Global Journal of Computer Science and Technology
Network, Web & Security
Volume 13 Issue 9 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 0975-4172 & Print ISSN: 0975-4350

Increase the Alive Nodes based on the Cluster Head Selection Algorithm for Heterogeneous Wireless Sensor Networks

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GJCST-E Classification : *C.2.1*

Strictly as per the compliance and regulations of:

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Abstract - The use of Wireless Sensor Networks (WSNs) is estimated to bring enormous changes in data gathering, processing and distribution for different environments and applications. However, a WSN is a powerful controlled system, since nodes run on limited power batteries. Prolong the lifetime of sensor networks depends on efficient management of sensing node of energy. Hierarchical routing protocols are best known in regard to energy efficient. By using a clustering technique hierarchical routing protocol greatly minimize the energy consumed in collecting and distributing the data. The proposed protocol focuses on reducing the energy consumption and increasing the energy efficiency and also increasing the number of alive nodes of wireless sensor networks better than exiting protocol.

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I. Introduction

The Wireless Sensor Networks (WSN) [1, 2, and3] is a broadcast network consists of a large number of sensor nodes that are limited in energy, processing power, storage and sensing ability. The WSN based on routing techniques that handles more complex functions. The energy of nodes is the most important consideration among them because the lifetime of Wireless Sensor Networks is limited by the energy of the nodes. Thus, a network of these sensors gives increase to more robust, reliable and accurate network.

The WSN is used the two types of networks homogeneous and heterogeneous. The homogeneous mixture is a mixture where the components that make up the mixture are uniformly distributed throughout the mixture. The heterogeneous mixture is a mixture where the components of the mixture are not uniform or have localized regions with different properties, but heterogeneous networks are more efficient than the homogeneous network in WSN.

LEACH (Low-Energy Adaptive Clustering Hierarchy) [4] is a clustering-based protocol and one of the first hierarchical routing approaches for sensor networks that utilizes the randomized rotation of local cluster base stations to evenly distribute the energy load within the network of sensors. In LEACH, the cluster head (CH) nodes reduce the data arriving from nodes that belong to the particular cluster, and send an aggregated data to the base station in order to reduce the amount of information that must be transmitted to the base station. WSN is considered to be a dynamic clustering method. The dynamic is changing the network parameters.

We use the concept of heterogeneity and tried to improve the LEACH [5] algorithm. In this approach, cluster head gets the data from nodes of the cluster and aggregate the data before sending it to the base station. In each round cluster head rotates and consumes the same energy, hence it utilizes the uniform energy distribution for the whole network. The LEACH protocol follows the concept of nodes homogeneity, which means that entire nodes have same initial energy. But practically it is visible that the network is not pure homogeneous. The heterogeneity, which means some of the nodes of the sensor network are equipped with additional initial energy, this type of sensor network is called heterogeneous wireless sensor network. This protocol of LEACH does not give good result so we have to provide some modification in the existing protocol.

LEACH is a cluster based routing protocol and one of the hierarchical based routing [6] protocols. Hierarchical based routing is to efficiently maintain the energy consumption of sensor nodes and communication between a number of nodes within a particular time and by performing data aggregation and data fusion. Data fusion helps to reduce the amount of data transmitted between sensor nodes and the base station.

The new proposed protocol is an energy efficient communication protocol for WSN. The communication takes place between all the cluster members and cluster heads. The cluster heads can perform data aggregation for communicating to the Base Station. The number of transmission is reduced from cluster to base station known as data aggregation. The new protocol can achieve energy efficiency, reduces energy consumption and increasing the number of a live nodes in every round than existing algorithms.

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The paper is organized as follows: Section II describes the assumptions used for the related work. In Section III describes the design of LEACH protocol and new proposed protocol in detail. The simulation result is discussed in Section IV. Finally conclusions made in Section V.

II. Related Work

WSN involves so many clustering techniques such as LEACH [7, 8], EEAP [9], En-LEACH [10], EERR [11], EAPHRN [12], and I-LEACH [13] for balancing the energy consumption, increase the energy efficiency and increase the lifetime of the sensor network. LEACH (Low Energy Adaptive Clustering Hierarchy) [7] is one of the important clusters based structures, in wireless sensor networks. LEACH uses a TDMA technique based MAC protocol, and in order to maintain balanced energy consumption. TDMA (Time Division Multiple Access) is a more flexible scheme which comprises all technologies that allocate certain time slots for particular communication means that the receiver can stay at the same frequency the whole time. LEACH protocol is used to reduce the energy consumption of the network resource in each round.

LEACH protocols [8] highly affect the performance of wireless sensor networks by an even distribution of energy load and decreasing their energy consumption and prolonging their lifetime. Thus, designing energy efficient protocols is important for prolonging the lifetime of wireless sensor networks. Leach-Heterogeneous System provides better energy efficiency and increasing the lifetime of the wireless sensor networks than homogeneous networks.

Energy-Efficient Adaptive Protocol for Clustered Wireless Sensor Networks (EEAP) [9] is used to increase the lifetime of the sensor networks by balancing the energy consumption of the nodes. EEAP makes the high residual energy node to become a cluster-head. The elector nodes are used to collect the energy information of the neighbor sensor nodes and select the cluster-heads and increase the energy efficiency.

In En-LEACH [10], all cluster members are reserved informed about the cluster head, since the probability of breakdowns of cluster-head is high during the data transmission phase. En-LEACH is more effective; producing the information about the nodes are monitoring in an energy-efficient. En-LEACH is able to handle non-uniform energy distribution of sensor nodes which is an important characteristic of a dynamic sensor networks.

EERR (Energy Efficient and Reliable Routing protocol) [11] is an extension of leach where the cluster head is called headset. The headset consist the number of nodes and each node will be acting like a cluster head in a particular time interval. Two types of phases. In the election phase the cluster head is selected on a random basis.CH node is an advertising message to all nodes in the network using a CSMA MAC protocol. Each node transmits a unite request message to the CH as an acknowledgment. Using this CH forms a headset. The headset is followed by TDMA schedule and transmits this schedule to the nodes in the cluster. In this data transfer phase, all the non-cluster head nodes will collect the information and transmit it into the headset. Then the headset transmits or sends it into the base station. The next new round all the nodes are taken as a normal node and the process will continue further.

EAPHRN (Energy aware PEGASIS based Hierarchical routing protocol) [12] is a hierarchical chain based routing protocol. In EAPHRN, the nodes can select randomly forms a group of possible nodes but within the distance threshold DT. In EAPHRN divided into two phases. In the first phase chain set up, each node must be calculate the local DT (LDT). It is an average distance between the node and the neighboring node in the network. LDT threshold is computed, after that, the node sends to the BS. BS collects all the LDT from the number of nodes and calculated the DT. Then it sends the DT to the number of nodes in the WSN to start forming the chain. Finally, when the chain formed, choosing a chain leader is based on the leader is a closest node to the BS. Once chain leader received the data it aggregates and sends it in to BS.

I-LEACH (Improved LEACH) [13] is enhanced from the leach protocol. I-leach solves the problem of node heterogeneity. In I-leach the selection of cluster head is based on the residual energy rather than probability. If the nodes have different initial energy levels instead of uniform initial energy level, they selection of cluster head can be prepared effectively. I-Leach each node will have a CH in their neighborhood. It improves the lifetime of the network.

III. Protocol Performance

a) LEACH Protocol

Low-energy adaptive clustering hierarchy (LEACH) is one of the most popular hierarchical routing algorithms for wireless sensor networks. Is protocol architecture for micro sensor networks that combine the ideas of energy-efficient cluster-based routing and media access together with application-specific data aggregation to achieve good performance in terms of system lifetime, latency, and production cost.

Calculate the distance (d_0) by using energy per bit (E_{fs}) divide energy per area (E_{mp}).

$$d_0 = \frac{E_{fs}}{E_{mp}} \quad (1)$$

i. *Cluster Heads Selection Algorithm*

$$T(n) = \begin{cases} \dfrac{P}{\left(1-P*mod\left(r,round\left(1/P\right)\right)\right)} & n \in G \\ 0 & Otherwise \end{cases} \quad (2)$$

With P is the cluster-head probability, r is the number of the round and G is the set of node. This algorithm ensures that every node becomes a cluster-head exactly once within rounds. Although the randomization of electing cluster head nodes can distribute the load among the network. Cluster heads have changed randomly over time in order to balance the energy dissipation of nodes. This decision is made by the nodes are choosing a randomly the values of each node between 0 and 1. If random $< T(n)$, means the sensor node becomes the cluster-head, otherwise it is a cluster member.

a. *Minimum Distance*

Find the minimum distance for the election of an associated cluster head for by m_d.

In LEACH we need to find the minimum distance in order to send data from the base station to cluster head.

$$m_d = \sqrt{(XR(i)-C(c).xd)^2+(YR(i)-C(c).yd)^2} \quad (3)$$

If the minimum distance greater than the initial energy

$$E_d = E_d-(ETX*(cpl)+E_{mp}*cpl*(m_d{}^4) \quad (4)$$

In the Eq. (4) E_d is the initial energy of each node. The ETX is the transmitted the energy. Length of packet (cpl) sends the packet between the base stations to the cluster head.

Length of packet (*pl)* sends the packet between the base station to cluster head.

$$E_d = E_d-(ETX*(pl)+E_{mp}*pl*(m_d{}^4) \quad (5)$$

Two types of transmitting amplifier, first one E_{fs} and second one E_{mp}. E_{fs} is the energy per bit and E_{mp} is the energy per area.

If the minimum distance less than the initial energy

$$E_d = E_d-(ETX*(cpl)+E_{fs}*cpl*(m_d{}^2) \quad (6)$$

$$E_d = E_d-(ETX*(pl)+E_{mp}*pl*(m_d{}^2) \quad (7)$$

b) New Protocol

The main aim of the new protocol is the hierarchical routing is to efficiently maintain the energy consumption and increasing the energy efficiency of sensor nodes by performing data aggregation and data fusion in order to decrease the number of transmitted between the cluster head and the base station. All sensor nodes are identical and charged with the same amount of initial energy. The new protocol can achieve energy efficiency, reduces energy consumption and increasing the number of alive nodes in each on every round than existing algorithms.

Protocol based dynamic clustering method. Dynamic routing allows routing is to change the possible routes. In case of wireless sensor networks dynamic routing is employed because nodes may frequently change their position and die at any moment.

i. *Cluster Head Selection Algorithm*

In the Eq. (8), *p* is the percentage of cluster heads over all nodes in the network, i.e., the probability (0.05) that a node is selected as a cluster head; r the number of rounds of selection; and G is the set of nodes that are not selected in round 1/p. E_0 is the initial energy (0.5 J) divided by the number of nodes and multiply the X is the optimal cluster head number. As we can see here, the selection of cluster heads is totally random.

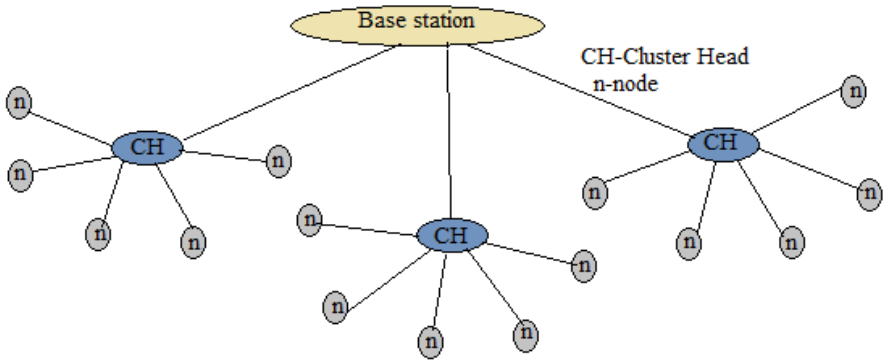
$$T(n) = \frac{P}{\left(1-P*mod\left(r,round\left(1/P\right)\right)\right)} - \left(E_0/(n*X)\right) \quad (8)$$

$$X = \left(\frac{n}{2}*\frac{22}{7}*d_0*sqrt\left(M/d_{bs}\right)\right) \quad (9)$$

Where *X* is the optimal cluster head number, n is the total number of sensor nodes, M (10) is the length of nodes distributing fields, d_{bs} (30) *is* the distance between the nodes and the Base Station.

Fig. 1 First select particular node, that node is known as cluster head and joining the number of nodes with cluster head. Number of individual nodes are connected is known as clustering. All clusters are having one cluster head which performs data collection and data fusion. Clustering is the method by which sensor nodes in a network organize themselves into hierarchical structures. Cluster head provides data communication and data aggregation also. It is the number of nodes that sends data to the sink directly after aggregating the data.

Figure 1 : Communication between all the nodes in Cluster Head and Cluster Head for Base Station



Each on every node sends the data to its own cluster head. There are two steps in Data transmission. Firstly, data are transmitted to cluster head nodes and second step the data aggregation takes place from cluster head to base station.

a. *Minimum Distance*

Minimum Distance for only nodes:

The minimum distance is called based on Eq. (3)

Minimum distance from cluster head:

$$E_d = \begin{cases} E_d - \left(ETX + E_{mp} * {m_d}^4\right) & m_d > do \\ E_d - \left(ETX + E_{fs} * {m_d}^4\right) & otherwise \end{cases} \quad (10)$$

In the Eq. (4) E_d is the initial energy of each node. The *ETX* is the transmit energy (5×10^{-8}). Two types of transmitting amplifier, first one E_{fs} and second one E_{mp}. E_{fs} Is the energy per bit (10^{-11}) and E_{mp} is the energy per area (1.3×10^{-15}). m_d Is the minimum distance from cluster head. C_{md} Is the initial energy for a minimum distance of the cluster. Two types energy (*ETX, ERX*), *ETX* and *RTX* (5×10^{-8}) are the transmit energy and receive energy, In Eq.11 using the receive energy. l Is the length of the packet (6400) are multiplied when the minimum distance greater than zero otherwise using cl is the length of control packet (200), the initial energy is divided by residual energy. They are using transmit the packet between cluster head to the base station.

$$C_{md} = \begin{cases} (ERX * l * m_d * Eo/res) & (m_d > 0) \\ (ERX * cl * m_d * Eo/res) & otherwise \end{cases} \quad (11)$$

In Eq. 12 using the receive energy (ERX), the receive energy is 5×10^{-8} and energy per area are multiplied when the minimum distance is greater than distance otherwise using the energy per bit for increase the number of alive nodes in each round.

$$C_{md} = \begin{cases} \left(ERX * E_{mp} * m_d * Eo/res\right) & (m_d > d_0) \\ \left(ERX * E_{fs} * m_d * Eo/res\right) & otherwise \end{cases} \quad (12)$$

IV. Simulation Result

The performance of new protocol was analyzed using MATLAB. The number of rounds(r=10,000) is considered in X axis and the number of alive nodes (n=100) in Y axis.

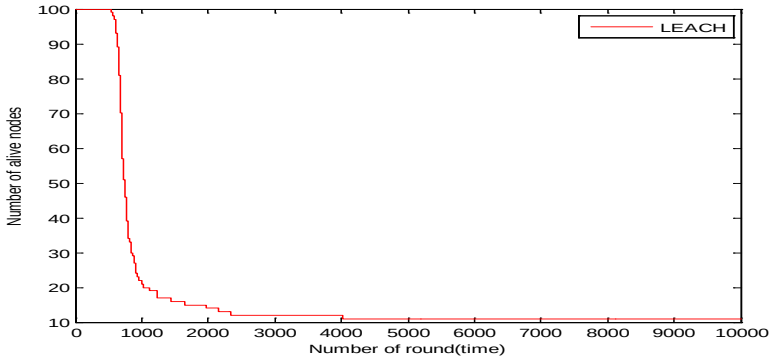


Figure 2 : LEACH Protocol

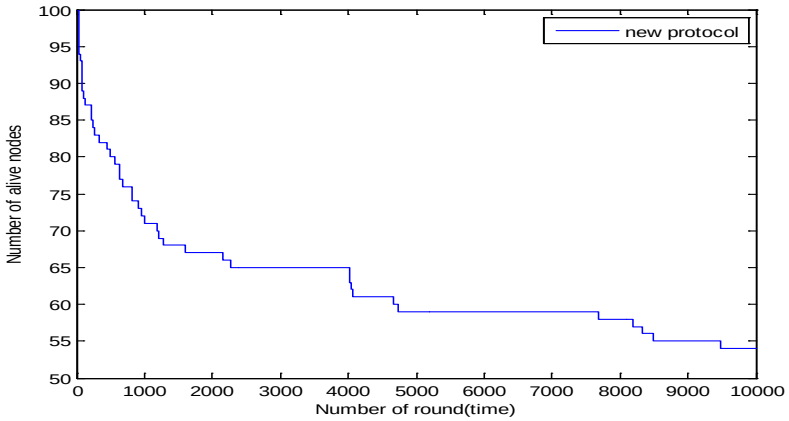


Figure 3 : New Protocol

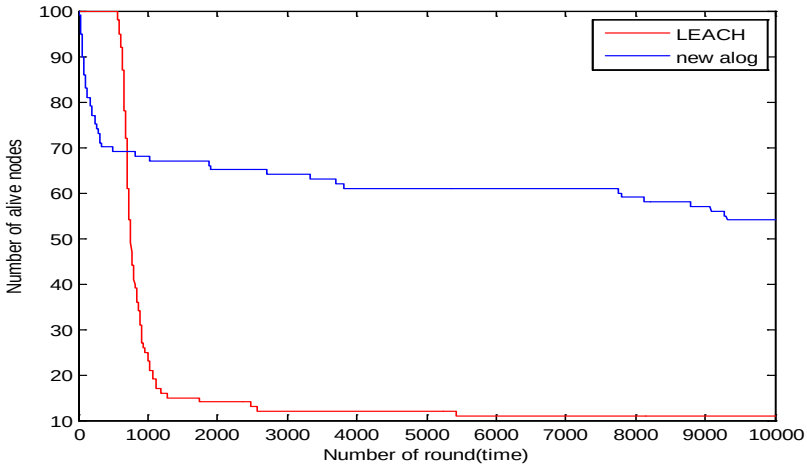


Figure 4 : Comparative analysis of LEACH and new protocol

Figure 2 shows the energy efficiency of the LEACH algorithm. Rounds increases from 0 to 10,000. The number of alive nodes was calculated for each round in order to find the energy efficiency of the network. The existing algorithm increasing the number of alive is 20 percentages. Figure 3 shows the energy efficiency of the new algorithm. Rounds increases from 0 to 10,000. The number of alive nodes was calculated for each round in order to find the energy efficiency of the networks. In the new protocol of heterogeneous system is number of alive nodes is increased near to 60% than the leach heterogeneous system and lifetime of the networks also increased. From the comparative analysis of figure 4, we analyze that the number of alive nodes is increasing in newer protocol than LEACH protocol.

V. Conclusion

LEACH protocol is one of the routing protocols based on clustering algorithm to calculate the energy efficiency of the network. A new protocol was proposed based on existing LEACH protocol to save the energy of the network. Energy efficiency was analyzed by calculating the number of alive nodes in the network by considering the number of rounds. The performance analysis using MATLAB shows that the number of alive nodes is increasing in each round than exiting algorithm. Thus the new protocol is suitable to save the energy of the network, increasing the number of alive nodes and energy efficient.

References Références Referencias

1. Akyildiz, W. Su, Y. Sankarasubramaniam and E. Cayirci, "A survey on sensor networks," IEEE Communications Magazine, vol. 40, no. 8, pp. 102–114, August 2002.
2. I.F. Akyildiz, W.J. Su, Y. Sankarasubramaniam, E. Cayirci, Wireless sensor networks: a survey, Computer Networks 38 (2002) 393–422.
3. K. Akkaya, M. Younis, A survey on routing protocols for wireless sensor networks, Ad Hoc Networks 3 (3) (2005) 325–349.
4. Baiping Li, Xiaoqin Zhang "Research and Improvement of LEACH Protocol for Wireless Sensor Network" International Conference on Information Engineering *Lecture Notes in Information Technology, Vol. 25 -2012.*
5. W. R. Heinzelman, A. P. Chandrakasan and H. Balakrishnan, "Energy efficient Communication protocol for wireless Microsensor networks," *Proceedings of 33rd Hawaii International Conference on System Sciences (HICSS)*, 2000.
6. W.R. Heinzelman, A.P. Chandrakasan, H. Balakrishnan, An application-specific protocol architecture for wireless microsensor networks, IEEE Transactions on Wireless Communications 1 (4) (2002) 660–670.
7. Mortaza Fahimi Khaton Abad, Mohammad Ali Jabraeil Jamali "Modify LEACH Algorithm for Wireless Sensor Network" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011.
8. R. Saravanakumar, S. G. Susila, J. Raja "Energy Efficient Homogeneous and Heterogeneous System for Wireless Sensor Networks" *International Journal of Computer Applications (0975 – 8887) Volume 17– No.4, March 2011.*
9. K. Padmanabhan , Dr. P. Kamalakkannan "Energy Efficient Adaptive Protocol for Clustered Wireless Sensor Networks" IJCSI International Journal of Computer Science Issues, Vol. 8, Issue 5, No 1, September 2011 ISSN (Online): 1694-0814
10. Mr. Halke Rajesh 1, Mrs. Kulkarni V. A." Design of Enhanced LEACH Routing Protocol for Wireless Sensor Network" *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) ISSN: 2278-2834, ISBN: 2278-8735, PP: 07-12*
11. Padmavathy, T. V, Chitra M "EERR: Performance Evaluation of Energy Efficient and Reliable routing protocol for wireless sensor networks" Data management and network control in wireless networks (SICN), Volume(0), Issue(0): 2011.
12. Hasan Al. Hasan, Mohammad qatawneh, Azzam Sleit, Wesam Almobaideen "EAPHRN: Energy aware PEGASIS Based Hierarchical Routing protocol for wireless sensor networks" Journal of American science, 2011.
13. Naveen kumar, Mrs. Jasbir kaur "Improved Leach Protocol for Wireless sensor Networks", IEEE, 2011.