무선 센서망에서 라우팅 홀 문제 개선을 위한 에너지 기반 데이타 전달 방안

전야[0],우부재, 최영환, 박수창, 이의신, 진민숙, 김상하
컴퓨터공학과 충남대학교
{tianye ,Yufc, yhchoi, winter, eslee, badamul}@cclab.cnu.ac.kr and shkim@cnu.ac.kr

Energy-Efficient Data Dissemination Protocol for Detouring Routing Holes in Wireless Sensor Networks

Ye Tian[0], Fucai Yu, Younghwan Choi, Soochang Park, Euisin Lee, , Minsuk Jin, and Sang-Ha Kim
Dept. of Computer Engineering, Chungnam National University

1 Introduction

Geographic routing has been considered as an attractive approach since it exploits pure location information instead of global topology information to route data packets, this location based scheme makes it a more efficient, simple and scalable routing protocol in wireless sensor networks [1-5]. This mechanism can minimize the hops from the source to the destination.

Holes, it also called local minimum phenomenon [6], as an inevitable phenomenon exist in geographic routing. Among existing routing protocol in the literature [7], most existing geographic routing protocols adopt static and peripheral mode bypass holes.

In this paper, we extend the previous work [10] by constructing a dynamic detour path hole geometric model for balance energy consumption. The location of hole detour anchor point is dynamically shifted according to Gaussian function, just generating dynamic hole detour paths.

2 Proposed Protocol

To make every detail clearly, we first briefly introduce the previous work [10].

A node can detect whether it is locating on the boundary of a hole by the mechanism proposed in [6]. The node which firstly detects a hole sends out a Hole Boundary Detection (*HBD*) packet along the boundary of the hole by the well-known right hand rule [9]. The mission of *HBD* packet is to trace the location information of all nodes on the boundary of the hole. For example, Node B_0 initiates a *HBD* packet marked with its ID and forwards the *HBD* packet to hole boundary node B_1 by right hand rule. This process repeats until the *HBD* packet has traveled around the hole and eventually been received by the initiator node. Then node B_0 selects two nodes B_p and B_q from the nodes on the boundary so that the distance between B_p and B_q is the longest distance among the distances between any two nodes. Then on each side of $\overline{B_pB_q}$ a node that the vertical distance from it to $\overline{B_pB_q}$ is longer than other hole boundary nodes on corresponding side of $\overline{B_pB_q}$ e.g., B_j and B_k, is selected by node B_0. Then through B_p, B_j, B_q and B_k, node B_0 can obtain a rectangle, and the bisectors of four right angles of the rectangle intersect at point F_1 and F_2. Then node B_0 selects B_m from the nodes on the boundary so that the sum distances of $\overline{B_mF_1}$ and $\overline{B_mF_2}$ is the longest than that of other nodes. Assume that $\overline{B_mF_1}+\overline{B_mF_2}=2a$, then B_0 defines an ellipse. Where a is the semimajor axis of the ellipse. Assume the distance between F_1 and F_2 is $2c$, and then according to ellipse property, we can get the semiminor axis of the ellipse b. Then node B_0 initiates an Ellipse Distribution (ED) packet which includes all information about the ellipse, and geocasts the ED packet to all nodes inside the ellipse. Then all nodes inside the ellipse are aware of the ellipse.

We suppose V is agent point of U for the packet destined to destination D. Line $\overline{UV}$ is tangent to the ellipse through tangent point U. Node U can get the location of V if it knows the length L. Node U calculates L by following formula:

$$L = \sqrt{a \cdot b}(1+\alpha) - d, \quad 0 \le \alpha \le 1, \qquad (1)$$

Where d is the vertical distance from the centre of the ellipse to line $\overline{UD}$ and α is a balance parameter set by system. Then node U can calculate out d.

Now, we describe our promoted algorithm. We balance energy consumption through the dynamically anchor point. The dynamically anchor point is still determined by the node which is on the boundary of the hole. In addition, we modify the set of all possible values of the balance parameter α. As step 1, the tangent node calculates L will follow (2):

$$L = \sqrt{a \cdot b}(1+\alpha) - d \quad 0.2 \le \alpha \le 1.2, \qquad (2)$$

We get the anchor point through (2), and we suppose the coordinate of the anchor point is (a, b). Our promoted protocol has two main steps about how to get the dynamically anchor point. Step1, tangent point node gets the basic location information of anchor point using (2). Step2, base on the 2-dimensional Gaussian function anchor point dynamically shifted. The 2-dimensional Gaussian function is following:

$$f(u,v) = \frac{1}{2\pi\sigma^2} e^{-\frac{(u^2+v^2)}{2\sigma^2}} \qquad (3)$$

Source node S transmits a data packet to destination D along the line $\overline{SD}$ by geographic routing protocol. Nodes on the ellipse are distinguished with the others by ED packet information which is existent in nodes on the ellipse. When data packet reaches the boundary of the ellipse, it sets the data packet to anchor mode, and adds the anchor location information to the data packet which is calculated by (2) and (3), and then forwards the data packet to the node which is geographically closest to the anchor location. When the node closest to the anchor location receives the data packet, it resets the data packet to destination transmission mode and resets anchor location field in void state, then transmits the data packet to destination directly.

3. Conclusions

Our algorithm has three prominent advantages: (a) it prevents data packets from entering the stuck area of a hole, thus reducing route rediscovery overhead; (b) it reduces energy consumptions and data collisions of the node on the boundaries of holes.(c) it balances energy consumption of the entire hole existing area.

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