A Distance and Angle Based Routing Algorithm for Vehicular Ad hoc Networks

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Abstract

Vehicular Ad hoc Networks (VANETs) is the new wireless networking concept of mobile ad hoc networks in research community. Routing in vehicular is a major challenge and research area. The majority of current routing algorithms for VANETs utilize indirect metrics to select the next hop and produce optimal node path. In this paper, we propose a distance and angle based routing algorithm for VANETs, which combines a distance approach with an angle based geographical strategy for selecting the next hop, with the purpose of using direct metrics to build a optimal node route. The proposed algorithm has better performance than the previous scheme.

1. Introduction

Vehicular ad hoc networks (VANETs), as a special kind of mobile ad hoc networks (MANETs), have been subject to extensive research efforts from many parts.

Since the network topology in the VANETs is frequently changing, finding and maintaining routes is very challenging in VANETs. To facilitate communication within a network, a routing protocol is used to find reliable and efficient routes between nodes so that message delivers between them in timely manner. Routing is responsible for selecting and maintaining routes and forwarding packets along the selected routes. Routes between source and destination node may contain multiple hops, this condition is more complex compare to the one hop communication. Intermediate vehicles (nodes) can be used as routers to determine the optimal path along the way.

However, current proposed position based routing algorithms [4,5] share one common characteristics. That is, the majority of them utilize indirect metrics to produce optimal node path. So the proposed routing algorithm in this paper, similar to GyTAR [4], exploits the distance and vehicle density at intersections. Moreover, we propose a new decision making at road intersections. It takes into account information about angles and distances since we suppose real city configurations with multi lanes and double direction roads. It aims to efficiently use the direction and distance by selecting the next hop and to produce optimal node route.

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2. Related Work

Routing protocols like Ad hoc On Demand Distance Vector (AODV) [2] and Dynamic Source Routing (DSR) [1] are designed for MANET applications. In an improved GPSR model and simulation analysis (IGPSR) [7], the authors adopt the probability transport mechanism to select the next hop node in the segment of the chosen forward region. GPSR-L [6] introduces the concept of the lifetime calculated between the node and each of its neighbors. Improved Greedy Traffic Aware Routing protocol GyTAR [4] uses the metrics of vehicle density between two adjacent intersections and the distance to destination to compute the next hop intersection. A-STAR [3] utilizes city bus routes as a strategy to find routes with a high probability for delivery.

3. Proposed Algorithm

In a VANET, vehicles are referred to as mobile nodes, traffic lights in the 4-way intersections are considered as static nodes such as A,B,C,D in this paper. We also assume that each node is equipped with a short range wireless device and has the same communication range r which represents the junction radius as shown in Fig. 1. Each mobile node is equipped with GPS navigator form which it can read its current location.

Mobile node periodically broadcasts HELLO message including the current location and velocity of the node to its direct neighbor nodes, while static node periodically broadcasts HELLO message that contains all the information stored in that node. Mobile node can get the location of static nodes at both ends of the road segment on which the mobile node is moving through the HELLO message exchange with the passing static node.

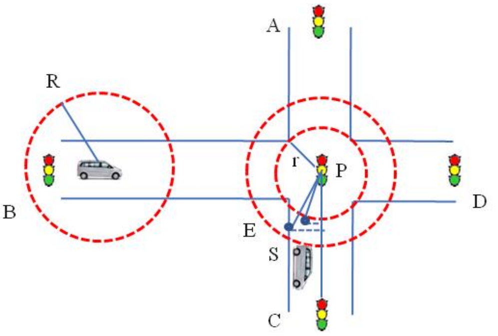

Fig.1. Node deployment

As an example, Fig. 1 shows how the node deployment is conducted for the routing. In this figure, the repeater R is equipped with four fixed directional antennas pointing to four road segments. When R receives a packet from the vehicle, it at once forwards this packet to the directions of vehicle A, C and D, respectively. In addition, the vehicle receives the packet by the processing of directional broadcast on the straight road.

Assume that a mobile node is moving from BP road segment to PC road segment. When the mobile node is moving to the road junction, it receives the HELLO message from the static node in that road junction, and then extracts the radius of the junction, the location of the static node and all its neighbor static nodes. We calculate the angles between vector $PS, PA, PC,$ and PD, respectively, and also calculate the distances between PS and PE to destination respectively. If the mobile node moved to a new road segment where locates a position S exceeding the radius of the junction, then we conduct the calculating process of the distances and angles as follows:

$$\overrightarrow{PC} \cdot \overrightarrow{PS} = |\overrightarrow{PC}| \cdot |\overrightarrow{PS}| \cdot \cos\beta$$

$$\beta = \cos^{-1}\frac{\overrightarrow{PC} \cdot \overrightarrow{PS}}{|\overrightarrow{PC}| \cdot |\overrightarrow{PS}|}$$

We compute that the road segment SC which is the new road segment to that the mobile node has moved. So according to the above approach, when a mobile node moves to a new road segment, the two static nodes at both ends of that road segment can be calculated. In GPSR, source node P selects neighbor node E as next forwarding destination C. But we select the road segment which makes the smallest angle with vector PC as a new road segment the mobile node has moved in.

To get the next hop, we refer to checking neighbor table and recalculating the location of the neighbor nodes. Due to high mobility, the mobile node might have gone of range in this broadcast cycle. Consider the node movement situation shown in Fig.2, the broadcast cycle of node M_0 and M_0 are assumed to be t_m and node communication range is R.

On reception of the HELLO message from M_1, the position of node M_0 is located at point P_0, while M_1 at the point of P_1. Over the next $t < t_m$ time interval, the following scenario may occur. M_0 moves to a point P_0, while M_1 moves to point P_1. Thus, at moment t, M_1 might have gone out of range of M_0.

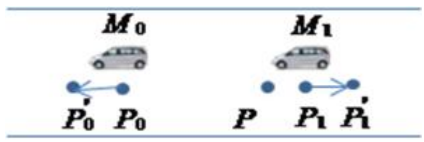

Fig.2 Node movement

Now we give the process of calculating the distance between P_0' and P_1', which stands for the move distance $P_0'P_1'$ and angle.

4. Conclusion

In this paper, we proposed a distance and angle based routing algorithm for vehicular ad hoc networks. Our goal is to utilize the smallest angle and short distance to select the next hop, with the purpose of using direct metrics to build a optimal node route. As for future work, we are planing to combine the route selection and discovery process of destination nodes. Moreover, we have a plan to conduct simulations for verifying the validity of the proposed protocol.

References

[1] B. Johnson and A. Maltz, "Dynamic Source Routing in Ad Hoc Wireless Networks," *Computer Journal of Mobile Computing*, vol. 353, no. 6, pp. 126-129,

2004.
[2] E. Perkins and M. Royer, “Ad-Hoc on Demand Distance Vector Routing,” *Proceedings of 2nd IEEE Workshop on Mobile Computing Systems and Applications*, pp. 90-100, 1999.
[3] J. Bernsen and D. Manivannan, “Greedy Routing Protocols for Vehicular Ad Hoc Networks,” *Wireless Communication and mobile computing,* pp.632－637, 2008.
[4] M. Jerbi, S. M. Seouci, and R. Meraihi, “An Improved Vehicular Ad Hoc Routing Protocol for City Environments," *ICC 2007*, pp. 3972-3979, 2007.
[5] M. B.Sardar and M.Saad, "An imporved vehicular ad hoc routing protocol for city environment," *INMIC 2011*,pp.296-300,2011.
[6] R. S. Aditya and P. M. Boussedjra, “GPSR-L:Greedy Perimeter Stateless Routing with Lifetime for VANETS,” *Proc. of the 8th International Conference on ITS Telecommunications,* pp.299-304, 2008.
[7] S. Wu, X. Wang, and T. Yang,“Improved GPSR model and simulation analysis,” *Computer Engineering and Applications,* pp.100-104, 2011.