Energy Efficient Routing in Wireless Sensor Networks by Cber Protocol

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***Abstract*— Due to recent technological advancement in electronics and wireless communication has enabled the improvement of low-power and low-cost wireless sensors networks. A Wireless Sensor Network (WSN) of spatially distributed autonomous sensors to monitor physical or environmental conditions such as sound, pressure, temperature, etc. and cooperatively pass their data through the network to the main location by using multi hop wireless routing. The most important challenges in WSNs is to design energy efficient routing mechanism to increase the network lifetime due to the limited energy capacity of the network nodes. Hot spots in a WSNs emerge as locations under heavy traffic load, in such areas nodes quickly drain energy resources, which leads to disconnection in network. Cluster based routing algorithms in WSNs have gained increased interest recently, and energy efficiency is of particular interest. In a cluster of nodes, cluster head (CH) is elected and gathers information from all its cluster members and forwards to adjacent CH and last to sink node. CH absorbs more energy as compared to other cluster members. To balance the traffic load in the network and the energy consumption, the CH should be rotated among all nodes and the cluster size should be carefully determined at different parts of the WSNs. In the proposed system, we proposed a cluster based energy efficient routing algorithm (CBER), CBER elects CH based on nodes near to the optimal cluster head distance and residual energy of the nodes. In WSNs most of the energy is consumed for transmission and reception of data, and it is a non linear function of transmission range. In this project, the optimal cluster head distance which is linked to optimal energy consumption is derived. The residual energy is considered in the CH election in order to increase the network lifetime and energy efficiency.**

Keywords*— *MANETs, Clustering, Energy efficiency, Wireless Sensor Networks, and Routing

1. INTRODUCTION

Typical sensor nodes are able to carry out sensing, data processing, and communicating components, making it feasible for a wide range of promising applications, such as: environmental monitoring (e.g., humidity, temperature), disaster and health care areas providing relief, conferencing, file exchange, commercial applications including controlling product quality, military applications and managing inventory . For these purposes, sensors are usually deployed densely and operated autonomously. Furthermore, sensor nodes are normally battery-powered, and left alone makes it quite challenging to recharge or replace node batteries. Hence, one of the important problems in WSNs is how to prolong network lifetime with constrained energy resource. If each and every node starts to transmit and receive data in the network, great data collisions and congestions will be experienced. Therefore, the nodes in WSNs will run out of energy very quickly. As a result, the energy of each sensor nodes has been a major limitation. The research in data centric WSNs isconcentrated on selection of network architecture and energy efficient data gathering, as a backbone of routing protocol and data aggregation mechanism, plays an important role in achieving it. All aspects, including protocols, architecture, algorithms and circuits, must be made energy efficient to prolong the network lifetime of the sensor node. At routing layer, the main purpose is to determine ways for energy efficient route and reliable forwarding of data from the source nodes to the sink to save energy consumption.

Project aims on the network level energy preservation protocols and algorithms in this project. Due to different inherent characteristics of the WSNs that differentiates from other known networks such as cellular or mobile ad hoc networks makes very challenging for designing routing protocols. Furthermore, there may also be other critically-located sensors not necessarily close to data sinks, which carry the burden of relaying large amounts of data traffic, especially when multiple high rate routes pass through these sensors. Such nodes are usually frequently chosen to be data relays by routing algorithms and may serve a large portion of the network traffic, due to their convenient locations. Thus, avoiding the failure of such nodes caused by early energy depletion is critical to ensure a sufficiently long network lifetime.

2. RELATED WORK

Many different approaches have been carried out to design feasible WSNs. Energy conservation is crucial to prolong the network lifetime of WSNs. Many approaches for energy efficient routing have been proposed to reduce energy consumption. One alternative approach to conserve energy is using clustering technique [7]. In addition, when scalability is considered to be a major problem when network density is of hundreds and thousands of nodes then clustering is considered to be a useful technique. In various WSNs applications routing efficiency is considered important for energy efficiency, load balancing, and data fusion [8]. In this project we are concern about CH selection schemes and discuss some of the associated schemes. In clustering, only CHs need to communicate with the sink node via multi hop communication.

Low Energy Adaptive Clustering Hierarchy [3] is a well known clustering algorithm in which the CH in cluster is periodically rotated among members to achieve energy balance. However, this scheme showed only partial success, it needs a new cluster formation process at every section. With cluster formation, in each cluster with random probability a new CH node is re-elected, and from the promising CH candidates, the optimal node should be adaptively optimized for minimum communication distances to the maximum number of one hop neighbors. This only produce worst suboptimal solution due to cluster re-election process, which results in the nodes to spend additional delay and energy. In addition, LEACH requires all CHs to perform single hop transmissions to the networks sink, thus it suffers from the cost of long-range transmissions. As a result, the CHs that are further away from the sink depletes their energy much earlier than others.

EARACM [9] selects some overhearing nodes as CH nodes. This scheme adopted the multi-hop transmission to further minimize the energy absorption. Unfortunately, this benefit comes from sacrificing the resulting transmission delay and communication overhead since each CH node has to maintain the status of the other CH nodes.

In EECS [10], during cluster formation it allocates only less number of nodes to the clusters with longer distances to the sink node. Nevertheless, it is still based on single-hop communication to the sink from the CHs and is not scalable to large-scale or high density networks. In addition, clusters farther away from the sink node is limited by small cluster size by using a weighted parameter in order to reduce the energy consumption for long distance data transmission to sink node. Simulations results show that EECS performs better compared to LEACH in terms of energy efficiency. However, it needs extra knowledge about the WSNs, such as communication distance between CHs and Sink node. Furthermore, this extra requirement adds overheads to all nodes due to data aggregation in the WSNs.

In HEED[11] where a node uses its two parameters communication cost between cluster members and remaining energy to probabilistically elect itself to become a CH. HEED is a multi hop clustering algorithm for WSNs. Remaining energy of each sensor node is used to probabilistically choose the first set of CHs, as usually performed in other clustering techniques. In HEED, communication cost between cluster members shows the node degree or node as proximity to the neighbor and is main parameter that decides whether to join the cluster. However, hot spot issue in HEED appears in areas that are close to the sink, as nodes in such areas need to relay incoming traffic from other parts of the network. Furthermore, knowledge of the whole WSNs is necessary to determine communication cost between cluster members. HEED is a distributed clustering mechanism in which CH nodes are picked from the WSNs. HEEDs CH selection parameter is a hybrid of energy and communication cost.

3. CBER: CLUSTER BASED ENERGY EFFICIENT ROUTING

The CBER employ the self organization technique for routing and clustering of WSNs. Furthermore, here a network of homogeneous sensor nodes are considered. In the proposed scheme, each node has to perform the basic task of sensing the field parameters, form data packets, and communicate with the cluster head. Clustering in WSNs means partitioning nodes in network into different clusters. The network model considered in this project is a hexagonal structure with source nodes and sink node. Sink node is constant and fixed for each simulation.

Sensor nodes are homogeneous in nature, are assigned with a unique identifier and have same capability. They are able to function in an active or sleeping state. Nodes can use transmit power control to change the amount of power transmitted according to the distance of the receiver. In the CBER, each nodes shares information about the current energy state with only its one hop neighbors. The nodes of CBER will be in four different modes. The four modes are described as follows:

Cluster Head: While in CH mode, it gathers and aggregate information from its members and sends or receive message between the adjacent CHs or to sink node at regular intervals. In addition, it selects the next adjacent CH node where the data to be transferred. In hierarchical routing protocols, CHs are responsible for gathering, aggregating and forwarding the data to the sink. Thus, they are responsible for conveying the complete information of its cluster members. CH is then responsible to transmit this data towards the sink. There are two types of communication for CH, Intra cluster communication and Inter cluster communication. Intra cluster communication is between CH and its cluster members. Inter cluster communication is between CH and its adjacent CHs.

Cluster Member: A cluster member is a member that belongs to a particular cluster. It regularly transmits the collected information to its CH.

Dead Node: This is a state in which sensor node cannot operate anymore because its energy has been depleted completely or it has broken down. The node cannot either transmit or receive the data. In addition, the node is considered to be in this state when its residual energy (E res) is below 0.005J.

Isolated Node: This means node doesn't have any one hop neighbors either to transmit or receive the data. In this state, node is disconnected from the network. Operation in CBER is divided into section. We perform energy aware clustering in sections and each section results in selection of different CH. One section means one end- to-end packet delivery. The CH is rotated among sensors in each section and distributes the energy consumption across the networks. CBER is divided into setup and steady transmission phase. The first phase is the setup phase, where members are classified into certain clusters and CH is selected for particular cluster. And the second phase is the steady state phase to transmit data. Data packets is transferred intra cluster between CM and CH in each partition level and inter-cluster between CH leaders in each partition level. In the first phase, setup phase, the hexagonal based cluster is formed and each members in the network is assigned to different clusters. During the creation of route for inter-cluster routing, the CHs carry out their duties while transforming into the following three modes while relying on different roles.

Initial mode: When Inter cluster routing phase starts, all CHs are initialized as the initial state.

Route broadcasting mode: This is a mode where the signals are broad-casted to establish an inter-cluster route.

Route established mode: In this mode, routes are established from its own routes and those of its neighbors.

4. ENERGY CONSUMPTION MODEL

In this project we use a radio model proposed in as radio energy model to measure energy consumption for proposed CBER algorithm. In the radio model is a combination of three main models: transmitter, the receiver and the power amplifier. The energy consumed by the transmitter consists of transmitter circuitry and the power amplifier, and the energy consumed in receiver for receiving data consists of the receiver circuitry. When a packet transmitted from a transmitter to a receiver, where the distance between them is d, the received signal power at the receiver is :

$$p_r (d) = p_r G_t G_r \lambda^2 /(4\pi)^2 d^\beta \text{ Loss}$$

where G_r and G_t are respectively receiver and transmitter gains. Furthermore, Loss represents any additional losses in the packet transmission and λ represents carrier wavelength. The propagation loss factor β, which is typically varies between 2 and 4. Hence, considering

$$G_t = G_r = 1$$

5. OPTIMAL CLUSTER HEAD DISTANCE

In an end-to-end multi-hop transmission considering a equal hexagonal cell, the best route between the source and sink node is the direct line between them, where intermediate nodes are properly deployed (the nodes exists whenever needed). we consider static traffic in the network. Network is considered to have static traffic when traffic rate following along the network is constant.

6. SIMULATION EVALUATION

In this section, we evaluate the performance of our proposed algorithm (CBER) using Network Simulator. In this paper, we consider the each node's energy consumption has the summation of energy consumed in the transmission and reception of data packets per section. We compare CBER with LEACH and HEED. The results obtained from simulation are average of several tests.

7. CONCLUSION

In this project, proposed the cluster based energy efficient routing algorithm (CBER) to extend the network lifetime, and simulation results are compared with the previous cluster based routing algorithms LEACH and HEED. The proposed CBER algorithm selects the CH node as the member (within the cluster) that minimizes the value of $[\alpha r^i /2r - (1{-}\alpha)Eres/\ Ecap\ ]$. Furthermore, this CH node is the node that has the best residual energy and requires the minimum energy to be reached by the cluster members. In addition, weight parameter α decides the relative importance placed on these two parameters. The results from simulations show that the CBER algorithm has best efficiency in terms of both data packets received by sink node and the network lifetime. CBER creates additional overhead of control packets during the end-to-end packet transmission and unbalanced utilization of nodes near sink. Our next step is to improve clustering algorithm to minimize the overhead of control packets and efficient utilization of nodes near sink.

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