Advanced Data Routing Protocol With Improved Hopping in Chiron

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ABSTRACT

Wireless sensor network [1] generally consists of large number of sensor nodes. The wireless sensor network can be defined as large number of small sensing self powered nodes which gather the information from the geographical area and communicate in wireless fashion with the goal of handing their processed data to the base station. Due to the power restriction of sensor nodes, efficient routing in wireless sensor networks is a critical approach to saving node's energy and thus prolonging the network lifetime. In this paper, we propose advanced data routing protocol with improved Hopping in Chiron. As in Chiron chain leader belonging to the certain covering angle transmits the gathered data to the chain leader of the different covering angle this creates the increase in distance, and delay. So the main goal of our research is to improve the overall lifetime of network, time required to transfer the packets and improvement in number of survival sensor. Simulation results show that the proposed protocol is superior to Chiron. Comparing to the Chiron the proposed protocol scheme achieves improvement about 8% to 12%, 9% to 13.5% , 5% to 11% in overall lifetime of the network, number of survival node and time taken for packets transmission respectively under various small and large simulation areas respectively.

Key Words-- Wireless Sensor Network, Routing protocol, Chiron, lifetime

INTRODUCTION

Wireless Sensor Networks (WSNs) have gained a great deal of attentions in recent years [3]. A WSN generally consists of a large number of battery-powered, resource constraints wireless sensor nodes, which might be randomly deployed in an unattended and unreachable terrain, for sensing and collecting the wanted data from the surroundings, and thus reporting the fused information to a remote *Base Station* (BS). WSNs have been widely employed in several applications such as habitat monitoring, disaster supervising, and bioinformatics [1] [10]. Due to the characteristics of random deployment and low cost with sensor nodes, it is expected to be difficult and unnecessary for recharging them once their energies are exhausted. As a consequence, how to conserve node's power and thus prolong the network lifetime is a critical issue in WSNs. Several power-efficient routing protocols have been proposed to address this topic [2] Chain-based routing is one of most significant routing mechanisms. In such routing scheme, sensor nodes are linked into a single or multiple chains in advance. In data dissemination phase, each node communicates only with its closest neighbors, and takes turns to be the chain leader for transmitting the aggregated data to the BS. Even the chain based routing protocols can effectively balance the node's energy dissipation, and thus significantly extend the network life time they would be easy to cause serious transmission delays and redundant paths, particularly for large sensing areas. In order to improve the deficiencies as aforementioned we propose advanced data routing protocol with improved Hopping in Chiron. In CHIRON the technique of Beam Star [9] is first used to divide the sensing area into several fan-shaped groups. The sensor nodes within each group are then self organized into a chain for data dissemination. Unlike traditional approaches, instead of taking turns, we consider the node with a maximum residual energy as chain leader candidate. In addition, for avoiding a longer transmission would be incurred among chain leaders, the nearest downstream chain leader will be elected for relaying the aggregated sensing information. With these strategies, our proposed protocol has the following merits. 1) Each node can get its location information passively from the BS with a minimum control overhead. 2) The collected sensing data can be reported to the BS, in a short-haul and multi-hop transmission manner. 3) It can effectively reduce the chain length and redundant transmission path, so thus significantly improve the delay time and save network energy as compared to other counterparts.

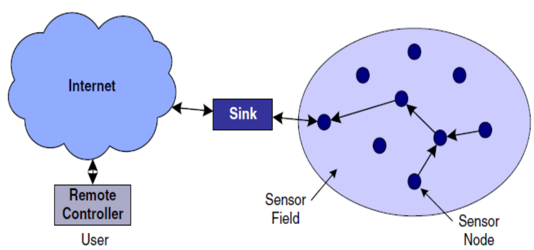

Fig. 1. Sensor network architecture.

The sensor nodes are usually scattered in a sensor field as shown in Figure1.Each of these scattered sensor nodes has the capabilities to collect data and route data back to the sink. Data are routed back to the sink by a multi-hop infrastructure less architecture through the sink as shown in Figure 1. The sink may communicate with the task manager node via Internet or satellite.

The remainder of this paper is organized as follows. In Section 2, routing technique used in WSN is discussed. In section 3 some previous related works which motivate our research are briefly reviewed and discussed. The design philosophy and implementation of our proposed protocol are detailed in Section 4. Section 5 discusses the improved scheme. Section 6 manifests our simulation environments, parameters, and results. The conclusion follows in Section 7.

2. ROUTING TECHNIQUES IN WSN

Wireless sensor networks (WSN) consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue. Routing protocols in WSNs might differ depending on the application and network architecture. Overall, the routing techniques [2] are classified into three categories based on the underlying network structure: flat, hierarchical, and location-based routing. Figure 2 shows routing protocols in WSNs.

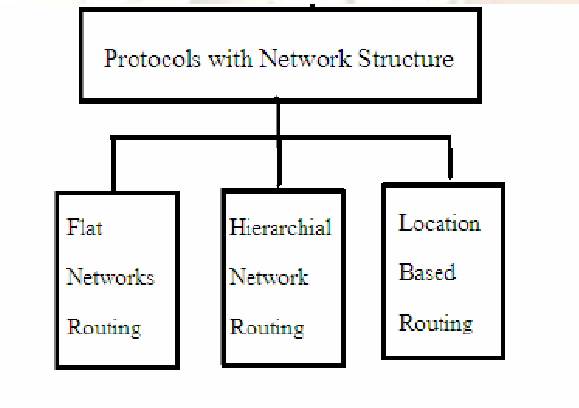

Figure 2: Routing Protocols in WSNs

In flat networks all nodes play the same role, while hierarchical protocols aim to cluster the nodes so that cluster heads can do some aggregation and reduction of data in order to save energy. Location-based protocols utilize position information to relay the data to the desired regions rather than the whole network.

3. RELATED WORK

In general, three strategies are considered for the design of data aggregation techniques in WSNs. They are cluster based, tree-based [6], and chain-based. In this section, we only review chain-based routing protocols, PEGASIS and Enhanced [5], and point out their pros and cons that motivate our research.

A. PEGASIS

PEGASIS is a basic chain-based routing protocol. In which, all nodes in the sensing area are first organized into a chain by using a greedy algorithm, and then take turns to act as the chain leader. In data dissemination phase, every node receives the sensing information from its closest upstream neighbour, and then passes its aggregated data toward the designated leader, via its downstream neighbour, and finally the base station. Although the PEGASIS constructs a chain connecting all nodes to balance network energy dissipation, there are still some flaws with this scheme. 1) For a large sensing field and real-time applications, the single long chain may introduce an unacceptable data delay time. 2) Since the chain leader is elected by taking turns, for some cases, several sensor nodes might reversely transmit their aggregated data to the designated leader, which is far away from the BS than itself. This will result in redundant transmission paths, and therefore seriously waste network energy. 3) The single chain leader may become a bottleneck.

B. Enhanced PEGASIS

In 2007, Jung et al. proposed a variation of PEGASIS routing scheme, termed as Enhanced PEGASIS [7]. In their method, the sensing area, centred at the BS, is circularized into several concentric cluster levels. For each cluster level, based on the greedy algorithm of PEGASIS, a node chain is constructed. In data transmission, the common nodes also conduct a similar way as the PEGASIS to transfer their sensing data to its chain leader. After that, from the highest (farthest) cluster level to the lowest (near to the BS), a multi-hop and leader-by-leader data propagation task will be followed. The EPEGASIS although has considered the location of the BS to slightly improve the redundant transmission path and the network lifetime, there are still some problems with that scheme. 1) For large sensing areas, the node chain in each concentric cluster would still become lengthy, and thus result in a longer transmission delay. 2) Since the leader node election strategy is same as that in PEGASIS (by taking turns), it did not consider the node's residual energy. 3) While the distribution of sensor nodes is not even, the transmission distance between two chain-leaders in different cluster levels might be lengthy, this would consume more energy.

4. PROPOSED PROTOCOL

For improving the deficiencies with the aforementioned schemes, in this section, we thus propose an energy efficient [4] hierarchical chain-based routing protocol. The design philosophy is described as follows.

A. Network model and assumptions

Without loss of generality, in our research, we also consider a WSN of *n* energy-constrained sensor nodes, which are randomly deployed over a sensing field. The BS is located at a corner of the sensing area, and equipped with a directional antenna and unlimited power. As a result, the BS can adaptively adjust its transmission power level and antenna direction to send control packets to all nodes in the WSN. Besides, for easy discussion, we define some notations as follows:

- R: the transmission range of the BS. For simplicity, we use distinct integers (1 … n) to represent various ranges.
- θ: the beam width (covering angle) of the directional antenna. Also, similar to the definition of R, different integers (1 … n) are used to indicate distinct angles.
- G θ, R: the group id. Theoretically, by changing different values of θ and R, the sensing area can be divided into n * n groups. Those are $G_{1,1}$ $G_{1,2}$ …, $G_{1,n}$, …, $G_{n,1}$, …, $G_{n,n}$
- Ni: the node i; the node set N= {n1, n2, n3… n i}, where 1≤i≤|N|.
- C x, y: the id of a chain which was formed in group G x, y. the chain set C= {$c_{1,1}$ $c_{1,2}$ ….}.
- L x, y: the leader node id of chain C x, y. The leader set L= {$l_{1,1,}$ $l_{1,2}$…}.
- Neighbour (ni): the neighbouring nodes of ni. The neighbouring nodes mean the nodes which are locating in the transmission range of a specific node.
- Res (ni): the residual energy of node ni.
- Dis(x, y): the distance between nodes x and y. The BS can be deemed as a special sensor node.

B. OPERATION OF PROPOSED PROTOCOL

The operation of proposed protocol consists of four phases: 1) Group Construction Phase. 2) Chain Formation Phase. 3) Leader Node Election Phase and 4) Data Collection and Transmission Phase.

1. Group Construction Phase

The main purpose of this phase is ready to divide the sensing field into a number of smaller areas so that it can create multiple shorter chains to reduce the data propagation delay and redundant transmission path in later phases. Instead of using concentric clusters as EPEGASIS scheme does, the proposed protocol adopts the technique of Beam Star to organize its groups. After the sensor nodes are scattered, the BS gradually sweeps the whole sensing area, by successively changing different transmission power levels and antenna directions, to send control information (including the values of *R* and *θ*) to all nodes. After all nodes receiving such control packets, they can easily determine which group they are respectively belonging to. In addition, by the received signal strength indication (RSSI), every node can also figure out the value of dis(ni, *BS*). A grouping example with *R*=1...3 and *θ*=1...2 is shown in Figure 3.

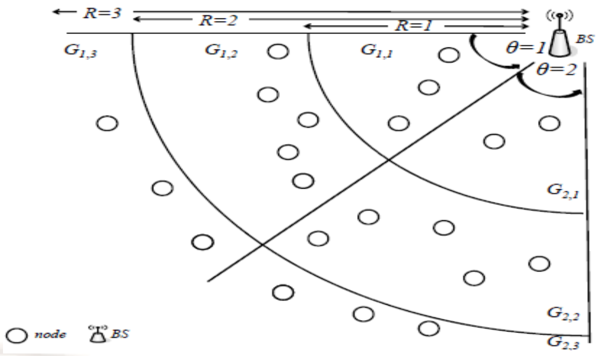

Figure (3): Grouping example with *R*=1…3 *and θ*=1...2

2. Chain Formation Phase

In this phase, the nodes within each group Gx,y will be linked together to form a chain Cx,y respectively. The chain formation process is same as that in PEGASIS scheme. For each group G x,y, the node ni with the maximum value of dis (ni, BS) (that is farthest away from the BS) is initiated to create the group chain. By using a [6] algorithm, the nearest node (to ni) of neighbour (ni) will be chosen to link the node ni, and become as the newly initiate node in next linking step. The process is repeated until all nodes are put together, and thus finally a group chain Cx,y is formed.

3. Leader Node Election Phase

For data transmission, a leader node in each group chain must be selected for collecting and forwarding the aggregated data to the BS. Unlike the PEGASIS and EPEGASIS schemes, in which the leader in each chain is elected in a round-robin manner, proposed protocol chooses the chain leader (*lx,y*) based on the maximum value *Res*(*ni*) of group nodes. Initially, in each group, the node farthest away from the BS is assigned to be the group chain leader. After that, for each data transmission round, the node with the maximum residual energy will be elected. The residual power information of each node *ni* can be forwarded with the fused data to the chain leader *lx,y* along the chain *cx,y*, so that the chain leader can determine which node will be the new leader for next transmission

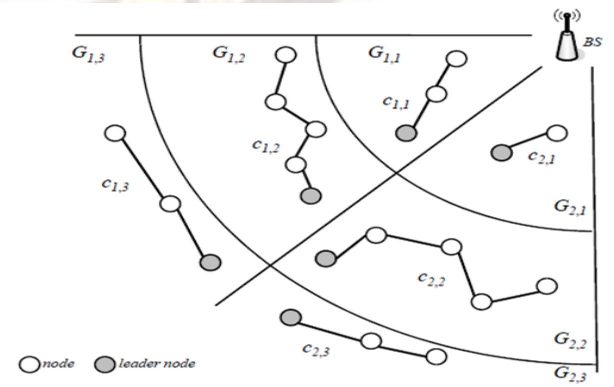

Figure (4): The group chains constructed from Figure 3

4. Data Collection and Transmission Phase

After completed the previous three phases, the data collection and transmission phase begins. The data transmission procedure in proposed protocol is similar to that in PEGASIS scheme. Firstly, the normal nodes in each group *Gx,y* transmit their collected data along the *cx,y*, by passing through their nearest nodes, to the chain leader *lx,y*. And then, starting from the farthest groups, the chain leaders collaboratively relay their aggregated sensing information to the BS, in a multi-hop, leader-by-leader transmission manner. In order to avoid a longer transmission distance incurred between two chain leaders.

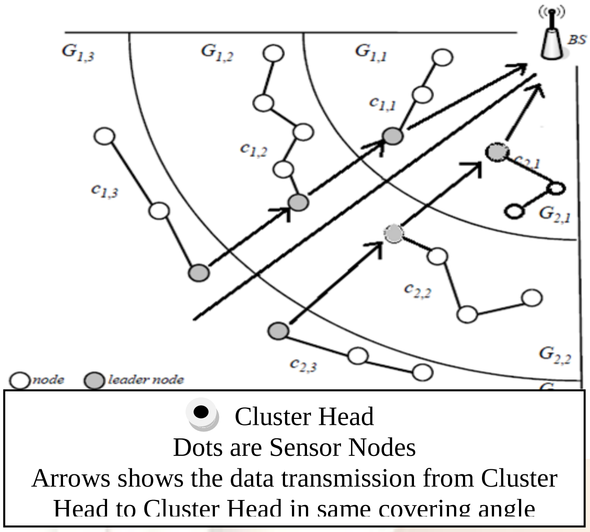

Figure 5: The data transmission flows

5. IMPROVED SCHEME

In Chiron the sensor field is used to split the area into the number of smaller area so that it can create multiple shorter chains to transmit the information. But due to change in covering angle occur at regular intervals so it increase the total distance and time to reach the information at the base station hence the lifetime of the network is affected. So to improve these parameter we change the scheme of data transmission flow. In proposed scheme the data is transmitted from cluster head to cluster in same covering angle. Hence data has no need to change its path from one covering angle to other. So the distance and time is decreased to transmit the information to the base station also the overall life and number of survival nodes are improved.

6. SIMULATION AND RESULTS

For evaluation the performance of our proposed protocol, in this section, we use a simulation tool MATLAB [8] to conduct several experiments.

A. Simulation environment and parameters

In our simulations, we consider three different sizes of sensing area: 100*100 m^2, 200*200 m^2 each is with 100 randomly deployed sensor nodes and 1000 iterations. The BS is located on the corner of sensing field. For each simulation scenario, the results are drawn by the average value of 10 runs.

B. Simulation results

Figure 6 shows the simulation results of improved number of survival sensor nodes versus number of iterations. In CHIRON routing is done on the basis of changing of covering angles. But in proposed algorithm there is no change in the covering angle occurs to transmit the data. Figure 6(a) shows that the numbers of survival rate of nodes are increased; Figure 6(b) shows that the overall lifetime of the network is increased. Figure 6(c) shows the improvement in the time taken to transferring the packets.

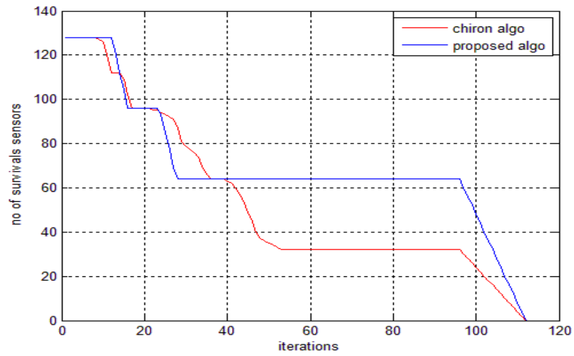

Figure6 (a): Number of survival nodes

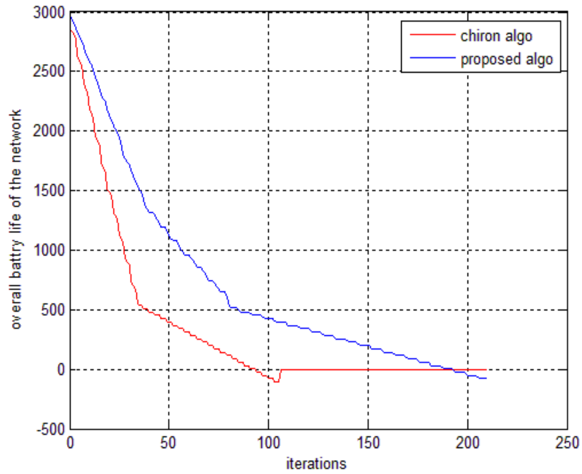

Figure6 (b): Overall lifetime of the network

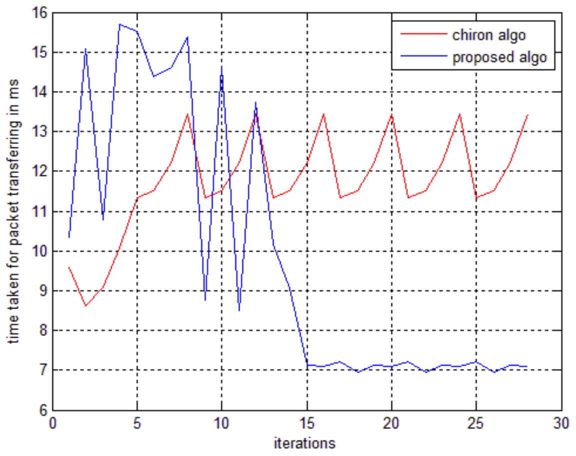

Figure6 (c): time taken for packet transferring in ms

7. CONCLUSION

In this paper, we propose an Advanced data routing protocol with improved hopping in Chiron which is suitable for large sensor networks with power and time constraints. As in case of chiron there are more hopping to transmits the data to the base station but in our case the data is transmitted through cluster head to cluster in same covering angle hence it reduces the extra distance covered in Chiron also the time taken to tranfering the packet to the base station thus it shows significantly improvement in the survival of overall sensors and lifetime of the network. Simulation results shows that the proposed protocol is superior to Chiron. Comparing to the Chiron the proposed protocol scheme achieves improvement about 8% to 12%, 9% to 13.5% , 5% to 11% in overall lifetime of the network, number of survival node and time taken for packets transmisson respectively.

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