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# IMPROVE VOID ROUTING COORDINATE FOR WIRELESS SENSOR NETWORKS USING QUALITY OF SERVICES

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*Abstract— To solve the routing void problem in geographic routing, high control overhead and transmission delay are usually taken in wireless sensor networks. Inspired by the structure composed of edge nodes around which there is no routing void, an efficient bypassing void routing protocol based on virtual coordinates is proposed in this paper. The basic idea of the protocol is to transform a random structure composed of void edges into a regular one by mapping edge nodes coordinates to a virtual circle. By utilizing the virtual circle, the greedy forwarding can be prevented from failing, so that there is no routing void in forwarding process from source to destination and control overhead can be reduced. Furthermore, the virtual circle is beneficial to reduce average length of routing paths and decrease transmission delay. Simulations show the proposed protocol has higher delivery ratio, shorter path length, less control packet overhead, and energy consumption.*

*Index Terms— Wireless sensor networks, geographic routing protocol, routing void, virtual coordinate.*

## I. INTRODUCTION

Over the past decades, , wireless sensor networks (WSNs) key technologies. Since a sensor node exploits a path depending only on the location information of neighbor nodes in geographic routing [4], routing protocol based on geographic information is more efficient. Due to its high expansibility and low influence by network size, geographic routing has wide application prospects in large scale WSNs [5], [6]. For example, plenty of nodes equipped with geophones are distributed uniformly on the ground and have the ability to get their own locations by global positioning system (GPS) or localization algorithms [7]–[10] in seismic exploration [11], [12], where geographic routing has potential to serve as routing protocol. However, if a routing void, called local minimum [13], is encountered resulting from the random distribution of sensor nodes, the greedy algorithm in geographic routing will fail, and ultimately data transmission also fails in such situation. To reduce the impact of the routing void, a strategy to isolate certain region around a routing void is proposed in [14]. Nodes located in this region are banned from being selected as a relay node in order to prevent data packets from accessing to the routing void. Ring-constraint forwarding (RCF) proposed in [15] establishes a multi-ring region around a routing void, in which relay nodes are selected to avoid routing void and balance energy consumption. In [16], relay nodes are selected according to the geographic location relationship between the destination node and the routing void in order to prevent failing of greedy algorithm. These algorithms above have low complexity, but high overhead of control packet and time delay result in high energy consumption and inefficient transmission. Beyond that, routing void problem still exists around those established regions, and that no further scheme is proposed to solve this problem. Greedy perimeter stateless routing (GPSR) composed of greedy forwarding and face mode is proposed in [17]. When routing void is encountered, GPSR works under face mode instead of greedy forwarding until finding a neighbor node closer to the destination. Boundary state routing (BSR) proposed in [18] adopts the same strategy as GPSR to detour the void. In [19], network is divided into some hexagon sub-nets, each of them is considered as a virtual node. When void is encountered, face forwarding mode begins to work among the virtual nodes. However, paths established by face forwarding are not optimized, a longer path may be chosen even if there exists a short one. Recently, to solve void problem by using virtual location information, some novel routing protocols have been proposed [20]–[23]. The main strategy of these routing pro-tocols is to build sensor node's virtual coordinate according to certain referenced nodes [20]–

[22] or neighbor nodes [23]. When the destination node is changed, virtual coordinates of corresponding nodes on the routing path have to be rebuilt, so current routing protocols based on virtual coordinates are more suitable to the scenarios with fixed destination nodes. Furthermore, routing voids still exist in the network. Routing protocols based on virtual coordinate have various forms, which make them flexible to implement according to practical network conditions without constraint from the physical locations. Though greedy algorithm is simple in principle and low in complexity, it cannot be applied to all sensor nodes when some routings based on virtual coordinate are adopted in the network. To solve previous problems, an efficient bypassing void routing protocol based on virtual coordinate mapping (BVR-VCM) is proposed in this paper. The basic idea of BVR-VCM is to build virtual coordinates of the whole void edge nodes by mapping their geographic

Fig. 1. Routing void in greedy forwarding

coordinates to a virtual circle that covers the void, and then establish a path by using these virtual coordinates. The virtual circle composed of edge nodes can solve routing void prob-lem and make greedy algorithm work in entire forwarding process, in this way overhead of control packets are reduced. Furthermore, the establishing and maintaining for virtual coor-dinates are not affected by alternation of destination node, thus energy consumption can be reduced. Due to the establishing process of virtual coordinates, the proposed routing protocol is more suitable for stationary sensor networks, such as seismic exploration, in which nodes are stationary during their working periods.

## II.RELATED WORKS

We consider the following situation: sensor nodes are modeled by a unit graph. All nodes within communication range $R_c$ of a node $n$ are considered as neighbors of $n$ and bidirectional links exist between $n$ and its neighbors.

### *A. Routing Void in Geographic Routing*

In geographic routing, when greedy forwarding is adopted, it can be easily interrupted due to the terrain or radio coverage, for example, pools, hills or buildings which locate in the sensor area. The finite distance of communication range can also cause greedy forwarding failing. When a sensor node tries to forward the packet to one neighbor node that is geographically closer to the destination node than itself, but such node doesn't exist, then a routing void is encountered. Greedy forwarding fails in this situation. As shown in Fig. 1, a node $n_1$ tries to forward a packet to the destination node $d_1$ by greedy forwarding in multi hops. First, node $n_1$ sends the packet to $n_2$ by greedy forwarding. Since the neighbor nodes set of $n_2$ is $\{n_1, n_3, n_4\}$, none of which is closer to the node destination $d_1$, and then a routing void is encountered and greedy forwarding fails to deliver the packet. Similarly, a routing void is encountered at node $n_5$ when it tries to forward a packet to the destination node $d_2$. Around the obstacle area in Fig. 1, greedy forwarding fails at node $n_5$ as described above. But for different destinations, greedy forwarding may not fail at the same node. For example, if $n_5$ tries to forward a packet to the destination node $d_1$, packet can arrive at $d_1$ along with the path $n_5 \rightarrow n_6 \rightarrow n_7 \rightarrow d_1$ without routing problem

Fig. 2.Edge structure without routing void.

### *B. Structure Without Routing Void*

Assuming the number of edge nodes around an obstacle in WSNs is $N_b$ , the set of edge nodes is $\{b_k \mid k = 1, \cdots N_b\}$, both of the following conditions should be satisfied:

$$d(b_1, b_{Nb}) < T_c \quad = \quad \cdots \quad - \qquad (1)$$

$$d(b_k, b_{k+1}) < T_c, \quad K \quad 1, \quad N_b \quad 1$$

and

$$2 \ = \ i \quad {}^{N}b \quad k \ = \emptyset \qquad (2)$$

$$\{b_{k+i} \mid d(b_k, b_{k+1}) < T_c, \quad k \ \ 2, \ldots \ N_b - \ 2,$$

$$\leq \ \leq \quad - \ \}_{\emptyset}$$

$$b_k \quad d(b_1, b_k) < T_c, \quad k \quad 3, \ldots N_b \quad 1$$

$$\{ \quad | \quad = \quad - \ =$$

$( \ , y \ )$ represents the distance Between

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where $d\,x$ Euclidean

node $x$ and $y$, $T_c$ represents the communication distance of nodes, $i$ is an integer. According to formula (1), (2), every edge node can only communicate with its two neighbors belonging to the set $\{b_k \,|k = 1, \cdots N_b\}$.

If all the edge nodes around the obstacle have the same

distance to a point $O$ as following:

$$d(b_k , O) = R, \quad k = 1, . . . N_b \tag{3}$$

where $R$ is a constant. In this situation, all the edge nodes locate on a circle with center point $O$ and radius $R$ as shown in Fig. 2. In this type of structure composed of the edge nodes, every edge node has two and only two neighbors locating on the circle. According to the geometrical features of circle, there is no routing void around this obstacle area for any destination node in the network.

In Fig. 2, all nodes in the network adopt greedy algorithm to select relay nodes; node $s$, $d$ represents source and destination respectively, packet delivering process is used as an example to describe the structure without routing void. First, edge node $b_1$ receives a packet from source $s$, it has two relay candidates in neighbors, $b_2$ and $b_5$. Since the two candidates locate on the same circle, there is at least one node that can be selected as relay node by greedy algorithm in this condition, so $b_2$ is selected and no routing void is encountered. Similarly, the packet reaches edge node $b_4$, and then $b_4$ selects $n_5$ by greedy algorithm. Finally, the packet reaches destination node $d$ all by greedy algorithm without routing void problem in the delivering process.

## III.EXISTING SYSTEM

The existing system presents routing protocol BVR-VCM (bypassing void routing protocol based on virtual coordinate mapping) which consists of **greedy mode** and **void processing mode**. Here, greedy algorithm is adopted to select relay node in greedy mode. If greedy mode fails when a routing void is encountered, void processing mode is activated. Void processing mode is composed of three phases, according to processing in the order, respectively void detecting, virtual coordinate mapping and void region dividing. After the implement of void processing mode, the virtual coordinates of edge nodes are established. Then greedy mode is reactivated, these edge nodes that have the virtual coordinates can be selected as the relay node by greedy algorithm.

**Void Detecting Phase:**

The main function of the void detecting phase is to collect edge node information around the routing void after the void is encountered.

**Virtual Coordinate Mapping Phase:**

The virtual coordinate mapping phase is responsible for mapping the edge node coordinates stored in the detecting packed to a virtual circle, i.e., converting a structure composed of edge nodes to the structure without routing void.

**Void Region Dividing Phase:**

The main function of the void region dividing phase is to divide the surrounding area of the void into three different regions, in which different routing strategies are applied. According to the void position and the location of destination node of the packets, the surrounding area of a void is divided into approaching region, departing region and free region.

## IV. PROPOSED SYSTEM

Along with existing system implementation, the proposed system also maintains the partial path information of previous transmission. The link quality of with all the neighbors is checked periodically and so the base station communication is reduced. Like existing system, the optimal routing path between the source and the destination is achieved with fewest hops. No need of full hop information calculation for each and every transmission. The proposed system aims to find the shortest path, each individual hop usually has long transmission distance with high quality link maintenance

.

- Nearest node location need not be retrieved from base station, since partial path information (achieved through maintaining trusted value of the path) is maintained.

- Calculation overhead is reduced since it maintains the quality details of previous communications.
- Retransmission count is reduced than the existing system.
- High quality link is maintained along with fewest hop path information.
- It is suitable for highly scalable and dynamic networks as it has drastically reduced the amount of overhead.

## V. MODULES

**1) ROUTING (GREEDY FORWARDING)**

**2) FIND PATH**

**3) LINK**

**A) UPDATE LINK QUALITY**

**B) UPDATE LINK THRESHOLD**

**C) FIND PATH STRENGTH**

### 1) ROUTING (GREEDY FORWARDING)

In this module, the network is drawn, source and destination node is selected. Then the slice is formed based on left side angle 30 degree and right side angle 30 degree of the source node up to the destination node is found out and the slice is drawn. Then the nodes with the transmission range of source node (S) are found out and node (A) with long distance with the source is selected. This process repeats for (A) and up to the neighbor node of destination node.

### 2) FIND PATH

In this module, nodes records are populated in 'from' combo box and 'to' combo box controls. When two different nodes are selected, then the path(s) between these two nodes (found already in the previous module) are fetched and displayed. Even if the node contains more than one path, all the path information are displayed.

### 3) LINK

**A) UPDATE LINK QUALITY**

**B) UPDATE LINK THRESHOLD**

**C) FIND PATH STRENGTH**

### A) UPDATE LINK QUALITY

In this module, the previous link formed nodes are measuring their link values periodically and updates in the database. This process occurs for all nodes and their neighbor nodes at a regular interval.

### B) UPDATE LINK THRESHOLD

In this module, the link threshold value is set from 1 to 100 to identify the link strength. Value >=50 is assumed that the link is having more quality to establish the communication.

### C) FIND PATH STRENGTH

In this module, nodes records are populated in 'from' combo box and 'to' combo box controls. When two different nodes are selected, then the path(s) between these two nodes (found already in the previous module) are fetched and displayed along with link strength between all the intermediate hops. If all the hops are having link value >=50 then the path is assumed suitable for successive communication and data can be passed through that path even partial path is found.

## VI. CONCLUSION

The project introduces a method to improve routing performance with small routing states. It solves the local minimum problem by embedding a network topology to a low-dimensional Euclidean space where hop distances between pairwise nodes. Based on accurate hop distance comparison between neighboring nodes, the greedy forwarding can find the shortest path between two nodes. The project shows that the routing quality can be improved by embedding a network topology to a Euclidean space. Nearest node location need not be retrieved from base station, since partial path information (achieved through maintaining trusted value of the path) is maintained. Calculation overhead is reduced since it maintains the quality details of previous communications

- The routing success ratio can be tracked.
- The routing log can be maintained.

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