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Cluster Head Selection Prediction in Wireless Sensor Networks

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Abstract-In Wireless Sensor Network (WSN), well known problems are energy consumption has been brie y studied to enhance the network life time of WSN. In clustering, cluster head(CH) is responsible to send data via other CH nodes to the base station. This tends to create situation known as nodes are die earlier. To increase the node aliveness in the network , energy consumption should be reduced in the network. To decrease the energy consumption of energy proper selection of cluster head is required. In this project, We are devising a algorithm for cluster head selection which is np hard problem. For the selection of cluster head we are using markov model which is used to predict cluster head in future on the basis of current state. The algorithm is checked in terms of no. of rounds vs remaining energy in the network.

Keywords: Markov Model, Routing, Clustering, Energy, Density

1. INTRODUCTION

1.1. Wireless Sensor Network

A wireless sensor network consist of spatially distributed autonomous small tiny sensors to monitor physical or environmental conditions, such as temperature, sound, pressure, etc. and to cooperatively pass their data through the network to a base station[3]. Distribution of sensor node is may be random or predefined location. Sensor nodes may be homogeneous (all node have equal capabilities)or heterogeneous(All nodes are not alike , some nodes have different capabilities). The development of wireless sensor networks was motivated by military applications such as battle field surveillance; today such networks are used in many industrial and consumer applications, such as industrial process monitoring and control, machine health monitoring, and so on[8].

1.2. Clustering

Cluster analysis or clustering is the task of bunching a set of senor nodes in a way that sensor in the same group (called a cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters)[1]. In wsn sensor nodes which have shorter distance to the near CH are in the same group. Its main task is to collect the data from the target area and pass it to the CH. After that CH forward the collected information towards the base station [6-7]

Cluster formation itself is not one particular algorithm, but the general problem to be resolved. It can be achieved by various algorithms that differ significantly in their notion of what constitutes a cluster and how to effectively find them. Popular notions of clusters are groups with shortest distances with the cluster members, areas of the data space is dense, intervals or particular statistical distributions. Therefore clustering is a multi-objective problem. The suitable clustering algorithm and parameter settings (including values such as the distance function to use, a density threshold or the number of expected clusters) depend on the individual data set and intended use of the results. Cluster analysis as such is not an automatic task, but an iterative process of knowledge discovery or interactive multi-objective optimization that involves trial and failure. It will often be necessary to modify data preprocessing and model parameters until the outcome achieves the required properties.

2. PRELIMINARIES

2.1. Energy Consumption Model

Sensor node reduces it energy to transfer data to the sink. The energy model, that is used in the network that decreases the energy in different operation such as transmission, reception, sensing and aggregation [5].

Equation 1 is for total energy consumption in transfer L bits of packet at distance d_m, where E_{elec} is the energy required per bit in transmits circuitry and E_{amp} is the energy required in amplification process.

$$E_{Tx}(L; d_m) = E_{elec} \quad L + E_{amp} \quad L \qquad (1)$$

Equation. 2 is for total energy required in receiving L bits of packet

$$E_Rx = E_{elec} \quad L \qquad (2)$$

Equation 3 and Equation 4 for energy required in ampli cation, where E_{fs} is energy required when free space model is used (i.e. distance shorter then threshold value) and E_{mp} is energy required when multi-path fading channel model is used (i.e. distance more then threshold value).

$$E_{amp} = E_f s \ d_m^2 \qquad (3)$$

$$E_{amp} = Emp \ d_m^2 \qquad (4)$$

Equation 5 for the amount of energy required in aggregation, where Eda is aggregation energy and N is the no. of members belongs to that cluster-head CH.

$$E_{da}(CH; N) = N \ eda \qquad (5)$$

Equation 6 represents energy required in transmitting L bits of packet for non CH to the CH

$$E_n \ CH = E_Tx(L; d_n \ CH) \qquad (6)$$

Equation 7 for the total energy required of CH Node.

$$E_{CH} = M\ E_{Rx}(L) + M\ E_{da} + E_{Tx}(L; d_{CH\ BS}) \quad (7)$$

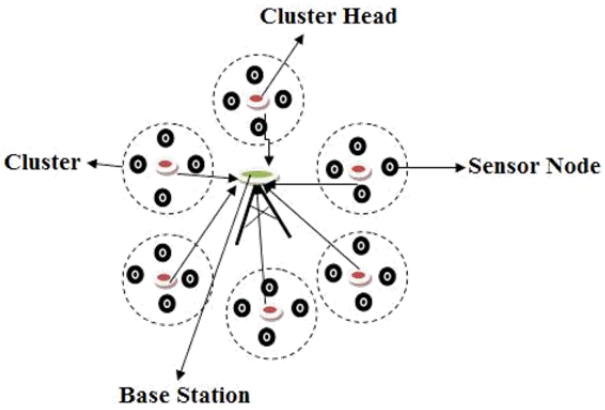

Figure 1: cluster head communication to the centralized base station

3. Cluster Head Prediction In Wireless Sensor Networks

To decrease the energy consumption and to improve the network lifetime for the sensors in wireless sensor network, Cluster Head prediction in wireless sensor network is devised. It is distributed clustering algorithm. It makes local decision to predict the cluster head. We have used Markov model to predict the cluster head on the basis of current state [4].

3.1. Set-up phase

The goal of the setup phase is to form the clusters and select the cluster head. For the formation of cluster Basic leach protocol is used and cluster head selection mechanism shown in the algorithm.

3.1.1. Proposed Algorithm

Data:
Energy of Sensor Node within the Cluster; Distance to the Base Station;
Result:
Selected Cluster Head within the cluster initialization;
while {No Change in Cluster Head Co-ordinates }**do**
read current State of the Sensor Node;
Apply Markov Model to analysis Sensor Node;
if
{Better Position is found}
then
(Update the Co-ordinates of Cluster head); **else**
(Fix Cluster Head Position and Start Communication);
end
End

Algorithm 1: Cluster Head Selection in Wireless Sensor Network

3.1.2. Initialization

In the initialization phase, random position of cluster head are selected for the cluster formation using leach equation

3.1.3. Representation of CH

Set of cluster head are represented by cluster head node id $C = (CH_i; CH_2; CH_3; CH_4:::::CH_n)$. All the sensor nodes are assigned to the cluster head which have shortest distance from all the cluster head.

3.1.4. Cluster head updating

In the initial round, all CH have the same energy but after some rounds CH and sensor depletes its energy in transmission, receiving and aggregation. After some rounds cluster head is selected on the basis of markov model which have energy greater than the average residual energy and average distance between sensor nodes to the cluster head is minimum.

3.1.5. position updation

update the selected cluster head node id until the desired condition meet.

3.2. Stead State Face

After the formation of cluster, TDMA schedule is assign for the data communication process. Initially all the sensor node sends sensing data, position and residual energy information to the CH as per the assign schedule of TDMA. CH shrinks the information and combines into the single signal then send to the BS or to the nearest CH towards the BS (when CH node communicating indirectly via other CH nodes instead of directly). Due to the impact of compression process on non-CH node as well as CH node, amount of information is reduced. After the completion of the round, set-up face and steady state face repeated.

On the basis of received information (position and energy) of the sensor nodes, the routing structure is created that is already discussed in the setup face.

After the creation of routing architecture, BS broadcast CLU-ROU-IND message to the entire sensor nodes. When the non-CH sensor nodes received CLU-ROU-IND message then it sends sensing data, position and residual energy to the CH node as per assign schedule of TDMA.

In the cluster, when all of the information is received at the CH, the CH node performs aggregation to the received information and combines them into the single signal SEN-INF-RSP.

This CH node SEN-INF-RSP message is send to the nearest connected CH towards the base station or directly to the base station if it is directly connected to the base station. Reformation of the cluster is begins when CH node doesn't received the signal from the non-CH node. Thus, the calculation overhead only depends on formation of the cluster and selection of the CH node within the cluster.

4. Experimental Analysis

To show the performance of proposed algorithm residual energy of CH is analyze. if the residual energy is more then network will sustain to the longer duration, it increases the network lifetime.

4.1. Residual Energy

It is the energy left after some communication rounds. IF distance between sensor node and CH is less , it will consume less energy otherwise it will consume more energy.

4.2. Simulation Environment

For the simulation analysis, experiment is performed in matlab and java-8.0. In which three test cases is analyzed. First when base station placed at the center, second when base station placed at the corner and third when base station placed outside the network. Parameters taken as input are initial energy of all sensor node is 2j, network size is 200*200, number of nodes 200 and all the nodes are homogeneous(means all node have same configuration).

4.3. Base station placed at the center

When Base station placed at the center, it is observed that performance of LEACH is lowest due to no parameter is taken to select the cluster head. Performance of E-Leach is better than leach due to one parameter energy is taken for selection. Finally performance of proposed algorithm better then both of existing works due to energy and distance both are taken as input for the selection. Result is shown in figure 2

4.4. Base station is placed at the corner

When Base station placed at the corner, performance of LEACH [1] and E-LEACH [9] depletes energy rapidly as compare to proposed algorithm as shown in figure 3. This is fact that due to CH in LEACH and E-LEACH dies earlier as compare to the proposed mechanism

4.5. Base station placed outside the WSN

When Base station placed at the outside the network, performance of LEACH[1] and E-LEACH[9] depletes energy rapidly as compare to proposed algorithm as shown in figure 4. This is fact that due to CH in LEACH and E-LEACH dies earlier as compare to the proposed mechanism. To improve the performance of case 2 and case 3, routing is one of the solution. Indirect communication is required instead of direct

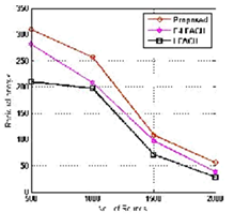

Figure 2: Base station place at center

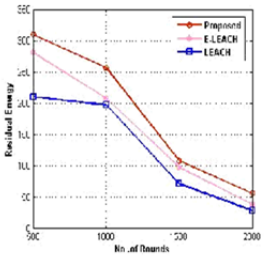

Figure 3: Base station place at top corner

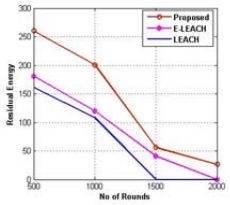

Figure 4: Base station place at outside the WSN

5. Conclusion And Future Work

In multi-hop inter cluster communication relay tra c increases at CH while getting near to the base station and consumption of energy is much more in direct communication between CH to sink node. Therefore, CH dies earlier. In this paper, cluster head prediction in wireless sensor network algorithm is devised to reduce the energy consumption in cluster communication. In order to achieve the objective workload markov model is used by taking energy and distance as a input criteria. But performance of network decreases as BS goes outside the network. So, in that case instead of direct communication indirect communication is required for that routing is needed In future we are going to implement clustering with routing mechanism to improve the performance.

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