ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

A Review on LEACH & PEGASIS Routing Algorithms in Wireless Sensor Networks

Neelima Arora[*1], Charanjit Singh[2]
[*1,2] Department of ECE, M.tech ECE ,Punjabi university, Patiala, Punjab, India
aneelima2421@gmail.com

Abstract

Wireless Sensor Networks have energy constraints, low-data-rate of high redundant and data flow of high-to-one, and so on. Energy effectiveness is the key performance indicators of wireless sensor networks. One of the weaknesses of wireless sensors networks (WSN) is the limit of energy which affects network's lifetime. Based on the analysis of energy management strategy in the wireless sensor networks, the main factors affecting energy consumption are: perceptual data, data processing and radio communications, the radio communication is the main part of energy consumption. In the wireless sensor networks, the realization of energy-efficiency could be improved while in the different layers of communication protocol stack. However, as the basis of the limitations of the physical layer, the improvement is focus on design and implementation of network layer protocol. The researchers agreed that the clustering of nodes in wireless sensor networks is an effective program of energy conservation. This paper dedicated to research the two clustering routing algorithm (LEACH & PEGASIS) in wireless sensor networks.

Keywords: Wireless Sensor Networks ; Clustering routing algorithm ; LEACH routing algorithm ;PEGASIS routing algorithm.

Introduction

Wireless sensor networks [1] have been paid much attention due to their rich application in different domains (scientific, medical, military)A WSN is formed by tens to thousands of sensor nodes deployed in a target field are organized into an ad hoc network through which they transmit their collected data to a remote base station (BS). One of crucial challenges in the organization of sensor networks is energy efficiency, because battery capacities of sensor nodes are severely limited and their replacement is often impractical. Once sensor nodes run out their batteries, the sensor network doesn't work anymore. Most of battery energy is consumed by receiving and transmitting data. In order to maximize the lifetime of WSN, it is necessary for communication protocols to prolong sensor nodes' lifetime by minimizing transmission energy consumption sending data via paths that can avoid sensor nodes with low energy and minimizing the total transmission power So, various network architectures and different protocols for saving energy consumption and extending the lifetime of sensor networks have been proposed in the literature. Among them, cluster-based network organization using a hierarchical routing [2], [9] is considered as the most favourable approach in terms of energy efficiency. Higher energy nodes can be used to process and send the information while low energy nodes can be used to perform the sensing in the proximity of the target. Consequently, it results a better saving of energy. Two large routing approaches use the hierarchical routing. First, a cluster-based organization, and second a chain-based organization.

Architecture of WSN

Architecture of the wireless sensor network[14] is depicted in Fig. 1.

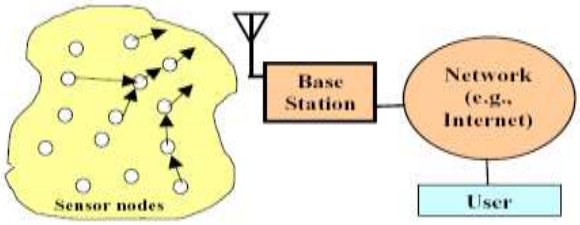

Fig. 1. The architecture of a wireless sensor network

In the wireless network ,the sensor nodes is base unit. WSNs connect the physical world to computer networks by deploying hundreds to

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

thousands of sensor nodes and gather information from the sensor nodes. In addition to sensing, the wireless sensor nodes can process the acquired information, transmit messages to the BS, and communicate to each others.

LEACH : Cluster Based Approach

LEACH Algorithm Process

Cluster sensor aggregation presents many advantages: while reducing routing algorithm complexity, and optimizing the access to the medium resource by performing it locally via a cluster-head. In addition, it facilitates data aggregation, and simplifies the network management(particularly, addressing management), and finally it makes the network more scalable [5].

LEACH[13] is low-power, adaptive and clustering routing algorithm, which is made for WSN by Chandrakasan in MIT. And compared to the general flat multi-hop routing protocols and static clustering algorithm, LEACH can extend the network life-cycle of 15%, mainly through the randomly selected sub-cluster leader and shared equally between the relay communication services to achieve the network life-cycle. LEACH defines the concept of "round". And one round consists of two phases which is the initialization phase and stability phase. In order to avoid the extra processing cost, the stabilization phase lasting a relatively long time. In the initialization phase, cluster head election process is as follows: Sensor node generates a random number range 0-1. If this random number is less than the threshold T (n), then it releases the information that he is the cluster head node to the nodes within the cluster. In each round of circulation, if the node has been elected as cluster head, then put the T (n) to 0, so that the node will not be elected as cluster head in the next round of re-elected. For the nodes, which had not elected as cluster head node, it will be elect as the cluster head node by the probability of T (n).

As the number of elected cluster head nodes increased, the threshold T (n) is even greater for the remaining node which had not be elected as the cluster head node, the probability of generating the random number which is less than T (n) is greater, therefore, the probability of one node to be cluster head node is greater. When only a node is not elected, T(n) = 1, so this node will be elected. T (n) formula can be expressed as:

$$T(n)=\begin{cases}\dfrac{P}{1-P\times\left(r \bmod \dfrac{1}{P}\right)} & \text{if } n\in G\\ 0 & \text{otherwise}\end{cases}$$

Where P is the percentage of cluster head node in all nodes, r is an election rounds, r mod (1 / P) is on behalf of the number of node which was elected as cluster head nodes in the cycle, G is the node set which is not elected as a cluster head node in this cycle.

After node is selected as cluster head, it will broadcast the information that he is the cluster head to the rest of the nodes in the same cluster. The remaining nodes decide to join the cluster according to the size of the received signal, and return the join signal. When the cluster head receives all join messages, it will allocate TDMA time slot information to all the nodes in the same cluster, notice nodes within the same cluster to send a TDNA message to the cluster head in its own time slot. In order to avoid signal interference near the cluster, cluster head can determine the CDMA codes which all nodes used. The CDMA codes which is used in the current phase and TDMA timing information will be sent together. When nodes within the cluster receive the message, they will send data to the cluster head in their own time slot. Algorithm will enter a stable phase.

Work in a stable phase, member nodes continuous collected monitoring data, and send data to the cluster head node in their own time slots. While the other time, it can turn off the radio module, into hibernation, and it is one of the main ways to save energy for LEACH. After the cluster head node received the data which is from its member, it will do the necessary processing of data fusion. Then the information is sent to the sink node. After a period of time of data transmission, nodes enter to a new work round, to re-select a new cluster head, and constantly circulating.

Advantages and Disadvantages of the LEACH Algorithm

It can be seen that LEACH algorithm as a typical sub cluster routing protocol has the following advantages[13]:

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

¨ Localized coordination and control for cluster setup and operation.

¨ Randomized rotation of the cluster (carried out by base stations or cluster heads) and the corresponding clusters.

¨ Local compressions, The CH nodes compress data arriving from the nodes affected to their respective clusters, and send an aggregation package to the base station in order to reduce the quantity of information to be transmitted to the base station. LEACH algorithm uses temporal multiplexing technique TDMA (Time division multiplexed access) as an access method to the medium. The hierarchy, path selection and routing information is relatively simple, and the sensor nodes do not need to store large amounts of routing information, and do not need complex functions.

-· The cluster head node is randomly selected, the opportunity of each node is equal, and the load of whole network is balance. Although LEACH reduces the energy dissipation above a factor of 7 compared to direct communication and a factor of 4 to 8 compared to the minimum transmission energy routing protocol, it presents some drawbacks. The idea of dynamic clustering brings extra (e.g. head changes, advertisements etc.,) which may moderate the gain in energy consumption. Also, in LEACH, furthest nodes from CH die quickly compared to closer ones. The number of messages received by CHs is proportional to the number of managed nodes, this leads to the fast exhaustion of their energy resource; the use of single-hop instead of multi-hop exhausts the energy of the nodes quickly and consumes more of bandwidth. LEACH assumes that all the nodes have enough energy to transmit to the BS, which is not always true. LEACH algorithm randomly selected cluster-heads; it can evenly distribute the high energy consumption to all nodes on the network by the using of the rotation of the election. So that nodes, which have no energy, can be randomly distributed. And the LEACH algorithm uses hierarchical structure; Cluster heads reduce the energy consumption of data transmission through the data fusion mechanism, and therefore compared to the general multi-hop routing protocols and static clustering algorithm, LEACH can extend the network life-cycle of 15%. However, there are a number of deficiencies in LEACH algorithm, such as: Because the cluster head in LEACH protocol are randomly generated, energy consumption can be evenly distributed in the network; however, it ignores residual energy of nodes, geographic location and other information in the election of cluster head node. So it can easily lead to exhaust the energy quickly in cluster head nodes.

LEACH assumes that all the nodes can be directly communicate with the cluster head node and the base station node, the actual network of base stations are usually far away from the sensing area, this would make the cluster head which is far from the base station is easier to fail. Therefore, expansion of the network is not strong, and is not suitable for large networks. Because the distribution of cluster head is totally dependent on the random number, so the number of the cluster heads can be big at a regional, and the number of the cluster heads will be little at other regional. In the cluster-heads centralized regional, the number of the general node is very little, and this can have lost the meaning of hierarchical routing; in cluster-heads sparse region, cluster head node is responsible too

The Improvement of the LEACH Algorithm

Based on the shortage of above algorithm in LEACH, we can improve the LEACH algorithm that is mainly from three aspects of the LEACH algorithm such as the cluster shape, clustered approach and the choice of the cluster head node.

In the LEACH algorithm, it will produce the cost in the process of the clusters establishment. If you can reduce the cost of this part, then it can make more energy to be consumed on the data transmission. The improved algorithm uses a fixed sub-cluster approach, that is, in the initial stage, after the clusters are divided, the node within the cluster will no longer be changed; meanwhile, in order to make energy consumption evenly distributed across all nodes, it need to rotate cluster head within each cluster. Cluster head node has an important position in wireless sensor networks; the energy consumption of cluster head node is much higher than normal sensor nodes. The energy consumption of cluster head node, including nodes within the cluster head and cluster communication, cluster head and cluster node, the energy consumed by communications The energy consumption of cluster head node, including the energy consumption when cluster head node communicates to nodes within cluster, and when cluster head node communicates to aggregation nodes; for the cluster node which is near to the aggregation nodes, because of the large distance, the cluster node which is far from the aggregation nodes can consume higher energy. The improved algorithm uses non uniform sub-cluster method (as shown in

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Figure 4), that is, the convergence radius, which is near to the aggregation node, is larger; and away from the aggregation node, the convergence radius is smaller.

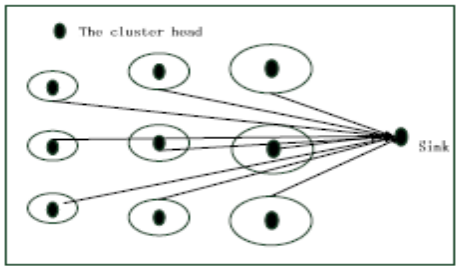

Fig 2 .Non Uniform Clustering

The cluster head node, which is near to the aggregation node, consumes greater energy within the cluster than the cluster head node which is far away from the aggregation node. That can make all the energy consumed by cluster head nodes are close to the same. Thus it can balance the energy consumption of the cluster head node. The selection of the cluster head node needs to make minimize the energy consumption. As well as the dynamic selection cluster head node in order to avoid the energy consumption of a single cluster head node. From these two points, which are the minimized energy consumption within the cluster and the largest energy consumption in the cluster head node, we select cluster head node according the residual energy of each node.

LEACH-C [3] (LEACH-Centralized) is a variant of LEACH that uses a centralized cluster formation algorithm to form clusters. The protocol uses the same steady-state protocol as LEACH. During the set-up phase, the base station receives information from each node about their current location and energy level. The BS performs the centralized cluster formation algorithm to determine cluster heads and clusters for that round. LEACH-C uses simulated annealing [11] to search for near-optimal clusters. LEACH-C chooses cluster heads randomly but the base station makes sure that only nodes with "enough" energy are participating in the cluster head selection. Once the clusters are created, the base station broadcasts the information to all the nodes in the network. Each of the nodes, except the cluster head, determines its local TDMA slot, used for data transmission, before it goes to sleep until it is time to transmit data to its cluster head, i.e., until the arrival of the next slot[12].

PEGASIS: A Chain -Based Approach

PEGASIS[12] protocol is an enhancement over LEACH. It is a near optimal chain-based protocol. The basic idea of the protocol is that in order to extend network lifetime, nodes will be organized to form a chain, so that they need to communicate only with their closest neighbors. The aggregated form of the data will be sent to the base-station by any node in the chain and the nodes in the chain will take turns in sending to the base-station. PEGASIS is able to increase the lifetime of the network twice compared to LEACH protocol. Such performance gain is achieved through the elimination of the overhead caused by dynamic cluster formation in LEACH. PEGASIS performs data fusion at every node except at the end nodes of the chain. Each node will fuse its neighbor's data with its own to generate a single packet of the same length and then transmit it to its other neighbor.

Nevertheless, PEGASIS presents a big delay for the most distant node in the chain, even if the clustering overhead is avoided. PEGASIS assumes that each sensor node can be able to communicate with the BS directly. In practical cases, sensor nodes use multi hop communication to reach the base-station. Also, PEGASIS assumes that all nodes maintain a complete database about the location of all other nodes in the network. In addition, PEGASIS assumes that all sensor nodes have the same level of energy and they are likely to die at the same time.

The main idea in PEGASIS[8]is for each node to receive from and transmit to close neighbors and take turns being the leader for transmission to the BS. For constructing the chain, we assume that all nodes have global knowledge of the network and employ the greedy algorithm. We could have constructed a loop, however, to ensure that all nodes have close neighbors is difficult as this problem is similar to the traveling salesman problem. The greedy approach to constructing the chain works well and this is done before the first round of communication. To construct the chain, we start with the furthest node from the BS. We begin with this node in order to make sure that nodes farther from the BS have close neighbors, as in the greedy algorithm the neighbor distances will increase gradually since nodes already on the chain cannot be revisited. Figure 3 shows node 0 connecting to node 3, node 3 connecting to node 1, and node 1 connecting to node 2 in that order. When a node dies, the chain is reconstructed in the same manner to bypass the dead node.

For gathering data in each round, each node receives data from one neighbor, fuses with its own

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

data, and transmits to the other neighbor on the chain. Note that node *i* will be in some random position *j* on the chain. Nodes take turns transmitting to the BS, and we will use node number *i* mod N (N represents the number of nodes) to transmit to the BS in round *i*. Thus, the leader in each round of communication will be at a random position on the chain, which is important for nodes to die at random locations. The idea in nodes dieing at random places is to make the sensor network robust to failures. In a given round, we can use a simple control token passing approach initiated by the leader to start the data transmission from the ends of the chain. The cost is very small since the token size is very small.

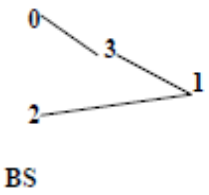

Fig 3.chain construction using greedy algorithm

In Figure 4, node c2 is the leader, and it will pass the token along the chain to node c0. Node c0 will pass its data towards node c2. After node c2 receives data from node c1, it will pass the token to node c4, and node c4 will pass its data towards node c2.

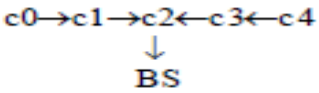

Fig 4. Token passing approach.

PEGASIS performs data fusion at every node except the end nodes in the chain. Each node will fuse its neighbor's data with its own to generate a single packet of the same length and then transmit that to its other neighbor (if it has two neighbors). In the above example, node c0 will pass its data to node c1. Node c1 fuses node c0's data with its own and then transmits to the leader. After node c2 passes the token to node c4, node c4 transmits its data to node c3. Node c3 fuses node c4's data with its own and then transmits to the leader. Node c2 waits to receive data from both neighbors and then fuses its data with its neighbors' data. Finally, node c2 transmits one message to the BS. Thus, in PEGASIS each node will receive and transmit one packet in each round and be the leader once every 100 rounds.

Advantages and Disadvantages of PEGASIS

Unlike LEACH, PEGASIS avoids cluster formation and uses only one node in a chain to transmit to the BS instead of using multiple nodes. This reduces the power required to transmit data per round as the power draining is spread uniformly over all nodes. The distance on which most of the nodes transmit is less compared to LEACH (where nodes transmit to a cluster-head).[8]

Second, the amount of data for the leader to receive is at most two messages instead of 20 (20 nodes per cluster in LEACH for a 100-node network). Finally, only one node transmits to the BS in a communication round. When a head node is selected, there is consideration how far the BS is located from the head node. When a head node is selected its energy level is not considered. Since there is only one node head, it may be the bottle neck of the network causing delay. Redundant transmission of data as only one head node is selected.

Improvement of PEGASIS

Routing Algorithm, because sensor energy is limited. Earlier PEGASIS protocol is based on two parameters i.e Distance and Residual energy. Modification is being carried out in decision parameter i.e response which check the response of nearby node before transmitting the data as well as specify the proposed algorithm for the modified PEGASIS protocol.

Conclusion

Routing algorithm in wireless sensor networks is a very hot research topic, because it has great research significance in saving energy and prolonging network life-cycle. This paper first described the wireless sensor networks and second, described the core ideas and analysis model of LEACH algorithm and PEGASIS algorithm . The focus of this paper is to study the advantages and disadvantages of the LEACH algorithm and PEGASIS algorithm, and improve the algorithms for those disadvantages.

References

[1] *F. Akyildiz, Weilian Su, Sankarasubramaniam, E. Cayirci, "A survey on sensor networks", IEEE Communications, Aug 2002.*

[2] *C. Schurgers and M.B. Srivastava, "Energy efficient routing in wireless sensor networks", MILCOM Proceedings on*

ISSN: 2277-9655
Scientific Journal Impact Factor: 3.449
(ISRA), Impact Factor: 1.852

Communications for Network-Centric Operations, 2001

[3] W..R. Heinzelman, A. Chandrakasan, and H.Balakrishnan, "An Application-Specific Protocol Architecture for Wireless Micro sensor Networks", IEEE Transactions on the wireless communications, Vol. 1, No. 4, pp. 660-670, Oct. 2002.

[4] W.R. Heinzelman, A. Chandrakasan, H. Balakrishnan "Energy-efficient communication protocol for wireless micro sensor networks", IEEE Hawaii International Conference on System Sciences, 2000.

[5] M. Younis, M. Youssef and K. Arisha, "Energy-aware Routing in Cluster-Based Sensor Networks", the Proceedings of the 10th IEEE/ACM International Symposium on Modelling, Analysis and Simulation of Computer and Telecommunication Systems (MASCOTS2002), October 2002.

[6] Jamal N. Al-Karaki, Raza Ul-Mustafa, Ahmed E. Kamal, "Data Aggregation in Wireless Sensor Networks - Exact and Approximate Algorithms", Proceedings of IEEE Workshop on High Performance Switching and Routing (HPSR), Phoenix Arizona, USA pp 18- 21,. April 2004.

[7] S. Lindsey, S. Raghavendra, "Data Gathering Algorithms in Sensor Networks Using Energy Metrics", IEEE Transactions on parallel and distributed systems, Vol.13, No.9, 2002.

[8] S. Lindsey, C. Raghavendra, "PEGASIS: Power-Efficient Gathering in Sensor Information Systems", IEEE Aerospace Conference Proceedings, Vol. 3, 9-16 pp. 1125-1130, 2002

[9] S. Bandyopadhyay, E. Coyle, "An Energy Efficient Hierarchical Clustering Algorithm for Wireless Sensor Networks", Proceedings of IEEE INFOCOM, Vol. 3, pp. 1713-1723. 2003

*[10] T. Thua Huynh et C. Seon Hong "An Energy*Delay Efficient Routing Scheme for Wireless Sensor Networks", MMNS 2005, LNCS 3754, pp. 11–22, 2005. IFIP International Federation for Information Processing 2005*

[11] P. Agarwal and C. Procopiuc. Exact and Approximation Algorithms for Clustering. In Proceedings of the Ninth Annual ACM-SIAM Symposium on Discrete Algorithms, pages 658-667, January 1999

[12] Azeddine Bilami, Djallel Eddine Boubiche "A hybrid Energy Aware Routing Algorithm for Wireless Sensor Networks" IEEE

[13] Qing Bian, Yan Zhang, Yanjuan Zhao "Research on Clustering Routing Algorithms in Wireless Sensor Networks", IEEE International Conference on Intelligent Computation echnology and Automation, Pages 1111-1113, 2010

[14] Cheng JianSheng :Energy Efficiency Clustering Algorithm in Wireless Sensor Network Application" IEEE