Dynamic Enclose Cell Routing in Mobile Sensor Networks

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Abstract

Many routing protocols for wireless sensor network have been proposed, with the purpose of achieving efficient routing. However, when the mobility increases rapidly and the network topology becomes more complex, they have to utilize broadcasting method for packet routing, but the overhead grows rapidly. In this paper, we propose Dynamic Enclose Cell (DEC) routing algorithm to decrease the overhead of routing by constructing the cells with sensor nodes. Compared to existing routing protocols, the DEC routing algorithm is expected to decrease overheads and retain stable networks in high mobility.

1. Introduction

The compact, low-power, wireless sensor network technology is emerging [1]. The wireless sensor network technology enables to collect, communicate, and share sensor data such as temperature, pressure, brightness, and sound. Routing protocols, scalability, energy-efficiency, and security in static, wireless sensor network are the main research issues to overcome the limitation of sensor nodes such as small memory, low bandwidth, limited power, etc [2, 3, 4]. However, a few researches have done for dynamic routing algorithms in the mobility of sensor network nodes.

Existing on-demand routing schemes and proactive routing schemes have been proposed in mobile wireless sensor network environment. The on-demand routing schemes (e.g., AODV, DSR, TORA) are used to develop the routing path only when necessary. However, they have the scalability problem when the number of mobile nodes increases [5, 6].

In this paper, an innovative routing algorithm in mobile, wireless sensor network environment is proposed. The algorithm, called *Dynamic Enclose Cell* (DEC) routing algorithm, groups the nodes into cells and develops the routing path using the cell boundaries. When the nodes are moving, only the adjacent cells of the moving nodes are reformed. In this way, the impact of the node mobility is minimized. We explain our algorithm in section 2 and conclusion in section 3.

2. DEC: Our Proposed Algorithm

DEC routing algorithm consists of four components: *A Neighbor Beacon Exchange Scheme, Cell Discovery Scheme, Cell Routing Path Update Scheme, The Cell Routing Selection Scheme*. Each one is following the subsections.

2.1 A Neighbor Beacon Exchange Scheme

A neighbor beacon exchange scheme aims at maintaining the location information of the adjacent nodes using the beacon message exchanging to construct cells efficiently. Each node periodically broadcasts a beacon message to its neighbors. The location information of a node in this beacon message is utilized to keep track of the movement of the neighbor nodes. If the sensor nodes are moving frequently, the beaconing rate will increase.

Each node records the information of its neighbor nodes such as NeighborID, Position, TransmissionTime, and ExpiredTime. The record will be removed in the neighbor at ExpiredTime. TransmissionTime is the communication delay time from the node to the neighbor nodes identified by NeighborID.

2.2 Cell Discovery Scheme

The purpose of the cell discovery scheme is to construct the cells to connect every node in the sensor network. A node examines that two adjacent nodes can communicate with each other directly and construct a cell using the node and the two adjacent nodes (i.e., construct a minimum set of triangle). If no triangle cell is constructed, the neighbor nodes begin to explore their adjacent nodes to construct a cell with the minimum number of nodes.

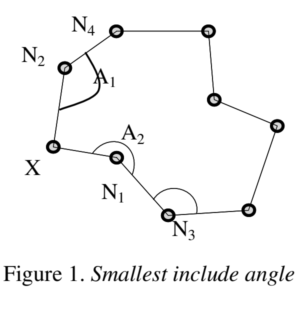

Figure 1. *Smallest include angle*

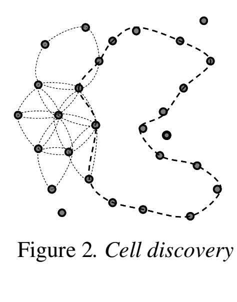

Figure 2. *Cell discovery*

For example, as shown in Figure 1, suppose that the source node, X, has only the two adjacent neighbor nodes (N_1, N_2). If N_1 can communicate with N_2 directly, a triangle cell (X, N_1, N_2) is constructed. Otherwise, N_1 and N_2 begin to find the next adjacent nodes from N_1 and N_2. N_1 identifies N_3 with the minimum angle, A_2 (the right side path). At the same time, N_2

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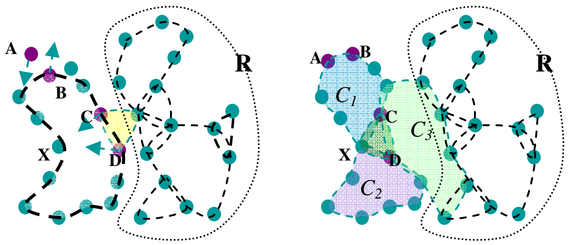
discovers N_4 with the minimum angle, A_1 (the left side path). While this step is applied iteratively, if the right side path meets the left side path at a single node, then a cell is constructed. Otherwise, no cell is constructed.

2.3 Cell Routing Path Update Scheme

The cell routing path update scheme reconstructs the cells when the nodes are moving. The main strategy of this scheme is to localize the cell reconstruction without changing the irrelevant cells in the entire network to recalculate the routing paths.



(a) (b)

Figure 3. *Cell routing path upgrade*

For example, as shown in Figure 3(a), suppose that node A and B are moving. In this case, it didn't change the cell because the adjacent nodes can reach at node A and B, and node A can communicate with node B directly.

Suppose that node C and D are moving. In this case, node X is able to reach at node C and D directly so that a new triangle cell (X, C, D) is constructed, as shown in Figure 3(b). The adjacent cells (C_1, C_2 and C_3) are adjusted accordingly. However, the irrelevant cells (e.g., the cells in R) are not changed. In this way, the cell routing paths are updated with minimum computation.

2.4 The Cell Routing Selection Scheme

The cell routing selection scheme selects a routing path with the minimum transfer time and effective computation to send a packet to the target node efficiently. We assume that each node has the information of all the nodes in a cell such as the location of all the nodes in the cell and transfer delay time from a node to another node in a cell.

The first step is to find the target node in the cells around the source node. If the target node is not found, the next step is to find the nearest node to the target node among all of the nodes in the cells which the source node belongs to. If the node is the neighbor node, a packet is just sent without selecting the cell. Otherwise, the cell is decided by the nearest node and packet is sent along the boundary of the cell. While this step is applied iteratively, a packet is sent to the target node.

For example, as shown in Figure 4, node M_1 is the nearest node to the target node, Y, of all the nodes in the cell C_1, C_2, and C_3 around the source node, X. Then M_2 is the nearest node from Y at M_1. Finally, Y is in the same cell, C_9 with M_1 and then the routing path is set up from X to Y.

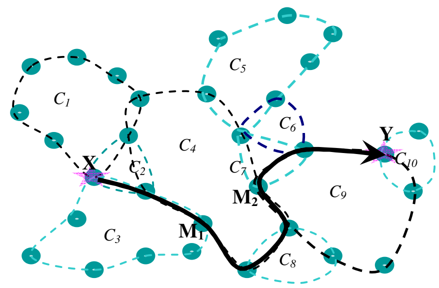


Figure 4. *Enclose Cell Geographic Forwarding*

3. Conclusion

Many protocols have been proposed for static wireless sensor network, we focus on the routing algorithm in mobile wireless network. Our routing algorithm is based on the cell construction and reconstruction when the nodes are moving. The main contribution of this algorithm is to introduce localization of the cell reconstruction to determine the routing paths without changing irrelevant cells in the entire network to recalculate the routing paths.

The future work is to simulate this algorithm and sensitivity analysis with changing the radio intensity and is to prove this algorithm is reachable.

4. Acknowledgement

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