Energy Efficient Cluster based Routing in Wireless Sensor Networks

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Abstract
Energy is a scare resource in the wireless sensor networks. Clustering is an effective way to enhance the system performance of wireless sensor networks. We propose a energy efficient cluster based routing protocol in wireless sensor networks. In this protocol, we study a data transmission for cluster based wireless sensor networks, where the cluster formations are based on some suitable parameters such as residual energy of the node, remaining buffer size, and distance to the sink. The Cluster head is collect the data and aggregated after find an efficient path then send to sink.

Keywords
Energy, Clustering, Data transmission, wireless sensor networks

I. Introduction

The Wireless sensor networks consist of group of sensor nodes to perform distributed sensing task using wireless medium. The sensor devices are equipped with a small battery, tiny microprocessor, radio transceiver, and a set of transducers that used to gathering the information from environment and send to the base station. It used to monitors the environment or system by measuring physical parameters such as temperature, pressure, humidity. The sensor node has low power, low cost. The wireless sensor network applications are military and battlefield surveillance, forest fire and flood detection, habitat exploration of animals, patient monitoring, and home appliances etc. The sensor networks are severely resource constrained such as energy, computing capabilities, communication resources. Energy is the most critical issue in wireless sensor networks. Each sensor is typically fitted with a finite non renewable energy source. Replacing batteries are impossible. The routing protocols are classified into three categories flat based routing protocol, hierarchical routing protocol, location based routing protocols. The hierarchical routing protocols are efficiently maintaining energy consumption of sensor nodes by using multi-hop communication and performing data aggregation and fusion. Clustering is grouping of nodes based on some criteria. In cluster, cluster head (CH) is the prime node which is responsible for data aggregation. Data aggregation is the combination of data from different sources by using function such as suppression (eliminating duplicates), min, max and average. It is used to eliminate the redundant transmissions and reduce the amount of data traffic. This protocol allows routing the data from cluster heads to base station and thus save the energy by reducing the long distance transmission occurrence. In this paper we have proposed an energy efficient routing based on clustering to prolong the lifetime of network.

II. Related Work

In hierarchical networks, nodes are separated to play different roles such as cluster heads and cluster members. Each CH collects data from cluster members with in its clusters, aggregates the data and then transmits the data to sink. All of the hierarchical routing protocols aim to save the energy and then extends the life time of the networks. The hierarchical clustering protocol may execute reclustering and reselecting of cluster head periodically in order to distribute the load uniformly among the network.[1].Energy residue aware (ERA)clustering algorithm is one of the energy aware hierarchical method. It is also improved from LEACH protocol by including communication cost into the clustering. The communication cost includes the residual energy, communication energy from the data transmission node to sink.ERA uses the same cluster head selection but it provides an improved scheme to select the Cluster head based on some criteria.[2] The Leach protocol includes randomized rotation of the high energy cluster head position such that it rotates among the various sensors in order to not drain the battery of single sensor node. In addition, LEACH performs local data aggregation to compress the amount of data being sent from the clusters to the base station, further reducing energy dissipation and enhancing lifetime. Sensors elect themselves to be local cluster heads at any given time with a certain probability.[3]These CHs broadcast their status to the other sensors in the network. Once all the nodes are organized into clusters, each cluster head creates a schedule for the nodes in its cluster. This allows the radio components of each non cluster head node to be turned off at all times except during its transmit time, thus minimizing the energy dissipated in the individual sensors. Once the CH collects the data from non cluster head nodes,

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then the CH is aggregates the data and transmit to sink .[4] In this protocol, we join different ideas from the previous protocols in order to optimally undertake the problem of prolonging lifetime in sensor networks. The proposed protocol performs cluster head election and routes discovery using various criteria such as residual energy, buffer size and distance to sink.

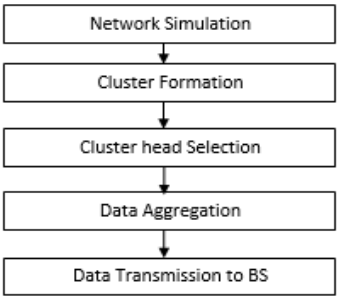
III. System Model

In this protocol, the role of cluster head must be rotated among all the sensors. Therefore the operation of this protocol divided into rounds. Each round begins with the formation of cluster heads phase and the then in the route discovery phase. Multiple paths between the CHs are constructed as well as aggregated data are sent to the sink node. In proposed scheme, the cluster heads are selected based these parameters.

Node Residual Energy: Selected nodes must have a high residual energy.

Distance to neighbor nodes: It is the sum of distance of each active neighbor nodes to node Si itself.

Cluster head frequency: A record of the number of times each node served as a cluster head is kept to avoid electing the same node recently.



System Model

A. Network model

This paper assumes that 106 sensor nodes are randomly scattered in a two dimensional square field. The simulation area is 1000*1000 square meter. Each sensor node has a unique ID in the network and nods are cannot be recharged. Also at any time, we assume that each sensor node is able to compute its distance to sink, residual energy and buffer size.

Area of simulation	-1000*1000 sq.m
Total number of nodes	-106
Common Nodes	-100
Cluster/Cluster Head	-4
Sink Node	-1
Access Point	-1

B. Cluster formation phase

Clustering is grouping of nodes based on some criteria such as residual energy of the node, buffer size and frequency range. Clustering is in such a way that intra cluster similarities is more and inter cluster similarity is less. In cluster, Cluster Head (CH) is the prime node which is responsible for data aggregation.

Procedure for Generate Clusters ()

{ #Determine alive nodes in current round
For i=1to N
If RE(si)>0
Alive_node_list← Alive_node_list U si
Calculate average node energy
For i=1to N
Tot ←Tot+RE(si)
Avg_eng ←Tot/N
For i=1 to N
If RE(si)> Avg_eng
#Calculate cluster head selection probability of the node
CHPsi=(RE(si)/Eo+C+1/FQ.si) – D and C= A_node(si)/ N_node(si)
# RAND() is function generates random number between [0,1]
T= RAND(0,1)
# x is initial cluster probability
If CHPsi > xT
Clusterhead _list ←Clusterhead _list ∪ si
Member_list←Alive_node_list - Clusterhead _list
For each node belongs to Member _list
For each cluster_head i Clusterhead _list
Calculate distance distto(si) between each member node and cluster_head si
Min_dist←min{distto(si),distto(si+1),distto(si+2),……distto(|Clusterhead_list|)}
id← node id of minimum distance cluster head from the node ,← si Clusterhead _list
Clustermember(id)←Clustermember(id)∪ {node}
Clusterhead(node)← id }

C. Cluster head selection

Each node first broadcast the cluster head election message (CE_Msg) with in a radio range r. This message contains the value of CE parameters. Each node receives the CE_Msg from all neighbors in its cluster range and compares it with its CE.If nodes CE is the largest value with in radio range r, it will set its state as cluster head. CE parameter obtained by equation 1.

$$CE = \frac{(E_{node\,-\,res})\,j}{(1-\frac{(dis(j)))^2}{100}}$$

Where,(Enode-res)j is the current residual energy of node j dis (j) is calculated by equation 2.

$$dis(j) = (\sum (|D_{db}(j) - D_{db}(i)|) \times t_p \times k)$$

In here Ddb is node distance to sink also we assume that number of bits, k=1 and transmission power, tp=1.

After selecting the CH node, the CH node collects the data from within its cluster members and aggregated. The data aggregation function is to reduce the amount of data traffic and data redundancy.

Data aggregation

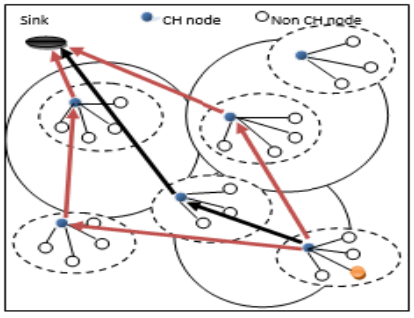
Data aggregation is a process of aggregating the sensor data using aggregation method. The general data aggregation algorithm uses the sensor data is aggregated by using some aggregation approaches such as centralized approach, In network aggregation approach etc.This aggregated data is transferred to the sink node by selecting the efficient path.

In network aggregation

In network aggregation is the global process of data gathering and routing information through the multihop network, processing data at intermediate nodes with the objective of reducing resource consumption, thereby increasing network lifetime.

D. Energy aware multihop Routing

When cluster heads deliver the data packet to the base station, they first aggregates the data received from cluster members and then send the packet to the base station using multi hop path via the intermediate cluster heads. Choosing energy consumption procedure to extend the network life time. On the other hand, decreasing the energy cost per packet also contributes to network life time. Here, we design a routing path from each cluster head to base station that trying to minimize the energy cost per packet. The routing method is based on shortest path algorithm. The source node is to find shortest path then reach the sink node. We propose an energy aware routing strategy in order to provide balanced energy consumption in wireless sensor networks, hence,prolonging the lifetime of the network..In first phase,the base station has the knowledge of entire network. It forms a connected graph G=(V,E) using the cluster head as the vertices.



Functional diagram of the EECR

Therefore G consist of vertices V=Cluster head)_list{base station}and two vertices are connected each other if only if

(si,sj)={(si,sj)|d (si,sj)U2Ri&& d(sj,BS)<d(si,BS)}

The cost is assignment to each in the graph using the following formula:

$$Cost(si,sj) = RE(sj)/d(si,sj)$$

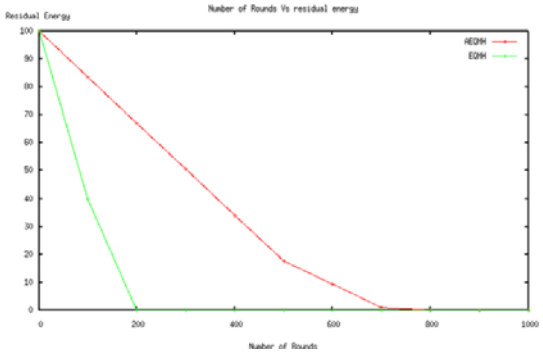
Where α is a propagation constant between [2,4] and Ri is transmission range of sensor si. The base station uses dijistra's shortest path algorihm choosing base station as source. Where α is a propagation constant between and Ri is transmission range of sensor si. The base station uses dijistra's shortest path algorihm choosing base station as source.

Table.1 Simulation parameters

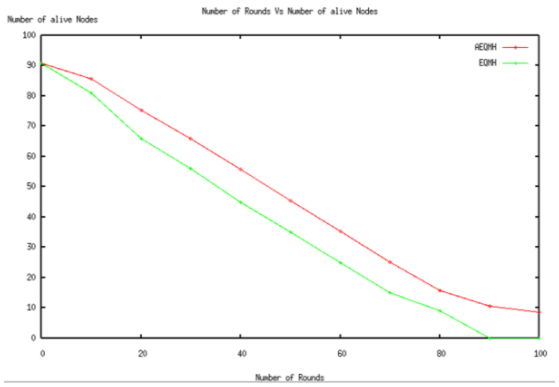
Parameters	Value
Network field	1000*1000
Number of nodes	106
Cluster radious R	30m
Sensing radious r	10m
Initial energy	10J
Data packet size	1024 bytes
Ethreshold	0.01 J
Eele	50 nJ/bit
Efs	10 nJ/bit/m2
Threshold distance	
MAC layer	IEEE802.11
Simulation time	1000s

IV. Simulation Results

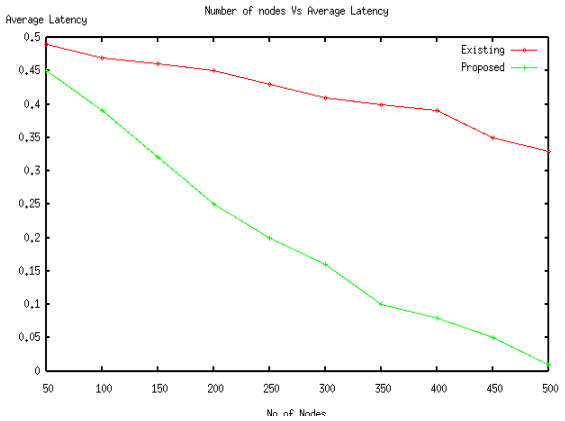
Energy efficiency



Network lifetime

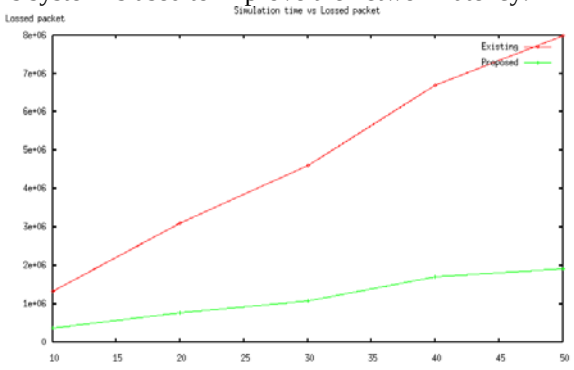


Number of Alive Nodes



Network latency

The proposed system is to provide the better performance than existing one. Results are analyses based on graphs. This system is used to improve the network latency.



Packet delivery ratio

First, we evaluate the energy efficiency of the proposed protocol and compare the network lifetime of the proposed one. Figure shows that the number of nodes still alive over the simulation period and it clearly improves the network lifetime.

V. Conclusion and Future work

In this paper, we proposed a Energy Efficient cluster based routing protocol (EECR) for wireless sensor network. Instead of selecting the cluster heads based on residual energy, buffer size and node distance. The cluster head responsible for data aggregation and aggregated data send to the base station. Simulations shows that the proposed model improve the life time of the network.

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