Self-determining Geographic Routing considering Mobility in Mobile Wireless Sensor Networks

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Abstract. Geographic routing is a promising candidate for large-scale wireless ad hoc networks due to its simplicity and scalability. In Mobile Wireless Sensor Networks (MWSNs), sensor nodes with limited power and resources usually propagate data packets in a multihop fashion. Therefore, it is essential to increase network lifetime in wireless sensor networks. Thus, we propose a self-determining geographic routing considering mobility in MWSNs. In this paper, a relay node is selected based on remaining energy, location and mobility. The experimental result shows that the proposed scheme can provide an efficient greedy forwarding scheme in terms of energy consumption and the end-to-end delay.

Keywords: Geographic routing, Greedy Forwarding, Mobile Wireless Sensor Networks

1 Introduction

In MWSNs, there is a wide variety of applications which can be categorized as belonging to different areas such as industrial, home, health, environmental, military, automotive and commercial [1]. Geographic routing is generally considered as an attractive routing method in terms of scalability for both mobile wireless ad-hoc and sensor networks because a node utilizes the geographic location information of each sensor node to deliver packets over a network [2-4]. Therefore, geographic routing is an elegant way to forward packets from source to destination in very demanding environments without wasting network resources or creating any impediment in the network design. The limited lifetime due to the sensor node's battery is a typical problem. Several routing protocols have been designed for wireless sensor networks to satisfy energy utilization and efficiency requirement [5-6].

GPSR(Greedy Perimeter Stateless Routing) [4] is one of the well-known geographic routing schemes that are proposed using perimeter or face routing to route around voids or obstacles when greedy forwarding fails. A node sends the packet to neighbor nodes closed to its perimeter region.

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In this paper, we propose a self-determining greedy forwarding scheme to reduce the energy consumption and end-to-end delay. In this paper, all nodes calculate their weight based on their location information, remaining energy and mobility. Each node decides whether the node itself should be a relay node or not by evaluating the weight. A closest to the destination with a higher remaining energy node is selected as a relay node. The experimental result shows that the proposed scheme can provide an efficient greedy forwarding scheme in terms of energy consumption and the end-to-end delay.

The rest of this paper is organized as follows. Section 2 presents our proposed scheme. Next, in Section 3, we present some simulation results in order to evaluate the proposed scheme. Finally, we conclude our paper in Section 4.

2 Proposed scheme

In this paper, the process is localized and distributed so that all nodes involved in the routing process contribute to make a routing decision by them. Receiving packet nodes calculate the weight as a metric to determine whether it is responsible for forwarding the packets or not. A candidate node has the lowest value of weight is selected as a relay node. The weight is calculated by the equation below.

$$weight = \alpha \times \left\{ \left(\frac{Energy\_remaining}{Energy\_initial} \right)^{Q\_Distance} \right\} + \beta \times Q\_Mobility \quad (1)$$

where α and β are the modification coefficients to provide different weights for different parameters $(\alpha + \beta = 1)$.

In equation (1), the *Energy_remaining* and *Energy_initial* mean the amount of remaining energy of node and the amount of initial energy, respectively. A node with the highest remaining energy has the highest weight. Also the closest node from destination has the lowest value of *Q_Distance*.

In equation (1), the *Q_Distance* is calculated as follows:

$$\frac{T_r + \sqrt{(x_n - x_d)^2 + (y_n - y_d)^2} - \sqrt{(x_s - x_d)^2 + (y_s - y_d)^2}}{2T_r} \quad (2)$$

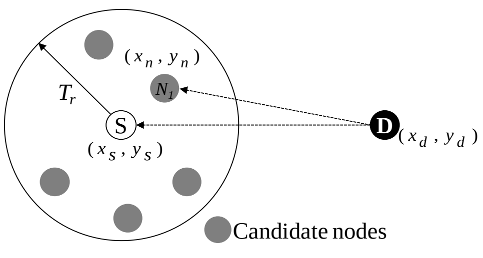

Fig. 1. the value of Q_Distance

An optimal relay node is selected by evaluating its weight as a candidate in relation to their energy, the distance and mobility. The relay node candidate closer should be the selected as the optimal relay node.

In second weighting factor in equation (1), the *Q_mobility* is computed considering the mobility as follows:

$$Q\_mobility = Q\_Distance \times P_{SN} \quad (3)$$

Where P_{SN} denotes the communication probability between the source and candidate node, which is calculated based on the predicted location.

3 Performance Evaluation

We consider that sensor nodes are randomly can aware the speed, movement direction and the amount of their remaining energy. Also, we assume that the sensor nodes with global positioning system (GPS) devices can be aware of their location using a localization mechanism [7-8].

Throughout the simulation, we set 1000 X 1000 network configuration. For our experiments, we used energy consumption for the simulation which was based on some numeric parameters obtained from [9]. The number of sensor nodes varies from 100 nodes to 400 nodes, transmission range is 150m. To validate the performance, we compare our proposed scheme with GPSR.

Fig. 2 demonstrates that our proposed scheme consumes lower than the other schemes. The objective of the algorithm is to prolong the network lifetime of the sensors and hence the network lifetime. We can see that our scheme is a more energy efficient forwarding scheme in terms of reducing energy consumption, which is one of the most important factors in wireless sensor networks.

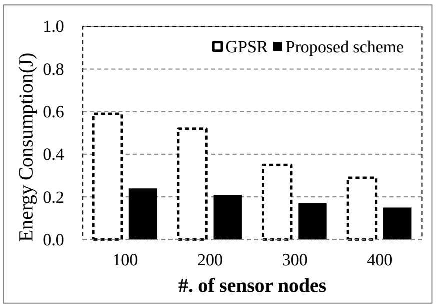

Fig. 2. Energy consumption

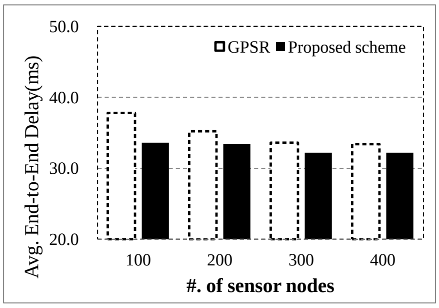

Fig. 3. Average end-to-end delay

As shown in Fig. 3, the end-to-end delay is lower than other schemes because a proposed scheme is designed by considering the distance from destination. In addition, in GPSR, the delay might be increased by selecting a closest node to the destination as a relay node considering just distance. This result of the simulation also indicates that a proposed scheme is more effective for delay sensitive applications compared to the other schemes.

4 Conclusion

In MWSNs, energy efficient and reliable greedy forwarding is important because once scattered sensor nodes in the field cannot get the power from outside. In this paper, we propose the self-determining geographic routing considering mobility in MWSNs. To reduce the energy consumption and the end-to-end delay, the closest node to the destination is selected as a relay node by evaluating the weight. Simulation results show that the energy consumption and the end-to-end delay can be reduced while the packet delivery ratio is higher relatively.

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