime of wireless micro-sensor network. The main point here is that the BS selects the CH according to the battery power of node, which remove the drawback of LEACH.

Peyman Neamatollahi et al. [1] explained that clustering is an effective approach for organizing the network into a connected hierarchy, load balancing, and enhancing the network lifetime. Basically, two types of clustering is used first one is static and second is dynamic. In static, once the CH is formed it can't change, whereas in Dynamic after one network operation CH is changed. This paper presents a Hybrid Clustering Approach (HCA).

Jakob Salzmann et al. introduced [3] a extension of MASCLE protocol as HEX_MASCLE, which enhance the network lifetime by changing the shape of cells. It use the combined concept of two phase cycle (2-MASCLE) and four phase cycle(4-MASCLE) to reduce the energy consumption. Simulation result shows the enhanced result as compared to predecessors.

K. Latif et. al. [4] proposed a new clustering technique namely 'Divide and Conquer' to prolong the network lifetime. In this paper author firstly divide the area into three concentric squares such as inner, middle and outer and by using

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

multi-hop communication author reduce the distance for sending information to the BS. Here author also use the mid-term algorithm to elect the CH in each region, which further collect the data from their respective sensor nodes and aggregate these all data. Next of it the aggregated data is send to the BS via multi-hop routing. Simulation results show that the energy consumption as compared to old fashioned techniques such as LEACH, LEACH-C, is far better and also show that the number of alive nodes is more.

Basilis Mamalis et.al [4] describes the concept of Clustering and described various design challenges of clustering in Wireless Sensor networks. The paper also describes various clustering Protocols including Probabilistic Clustering Approaches and Non-Probabilistic Clustering Approaches. The algorithms discussed in these protocols consider periodically re-election of Cluster Heads (rotation of Cluster Head role) among all nodes. The main drawback of these algorithms is that the time complexity of these algorithms is difficult to be kept low as the size of the Wireless sensor Networks becomes larger and larger, the extension in multi-hop communication patterns is unavoidable which increases the routing path.

Kiran Maraiya et.al [5]has presented an overview of wireless sensor network, how wireless sensor networks works and various applications of wireless sensor networks. In this paper it has been described that characteristics of wireless sensor network are dynamic network topology, lower power, node failure and mobility of nodes, short-range broadcast communication and multi-hop routing and large scale of deployment. But low power of sensor nodes is one of the limitation of wireless sensor network as in harsh environments it is difficult to replace sensor nodes so low power may cause energy hole in wireless sensor networks. Also multi-hop routing may cause more nodes deplete their energy while routing as compared to single hop routing.

3. PROTOCOL DESIGN

In this chapter we first focus on formation of cluster in order to solve the problem of energy hole and then divide the network into three sub-regions for coverage hole problem.

3.1 Cluster formation

In EDCR, static clustering is used. Nodes are randomly deployed in the each cluster and BS is located at the centre of the network. Mostly CH's elected on the basis of probability, but in our algorithm CH is selected on the basis of MID-TERM point and by using LEACH. The node which is closest to the mid-point of one region elected as CH and then by using LEACH algorithm based on energy of node, remaining CH is selected for other network operation.

Table 3.1 Notations used in mathematical model

Symbol	*Meaning*
Is	Internal Square
Ms	Middle Square
Os	Outer Square
Sn	n^{th} Segment
Sn	n^{th} Sqaure
T_r	Top right corner of internal square
T_l	Top left corner of internal square
B_r	Bottom right corner of internal square
B_l	Bottom left corner of internal square
D	Distance
a	Sensor node
b	Relay node
m	Energy of relay node
m_0	Energy of sensor node
u	For adding node in future

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

Ei(r)	Energy consumption of relay nodes
E(r)	Energy consumption of sensor nodes

Initially, network is divided into 3 concentric squares. These squares are known as internal, middle and outer regions. Following equations divided network into concentric squares –

$Tr\ (Is)\ (x2, y2) = (x1 + d, y1 + d),$ (1)

$B_r\ (Is)\ (x3, y3) = (x1 + d, y1 - d),$ (2)

$T_l\ (Is)\ (x4, y4) = (x1 - d, y1 + d),$ and (3)

$B_r\ (Is)\ (x5, y5) = (x1 - d, y1 - d).$ (4)

Where , d is the distance from the center of network field to the boundary of Is. It is also the reference distance for dividing the whole network area into concentric squares.

If we have n number of concentric squares then the corner coordinates of Sn can be calculated as:

$T_r\ (Sn)\ (xn, yn) = (x1 + dn, y1 + dn),$ (5)

$B_l\ (Sn)\ (xn, yn) = (x1 + dn, y1 - dn),$ (6)

$T_l\ (Sn)\ (xn, yn) = (x1 - dn, y1 + dn),$ and (7)

$B_r\ (Sn)\ (xn, yn) = (x1 - dn, y1 - dn).$ (8)

After deploying the sensor nodes we put relay nodes inside the internal region to prolong the lifetime of network. Because relay node has high power as compare to sensor node and its also capable for transferring the huge amount of data. The method that we use to add the relay nodes into the network is –

Popt (1+b) Ei(r) / (1+m (a+m0 (-a+b +m (-b+u))))) E(r)

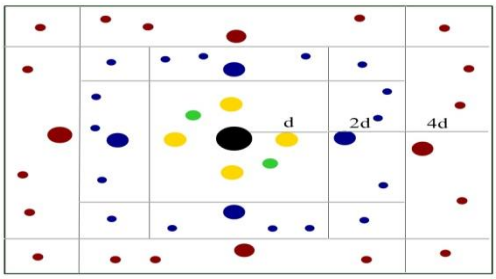

Figure 3.1 Deployed area

The inner region like where the yellow node is replaced having no CH and these nodes consumes more energy because it handle the data of outer as well as middle region. In order to reduce the consumption of nodes we put the relay node(green color) inside the internal square.

4. SIMULATION RESULTS

With the help of Network Simulation (NS-2) we generated the network with 41 nodes. The simulation result has been taken out in the NS-2 tool. There are number of packets shown on y-axis and time is given on x-axis in seconds.

International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 10, October 2015
Available at http://internationaljournalofresearch.org

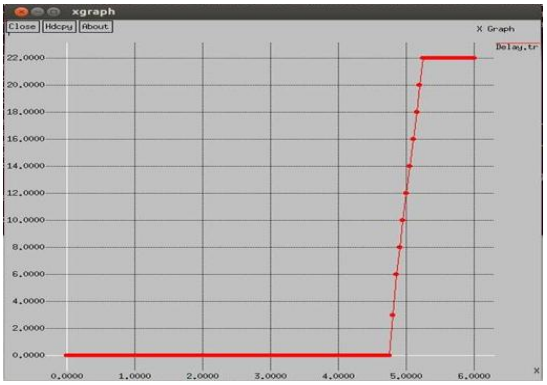

Figure 4.1 Delay

The figure 4.1 shows the experimental results of Delay of packets. Which are very less as compared to previous techniques.

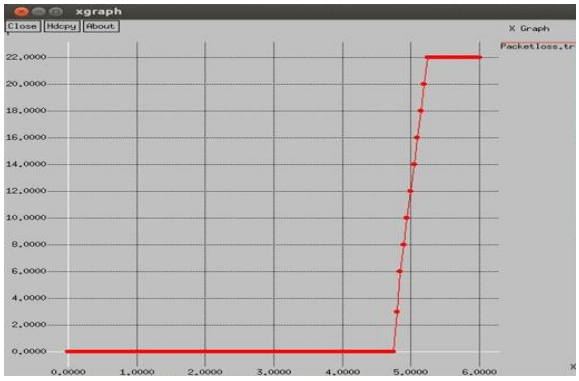

Figure 4.2 Packet Loss

The figure 4.2 shows the experimental results of Packet loss. For the packet loss the experimental results of the proposed novel technique are better than the existing technique.

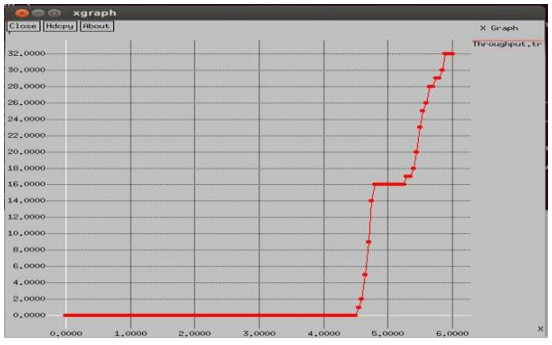

Figure 4.3 Throughput

The figure 4.3 shows the experimental results of throughput. As compared to previous one, now more packets is transmitted.

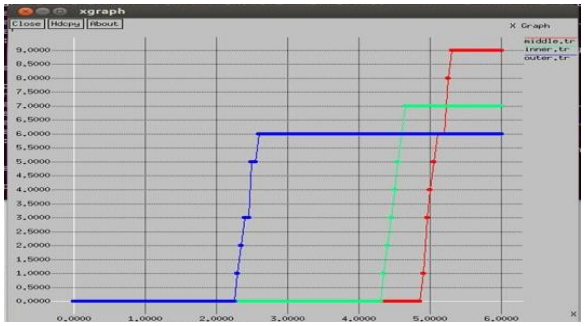

Figure 4.4 Energy consumption (inner, middle, outer)

We show the enhanced result than old fashioned techniques. Now the internal square consumes less energy and network lifetime is extended.

5. CONCLUSION

In this article, our main objective is energy efficient routing, and by using static clustering as well as the concept of dividing the network into sub-regions we reduce the energy consumption. Moreover, multi-hop communications also reduce the distance between nodes and regions. By selecting the CH on the basis of mid-term point and LEACH we show that our technique produced more effective results in terms of energy, throughput, delay and packet loss. In future, we may replace the inner region sensor nodes with relay nodes to extend the lifetime of network.

ACKNOWLEGEMENT

I would like to place on record my deep sense of gratitude to Er. Satish Arora for his generous guidance, help and useful suggestions and supervision throughout the course of research work.

REFERENCES

[1] Peyman Neamatollahi, Hoda Taheri, Mahmoud Naghibzadeh "A Hybrid Clustering Approach for Prolonging Lifetime in Wireless Sensor Networks" International Symposium on computer networks and distributed systems (CNDS), pp. 170 – 174, 2011 IEEE.

[2] Senouci, M.R., Mellouk, A., Senouci, H. and Aissani, A , 'Performance evaluation of network lifetime spatial-temporal distribution for WSN routing protocols', Journal of Network and Computer Applications, Vol. 35 Issue 4, pp. 1317– 1328, ISSN 1084-8045, 2012.

[3] Jakob Salzmann, Ralf Behnke, Dirk Timmermann "Hex-MASCLE – Hexagon based Clustering with Self-Healing Abilities" Wireless Communications and Networking Conference (WCNC), pp. 528-533, 2011 IEEE.

[4] K. Latif, A.Ahmad, N.Javaid, Z.A. Khan, N. Alrajeh ,"Divide-and-Rule Scheme for Energy Efficient Routing in Wireless Sensor Networks" 4th International Conference on Ambient Systems, Networks and Technologies (ANT), pp. 340-347, 2013.

[5] B. Mamalis, D. Gavalas, C. Konstantopoulos and G. Pantziou, "Clustering in Wireless Sensor Networks", RFID and Sensor network, pp. 323, 2009.

[6] K. Maraiya, K. Kant, N. Gupta, "Efficient Cluster Head Selection Scheme for Data Aggregation in Wireless Sensor Network" International Journal of Computer Applications, Volume 23-No. 9, 2011.

[7] K. Maraiya, K. Kant, N. Gupta, "Application based Study on Wireless Sensor Network" International Journal of Computer Applications (0975 – 8887), Volume 21– No.8,pp. 9-15,2006.

[8] A.A. Kharazian, K. Jamshidi and M.R. Khayyambashi, "Adaptive clustering in wireless sensor network: considering nodes with lowest energy ", International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC) Vol.3, No.2,2012.

[9] A.K. Somani, S. Kher, S. Paul, and J. Chen, "Distributed Dynamic Clustering Algorithm in Uneven Distributed Wireless Sensor Network",2006.

[10] A. Sahu, E.B. Fernandez, M. Cardei, and M. VanHilst "A Pattern for a Sensor Node"Department of Computer and Electrical Engineering and Computer Science Florida Atlantic University, Boca Raton, FL 33431,2011.

[11] B. Amutha , M. Ponnavaikko N.Karthick and M.Saravanan, "Localization algorithm using varying speed mobile sink for wire", International Journal of Ad hoc, Sensor & Ubiquitous Computing (IJASUC) Vol.1, No.3,2010.

[12] H. Dhawan , S. waraich, " A Comparative Study on LEACH Routing Protocol and its Variants in Wireless Sensor Networks: A Survey", International journal of computer applications , Volume95-No.8,2014.

[13] Heinzelman, W.R., Chandrakasan, A.P. and Balakrishnan, H., 'An application-specific protocol architecture for wireless microsensor networks,' Wireless Communications, IEEE Transactions on , vol.1, no.4, pp.660–670, doi: 10.1109/TWC.2002.804190,2002.