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Single Stage Chain Routing Protocol (SCRP) For Wireless Sensor Networks

Utpal Barman[1], Pranoy Bhowmick[2*], Kunal Gunjan Talukdar[3], Mrinal Goswami[4], Amit Mundra[5]

[1,2,3,4,5] Department of Computer Science and Engineering, GIMT Guwahati
E-mail: pranoy.bhowmick12@gmail.com

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Abstract- In recent years there has been development of systems to make human life easier. One of the emerging fields is wireless sensor networking. There have been many development in the last few years to make smart farming worldwide popular and several research works has been done by researchers to find the most efficient routing protocol as the sensor nodes used in smart farming have limited energy and thus its a challenge to utilize that limited energy efficiently for a long period of time. To address these issues we propose a new routing algorithm called Single Stage Chain Routing Protocol.

Keywords: CCM, PEGASIS, SPCRP and WSN.

1. Introduction

Wireless sensor nodes are mostly widely used in today's world. It is basically implemented in remote and hostile areas. So it is difficult to replenish the energy source once it is installed. The network lifetime of a wireless network can be defined as the time elapsed until the first node (or the last node) in the network depletes its energy. Energy consumption in a sensor node can be attributed as useful or wasteful sources.

Useful energy consumption can be due to transmitting, receiving, processing data or forwarding the data to the neighbouring node. On the other hand, wasteful energy consumption can be due to ideal listening to the media, retransmission of data due to packet collision, overhearing and generating or overhearing control packet.

Research work has been done to increase the lifetime of the sensor node and consequently the life time of the network because the lifetime of the network depend upon the lifetime of the sensor node by enhancing the use of battery of each node.

In order to increase the lifetime of the nodes, we propose a new routing algorithm to achieve energy conservation in WSNs, known as SINGLE STAGE CHAIN ROUTING PROTOCOL (SCRP). The main objectives of SPCRP is to minimize the total energy consumption, achieve more load balancing and increase the network lifetime with more stability compared with other routing algorithms, for example Chain-Cluster based Mixed routing (CCM),Low Energy Adaptive Clustering Hierarchy(LEACH) and Power Efficient Gathering in Sensor Information System(PEGASIS). We divide the network in horizontal chains that include all the nodes in the same row.

A chain head is selected sequentially and the all the other nodes in the chain transmits their data to the chain head. The chain head then aggregates the data and send it to the base station (BS).

This paper is organised in the following structure: section 2 Related work; section 3 network model ; section 4 single stage chain routing protocol; section 5 implementation and results and section 6 conclusion.

2. Related work

Research works have been done to improve routing algorithms. One of the routing algorithm is Low Energy Adaptive Cluster Hierarchy (LEACH) [1]. It is a hierarchical routing protocol. It is self organized and self adaptive. At each round the cluster is formed with one node acting as a cluster head. The main idea to form the cluster and cluster head is to save energy because only the cluster head will aggregate all the data from the other nodes of its cluster and will transmit the data to the sink. The cluster head selection is changed randomly with time in order to balance the energy of dissipation of nodes.

Another protocol is Power Energy Gathering in Sensor Information System (PEGASIS) [2,4] is a chain based routing protocol. The major idea of PEGASIS is that each node should receive and send data to the closest neighbour node and takes turn to be the chain head to transmit sensed data to the base station (BS). The construction of chain is done based on greedy algorithm approach and the chain head is selected randomly. Each node receives the data from the nearest neighbour fuses with its own data and transmits to the nearest neighbour. The main advantage of this algorithm is that energy consumption is low. The drawback of this algorithm is the delay caused by transmitting the data to all the members in the network and gathering it in the chain head and then transmitting it to the base station (BS).

Another protocol is Chain Cluster Based Mixed Routing Protocol (CCM) [3,5] which divides a WSN into a few chains and runs in two stages. In the first stage, sensor nodes in each chain transmit data to their own chain head node in parallel, using an improved chain routing protocol [6,7]. Each node in the chain takes turns to be the chain head. Token passing is used to attain mutual exclusion

during transmission within the chain. In the second stage, all chain head nodes group as a cluster in a self-organized manner, where they transmit fused data to a voted cluster head using the cluster based routing. The energy consumed to transfer each packet is given by:

Energy consumed=k*(wireless transmission distance)
where k= size of each packet
The main advantage of this routing protocol is it provides energy efficiency. Scalability remains a disadvantage to this routing protocol.

3. Network Model and System Architecture

A square area is taken for the model of our routing protocol. Details of the network model are specified below –

Area of the model	10 × 10 square units
Number of sensors deployed	100
Distance between each sensor node and its adjacent neighbours	1 unit
Packet length (k)	200 bit
Number of rounds	500 rounds

Table 1: System Details

3.1 Specification of a single sensor node:

1. All the sensor nodes are capable of transferring data to the base station.

2. Data is transferred from each sensor node to the closest neighbour in the first stage till the data reaches the chain head.

3. All the sensor nodes are identical having the same energy (= 0.5 J).

4. Algorithm

This routing protocol is an improvement to PEGASIS. Data fusion is performed at each step. Each node fuses its data with its nearest neighbouring node. It utilizes the chain head selection method of CCM. Each node in the chain takes turns to become the chain head. All the nodes keep on propagating the fused data until it reaches the chain head. Once all the data reaches the chain heads, they in turn transfer the data to the base station. The algorithm is explained below:

Step 1: The sensor node S(i,j) will be assigned chain head for the jth round.

Step 2:S(i,j) will generate two tokens and send them to S(i, 1) and S(i,n);

Step 3: let the index for the node with the token s x = 1and y = n;

Step 4: do

{

Step 4.1

If (x< j)

{

Fuse data received from S(i, x-1)where x>1 and its own data

S(i,x) will transmit the fuse data along with its token to its neighbouring nodes S(i,x+1)

x=x+1

}

Step 4.2:

If (y> j)

{

Fuse data received from S(i, y+1)where y<n and its own data;

S(i,y) will transmit the fuse data along with its token to its neighbouring nodes S(i,y-1);

y=y-1;

}

While(!(x= = j and y= = n));

5. Implementation and results

The network model is in the form of a 10 x 10 matrix of sensor nodes (a total of 100 nodes). The nodes are placed at a unit distance from each other. Each row of the matrix is a different chain, so we have 10 chains and each chain contain 10 nodes. Next step is to select the chain head. The first chain head is selected from one end of the chain. Each node in the chain takes turn to become chain head. Once a node is selected as a chain head it generates two tokens and propagates it to two ends of the chain. In case one of the end nodes is the chain head itself, the token received by the chain head is discarded. The tokens are used to attain mutual exclusion during transmission. Only nodes holding the token can transmit. Now, at both sides of the chain head, the node holding the token sends its data along with the token to its nearest neighbour within the chain. The receiving node in turn fuses the received data with its own data and propagates the token and fused data to its nearest neighbour. This goes on unless all the data fuses and reaches the chain head. The chain head adds its data to the lot and sends it to the base station.

For calculating the transmitting energy of a packet the equation is:

$Et(k,d)=Ec*k+Ea*k*d^2$ [3]

For calculating the receiving energy of a packet the equation is:

$Er(k)=Ec*k$ [3]

Where;

Et=energy consumed during the transmission

K=size of the data packet

D=distance between the node and the closest neighbour

Ec=energy needed to run the transmitter or the receiver

Ea=Energy consumed to run the amplifier

Er=Energy consumed during the receiving

The values assumed are as follows:

Ec=50 nJ/bit

Ea=100pJ/bit/m^2

K=200bits

The value for distance between two node is 1 units, while the distance between the chain head and the base station is given by:

$d=sqrt((xLoc-x)^2+(yLoc-y)^2);$

where :

xLoc= x coordinate of transmitting node

yLoc= y coordinate of transmitting node

x= x coordinate of base node

y= y coordinate of base node

Taking the same number of rounds, residual energy was found to be 3.6378 J (approx 7% of the total energy) in LEACH. Thus, consumption of energy is far less in SCRP compared to LEACH making it significantly more energy efficient.

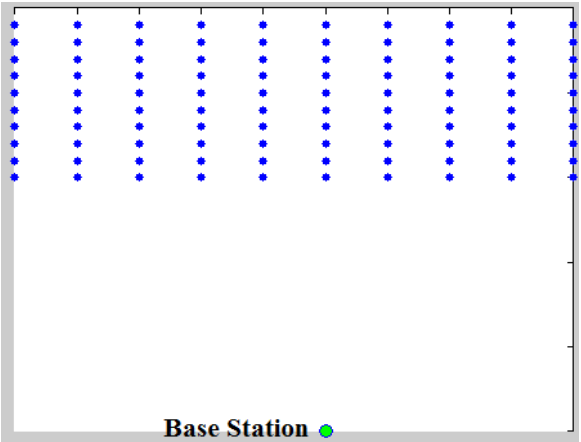

Figure: Network architecture of SCRP

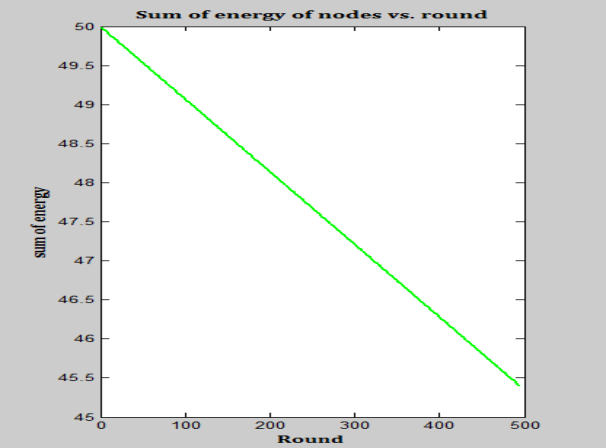

Figure: Sum of energy of nodes per round in SCRP

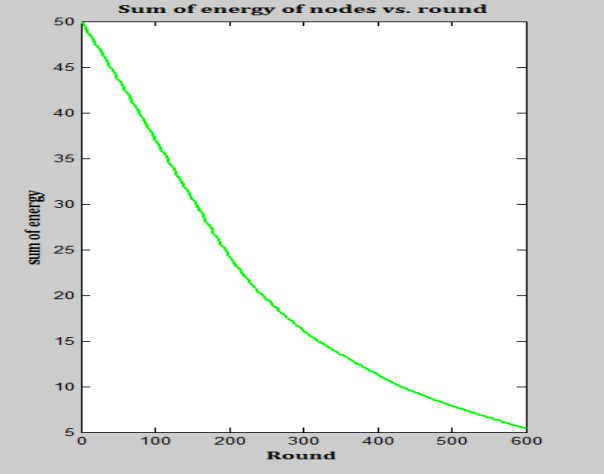

Figure: Sum of energy of nodes per round in LEACH

6. Conclusion

In this paper, we explained about the SCRP routing protocol for wireless sensor networks. In SCRP, the network is divided into a number of chains having a fixed number of nodes. In the proposed routing protocol, a chain head is selected at first from one end of the chain and then the chain heads are selected sequentially within the chain in different rounds. Data is transmitted from one node to the neighbouring node and gets fused. When the fused data reaches the chain head, it is sent to the base station. After 600 rounds, residual energy was found to be 44.4196 J (approx 89% of the total energy) in SCRP.

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