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Research Article

Energy Saving Techniques in Wireless Sensor Networks

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Abstract

Wireless Sensor Network nodes are battery powered nodes. Main focus of this article is to reduce the energy wastage and increase the lifetime of Wireless Sensor network by balancing the energy level of all nodes in network. Sensor nodes are small, cheap; resource limited devices and sensing the environment and communicating with each other. It consumes energy to transmit, to forward and to receive the data over network. Network lifetime is depends on energy level of nodes, depends on processing power of node, memory and transmitter power. Transmitting speed and receiving speed are differing from node to node. Saving more energy of sensor node by using energy efficient algorithms, the network lifetime will get increased. Survey is based on different techniques, which are to avoid the energy wastage of nodes in network and its success.

Keywords: *WSN, MHHC, routing, sensor, energy saving.*

1. Introduction

In computer network, there is more importance for wireless networks because the setup of wireless network is not difficult and not more expenditure. It has lots of ways to save the money and the bandwidth. In wireless network there is different form of network one of them is called as wireless sensor network. Numbers of sensors are available in the network and all are connected to each other through wireless link. All Sensors are performing the same function transmission of data and receiving of data.

All sensors are working in cooperative manner and trying to balance the network by balancing the different environmental factors of the network. Generally sensor networks are used for the monitoring the physical conditions such as regularity of temperature, whether conditions, different technologies related sound. Sometimes it is used to measure pressure and to check environmental pollutions.

Wireless Sensor Network is collection of different autonomous nodes and these nodes are battery powered nodes. When Source node sends some data to sink node, it routes through different nodes. There is one sender and one receiver but many nodes are required for making the communication between sender and receiver which are acting as a router in networks.

The tasks of these many intermediate nodes are according to destination address; process the data and forwards the packets over the network. Some energy is get used to process data and to forward data. If more number of nodes is doing the participations in communication then there is more energy use. If more energy use means network lifetime is get reduced. If less number of nodes used to send the data from source to destination means less energy consumption. But sending data from source to destination if same nodes are get used again and again then only that nodes energy will be get used more. Because of low energy that node can be dead and network goes down.

Many nodes are having enough energy and some nods are dead means there is no energy balance. Because of these dead nodes network can be get divided into many sub networks and if there will not be link between sub networks then and then no use of such network in communication.

Wireless Sensor Network can be the clustered according the number neighbour of it. For making communication from source to sink it should follow the sequences of clustering. Main cluster, sub-cluster, sub-sub-cluster like this.

The Structure of this paper is organised as follows: Section 2 describes how Wireless Sensor Networks Works and how energy is get wasted in the networks while transferring the data from source to destination. Section 3 discusses the different techniques which are currently available to reduce the energy wastage in Wireless Sensor Networks. We state their techniques in brief, advantages and disadvantages. Section 4 concludes the article and gives the summery reports of different energy saving techniques. Section 5 discusses the future scope of Energy saving in Wireless Sensor Networks.

2. Working of wireless sensor networks

Wireless Sensor Network is very dispersed Network. All devices are homogeneous type. All node are act as a

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router. All nodes are having potential of multiple routes. Working of Wireless Sensor Networks is depends on the construction of the network. Size of the Sensor networks matter in the communication. Number of neighbours, cluster head, energy level is the important factor in communications.

Microcontrollers are also used in the network to control monitoring activity of sensor. Radio transceiver is used for generating the radio waves. Energy Source is the important factor such as battery. The whole networks works concurrently using the different parameters of sensor and according to multiple routing algorithms.

For transmitting and receiving the data over the network every node consumes some energy level. Every node is either sender or receiver or forwarder in the network. The nodes which are not taking the part in the communication they are also continuously sensing the data over the networks and wasting the energy.

3. Energy saving techniques in WSN

Different techniques are used to reduce the energy wastage in WSN. In this section, we discuss the different recent techniques for balancing the energy level and saving the energy of WSN.

A. Solar-Aware Routing

Energy level of sensor node is depends on depends on network architectures and processing model. In Wireless sensor network to provide the energy for sensor node it uses the solar powered battery. This battery is used as energy resource for sensor nodes. This battery gets charged automatically on solar energy. The nodes which are having more energy level the traffic get transferred through that node as shown in the Fig. 1. Low energy level having very less traffic or many times they will not have any traffic, for balancing the network energy.

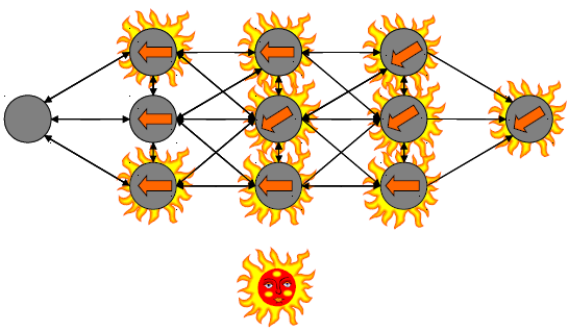

Fig: 1 Solar Aware Routing in WSN

The main advantages of this techniques is that its free. According to energy level of nodes traffic get switched to higher energy nodes.

Disadvantages of this technique are if it manages the traffic according to energy level then it is possible that it can choose longest path and more number of nodes takes participation in data transmission and more energy will be get utilise in communication. It depends on whether condition. In bad weather condition may be network cannot work because of less energy level and it does not guarantees that data will be transmitted from source to destination in rainy seasons.

B. Node Reliance Techniques

Node Reliance techniques (Alan W. F. Boyd, Dharini Balasubramaniam, Alan Dearle , 2010). is good to balance the traffic over sensor networks. For these techniques, the extra overhead is that calculation of absolute cost and relative cost for all nodes. This method is very simple for implementation. Everything is Static in this method. If nodes are moving from one location to another then for every moment the neighbour of the nodes changes and because of that the absolute cost and relative cost are also changes continuous.

The minimum energy routing, *minimum hop routing, load balancing routing and potential based routing* all these methods work similarly. Comparing all these method with node reliance then node reliance has some advantages that its simplicity and efficient load balancing.

In node reliance method the traffic balanced up to certain level but it is possible that it can use the same node again and again to transfer large amount of data from source to destination.

In this method the path is static and it is not depends on traffic it is depends on the location of nodes. Only because of the static route, same node can be get used again and again their energy level will be get down. Overhearing problem remains the same in node reliance technique.

C. Multi-Hop Hierarchical Clustering (MHHC)

In Multi-Hop Hierarchical clustering (MHHC) algorithm (Saeed Ebadi, Arsalan Va hi, Nader Vahdani Manaf, Saeed Rasouli , 2010)., it does the clustering of sensor nodes according to number of nods and number of clusters. It creates hierarchy of networks at different levels. While doing communication, it follows the sequence of cluster, from low level to top level (at sender side) and again from top level to low level (at receiver side).

After simulating this algorithm on NS-2, the result obtained that it improves the network life time by 22 percent than the LEACH protocol. This algorithm is depends on energy level, distance and number of neighbours. If any one of the factor is changing, then throughput also changes. Network model and Energy model is very useful to find the distance, number of neighbour and energy level of node at particular time instance.

MHHC algorithm is divided into three phases.\i.e. Initial phase, Hierarchical phase and final phase. In Initial Phase, it is doing the clustering of sensor networks up to different hierarchical level by sending the *start message* to all neighbours. Then all neighbour sends this start message to their neighbour. Like this way this message convey to all nodes.

In Hierarchical Phase, after getting *start message* it forms clusters, according to number of neighbour. After

doing clustering, each cluster chooses the cluster head according to number of neighbour and energy level of nodes. Then all these cluster head chooses the cluster head for parents cluster and so on.

Final Phase finalise the path for sending data from source to destination according to hierarchical level path.

Advantages of these techniques are that it follows the sequence path according to hierarchical level. It does not follow the different path to send the information from source to destination. It follows the static path.

Disadvantages of this method is that, because of this static path, the same nodes are get used in the communication repeatedly. So the energy level of the same nodes will be get down and if nodes are getting the dead because of low energy level then network lifetime is also get decreased. Can be some of the nodes will be permanents out of network even they are having good energy level.

D. Duty Cycling and Data Driven Approach

Energy Saving in WSN (Zahra Rezaei, Shima Mobininejad "Energy Saving in Wireless Sensor Networks, 2012) , the main focus of this article is the duty cycling and data driven approaches. Importance given to basic components of sensor network, that is sensing sub system for data actualization, processing and storage.

Major sources of energy wastage in wireless sensor networks are energy consumption due to transmitting data, receiving data and forwarding query requests.

Idle listening also one of the major energy wastage. If node is idle and lists the traffic of network for longer time, it reduces the energy level without giving the throughput. Because of packet collision, data loss can occur. Again packet should be get retransmitted by sender. Here it increases the work overhead of sender. Again in retransmission of the same packet, energy is get used. Energy gets wasted in overhearing. Node receives the packet but it is not for self, it is for other node, again forward it to destination. Energy get wasted in over-emitting where receiver is not ready to receive the packet but sender is sending.

E. SPIN-I Protocol

Routing algorithm for energy saving based on SPIN Protocol (Luwei Jing, Feng Liu, Yuling Li, 2011),gives the new solution for reducing energy wastage. This focuses on the major two problems. First is *"blindly forward"* and second is *"data inaccessible"*. Giving the solution for the same problem by designing the new routing algorithm, SPIN protocol solves this problem but the energy consumption is more uniform in whole network.

Sensor network application and routing protocols are related with each other. Many of researchers have designed number of routing protocol to reduce the energy wastage in sensor network. SPIN protocol is designed for lossless network based on metadata. In this method it is trying to avoid the redundant transmission of data over network and trying to manage the network resources very efficiently. SPIN protocol is not suitable for large network; it is suitable for small or medium size network. SPIN protocol is data-centric routing protocol.

Blind Forwarding means, source node sends data packet to all neighbours, then all neighbour broadcast this packet to its entire neighbour. This process gets repeated up to receiver when receiver receives message then this process stops. But in this process many nodes takes the part in communication even they are not required actually. Many nodes don't required actually for communication but they are doing energy wastage there. Blind forwarding reduces the lifetime of network and reduces the network performance.

Data inaccessible means network is unable to access the information over the network and it loses the meaning of application. Solution for these blind forwarding and data inaccessible is that when it broadcast the advertise message first it checks energy level of next node then choose the next node for communication. For this at start energy level of all nodes is equal and links are also symmetric. Wireless signals consume the same energy in all direction. Working mechanism of SPIN-I is divided into three stages. First is data broadcasting stage, second is data requesting stage and third is data transmission phase.
Up to certain level SPIN-I got the success in energy saving and increased the life time of networks. But main drawback of this is the transmission time is longer than the SPIN protocol. Transmission time is longer because each node does some calculation before choosing the next hop transmission. It helps to balance the energy of nodes rather than saving it.

F. Rendezvous Algorithms

Rendezvous algorithm is for mobility enabled Wireless Sensor Network. Recent research shows that the energy saving can be get achieved in mobility enabled sensor node that giving visit to sensor node and collect the data in short range communication.

The major performance in Wireless Sensor Network is bottleneck, it increase the network latency in data collection. Here is low movements speed of mobile base station.

To solving these issues they have proposed this Efficient Rendezvous Algorithms. It proposed subset of nodes which serves as *rendezvous points.* It aggregates the data from source and transfer to the base station when it arrives. It combines the approach of controlled mobility and data caching in network. It trying to balance the network energy saving and data collection delay. Using this algorithm, it proves the bounds for mobility base station. This solution is given for variable and fixed tracks.
Major disadvantage in mobility enabled WSN is the increased latency in data collection, there it is giving bottleneck performance. In this speed of mobile sensor system is also considered. Cost of network communication is depends on energy consumption of node for communication.

Conclusion

Wireless Sensor Network has attracted significant attention form last few years. Considering the growing scopes of WSN and its applications, they are very valuable in different domain such as civil and military, especially in hostile and remote area.

Node reliance and MHHC are easy for implementation but energy wastage is not reduced completely because of addition processing. Among the different techniques of energy saving for sensor node in WSN, each technique is having some advantages as well as weaknesses. Some methods have got the better result after simulation such as node reliance but it is having weakness of message overhearing. SPIN-I and MHHC having the good results but extra proceeding overhead is there.

Future Scope

In Node reliance techniques, the message overhearing problem remains, for further research on same techniques this problem can be taken into account when calculating the node reliance values.

In SPIN-I protocol the transmission time is longer than SPIN protocol. Reduction of transmission time is for future work. Although many techniques are just promising to energy saving but many changes are required in them. So the further research is valuable to handling these different types situations.

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