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Research Article

An Improved Energy Efficient Dynamic Cluster Head Selection in WSN with Inner and Border Nodes

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Abstract

Wireless sensor networks are basically energy constraint network. Carrying the limited energy for longer time is the challenge in hierarchical clustering algorithms. Clustering in WSN provides efficient way of utilizing energy to increase the network lifetime. Applications of WSN are surveillance networks, military applications, disaster recovery etc. In WSN, all nodes participate in cluster head selection which may give rise to death of border nodes very soon as border nodes participate in cluster head selection and sensing the environment for data. To avoid this situation we proposed a method which divides the network into inner area nodes and border area nodes allowing only the inner area nodes to participate in the cluster head selection. Hence this method not only increases the life time of border nodes but also the entire network life time. The cluster heads are selected within the inner nodes, based on dynamic cluster head selection scheme. The proposed scheme uses the residual energy of each node to elect as cluster head, if it finds multiple nodes with same residual energy then it considers cost values of those nodes to decide which node is made as cluster head.

Keywords: *Wireless sensor network; energy efficiency; lifetime; clustering; cluster-head; border nodes; inner nodes*

1. Introduction

A recent study predicted that in 2020 there will be 50 billion devices connected to the Internet. These devices are not only smart-phone and tablets, but also things which are able to perform various operations, such as sensing data, actuating on the external environment, and so on. With this perspective, Wireless Sensor Networks (WSNs) are getting mainstream in a wide variety of applications and systems; possible applications include environment monitoring, energy metering, smart cities, health care and intelligent houses**.**

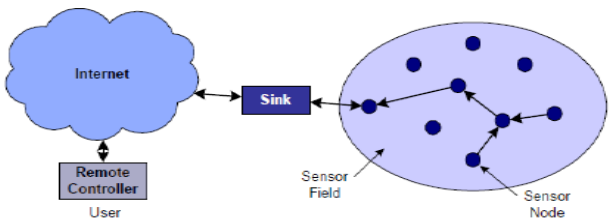

Fig 1: wireless sensor network architecture

Wireless sensor networks [D. Estrin, MOBICOM, 1999], are collection of large number of sensor nodes deployed in a field. Wireless sensor networks have layered architecture as shown in Fig 1. The end-user is not connected directly to the network but via a base station. Nodes sense the area and send the data to base station via single or multi hop communication. The end user accesses the data from base station.

Wireless sensor networks usually contain thousands or millions of sensors, which are randomly and widely deployed. Sensors are powered by battery, which is impossible to get recharged after deployment. Thus, energy efficiency is an important issue in sensor networks, so there are number of methods to resolve the energy efficiency problem .So Hierarchical method is the popular method, to save energy through clustering the sensor nodes.

The hierarchical method includes many protocols such as LEACH, PEGASIS, TEEN among these LEACH is the one of the energy efficient protocol hence in this paper we use Low Energy Adaptive Cluster Hierarchy (LEACH) [R P Yadav,2012]. LEACH selects the cluster head randomly among the nodes and performs the clustering in distributed manner. Cluster head in the network collects the data from nodes and sends the aggregated data to the base station. Role of cluster head is rotated over nodes after completion of a data gathering round. Thus Cluster head selection is the most important issue for saving energy and data aggregation. If the low energy node is selected as CH consumes more energy during data aggregation and communication which causes early node death. So node death in WSN does not follow any regular pattern but node with low energy selected as CH will die first.

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In this paper we proposed CH election scheme which divides network into two border nodes and inner nodes and the method prolong the lifetime of both border node and inner nodes hence entire lifetime of network will be achieved.

Rest of the paper is organized as: section 2 elaborates about the other energy efficient clustering algorithms. Section 3 describes about network model used. In Section 4 we discuss about existing system and proposed solution. The Section 5 produces simulation results. Section 6 finalizes the conclusion.

2. Related work

LEACH-E [D. Wei and H. Chan, 2006] propose an improvement over LEACH by selecting CH not randomly but considering remaining energy when energy level drops below 50% of the initial energy. Cluster head join process is determined not only by received signal strength but also by remaining energy of cluster head. The data is sent by a node only if data satisfies a predefined Condition. But scheme does not have view on informality in clusters.

EEHC (Energy Efficient Hierarchical Clustering) [Zhang/RFID and Sensor Networks, page251, 2009]: The main objective of this algorithm was to address the shortcomings of one-hop random selection algorithms such as LEACH by extending the cluster architecture to multiple hops. It is a distributed, *k*-hop hierarchical clustering algorithm aiming at the maximization of the network lifetime.

HEED (Hybrid Energy-Efficient Distributed Clustering): Another improved and very popular energy-efficient protocol is HEED (Hybrid Energy-Efficient Distributed Clustering) [Zhang/RFID and Sensor Networks, page251, 2009]. HEED is a hierarchical, distributed, clustering scheme in which a single-hop communication pattern is retained within each cluster, whereas multi-hop communication is allowed among CHs and the Base Station (BS). The CH nodes are chosen based on two basic parameters, residual energy and intra cluster communication cost. Residual energy of each node is used to probabilistically choose the initial set of CHs. On the other hand, intra-cluster communication cost reflects the node degree or node's proximity to the neighbor and is used by the nodes in deciding to join a cluster or not.

SPIN (Sensor Protocols for Information via Negotiation): is a series of resource adaptive protocols. SPIN uses three kinds of messages in separate phases, ADV, REQ, and DATA. New data will advertised by ADV message to all neighbors of a source node and those who interested in data will reply by REQ. so DATA is the real message itself. ADV message only consists of metadata that describes a node collected data. So it conserves energy by sending and receiving small advertisement messages.

PEGASIS (Power-Efficient Gathering in Sensor Information Systems): is a different kind of hierarchical protocols in this group nodes only communicate with nearest neighbors. Therefore, they form a chain and select a sensor node as a chain header per round which is responsible to send aggregated data among the chain members to the sink node. By using collaborative techniques and local coordination between nodes, PEGASIS could improve the network lifetime significantly.

3. Network Design

In the proposed protocol the mentioned network assumptions must be considered.

1. All sensor nodes in the network must be homogenous.
2. Once after deploying the sensor nodes in the network they must be stationary in position.
3. The single base station must be located at the centre of the network to reduce the communication distance.
4. The nodes deployed in the environment needs GPS attached to it, in order to find the location of nodes or must be use any other method to find location.
5. The network is differentiated as border and inner area nodes with distance'd'.
6. All the nodes in network must have data to send.

4. Problem statement and proposed system

LEACH is the most efficient clustering protocol to save the energy of sensor nodes .Which selects the cluster head randomly so that every node in the network will have a chance to become CH. But challenge is when the node with low energy elected as CH than that CH node will lose its energy early and that node will be no more functional.

In some of the critical field surveillance application such as military applications and health care applications, nodes are randomly deployed in the network and clusters are formed and CH is elected. Node from the border area with low energy level selected as CH will drain its energy soon compared to the inner area nodes. But in the previous study inner area node does not include any Ch selection methods.

a. Proposed solution

In the proposed method, nodes are deployed randomly as shown in the Fig 2. After deployment we will separate the network in to border nodes and inner area nodes.

According to energy model proposed in [D. Wei and H. Chan, 3rd Annual IEEE], for sending m-bit data over a distance d, the total energy consumed by a node is given by:

$$E_{Tx}(m,d)=E_{TX-elec}(m) + E_{TX-amp}(m,d) \quad (1)$$

And hence

$$E_{Tx}(m,d) = \begin{cases} m \times E_{elec} + (m \times E_{fs} \times d^2 , & d > d_0 \\ m \times E_{elec} + (m \times E_{amp} \times d^4 & d \geq d_0 \end{cases} \quad (2)$$

While the energy consumption for receiving that message is given by:

$$E_{Rx}(m) = m \times E_{elec} \quad (3)$$

Let d is the distance for partitioning the field. Area from boundary of the network up to distance d is border area and the remaining is inner area. Value of d for partitioning the network is crucial because high value makes inner area small and small value doesn't make difference for dividing network.

Once we divide the network we restrict the cluster head selection to inner area of network so that the border nodes survive for longer time.

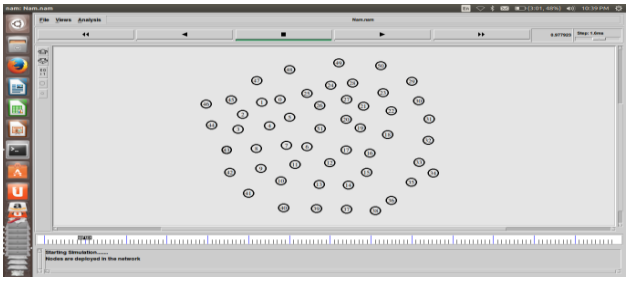

Fig.2: initial node deployment

The 'Improved Energy Efficient Dynamic Cluster Head selection' method is proposed in inner area part of network. Further the nodes will communicate with nearby nodes and advertise their position and virtual clusters are formed as shown in Fig 3 and nodes will calculate their energy level and advertises to all nearby nodes. If two or more nodes have same energy level than cost values should be calculated, the node with highest cost value is elected as CH.

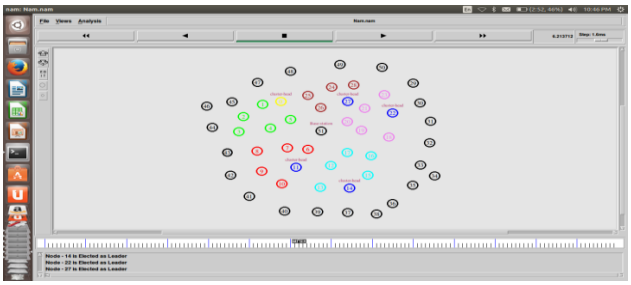

Fig.3: virtual clusters are formed and CH is elected

The selected cluster head (CH) will advertises its message all nearby nodes, and even to the nearby border nodes and the border nodes as well-as inner nodes which are in range of CH will send the join request and the CH accept the in-rage join requests. Than the cluster is formed and member nodes sense the environmental data and send to CH, further CH will aggregate the sensed data and transfer to base station and end user can collects the data from BS. The procedure is repeated until the last round.

Thus border area nodes as well the inner area nodes can sustain for longer period time hence overall lifetime of wireless sensor network will be improved.

5. Results

In this section, proposed scheme and leach are simulated in network simulator (NS-2, 2.35). The proposed scheme is compared with LEACH. The Graphs are shown for energy efficiency and throughput and packet delivery ratio and number of packet drop. The sensor network topology is considered for 50 nodes, the base station (BS) is located inside the field at the centre (50, 50), and initial energy of node is 100 Joules.

A. Energy consumption rate

Energy consumption rate defines the energy consumed against the time. The Fig 4 shows the comparison between LEACH and Proposed scheme.

As shown in the below graph the slope of curve with green line is below the slope curve of red line, which means the proposed scheme consumes less energy than the LEACH so the network is more efficient.

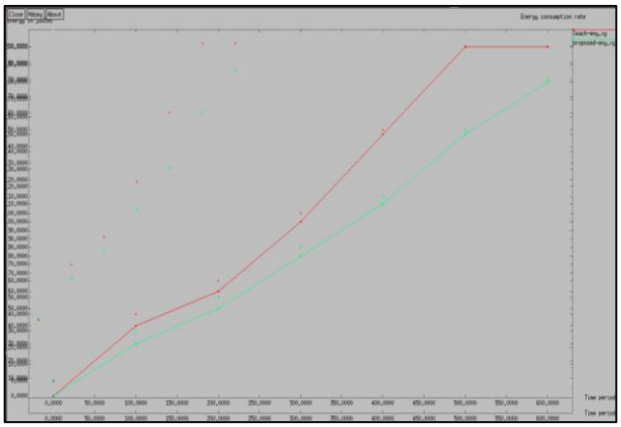

Fig.4: Energy consumption rate

B. Packet delivery ratio

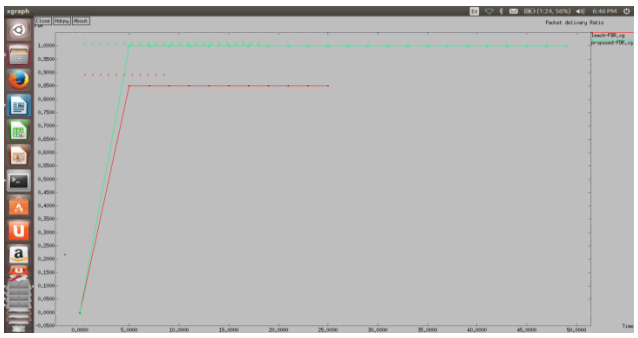

Fig.5: Packet delivery ratio

Packet delivery ratio defines, number of packets delivered with respect to time. Here the number of

packets received is more compared to number of packets received in LEACH. Fig 5 shows the packet delivery ratio is more in the proposed scheme.

C. Packet drop ratio

Which define the number of packets lost during data transfer. Fig 6 shows that there is none of the packets are lost in the proposed method whereas LEACH has variation in packet drop.

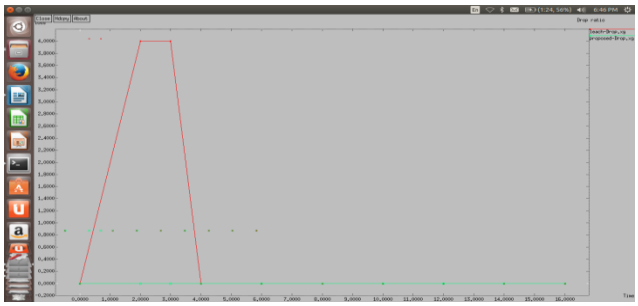

Fig.6: packet drop ratio

So the proposed scheme outperforms the energy efficiency of LEACH. As required for the lifetime of border and inner nodes, thus scheme prolong lifetime of WSN.

Conclusion

Energy efficiency is the very important issue in WSN which depends upon the CH selection method. In this paper we propose a Dynamic Cluster Head selection method with inner and border nodes. By separating the network we are not allow the border nodes to take part in cluster-Head selection but we restrict the CH selection to the inner area nodes hence both border and inner node perform for longer period of time then overall lifetime of the wireless sensor network will improved.

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