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Mobility Prediction to Select Reliable Relay Vehicles for Safety Message Broadcasting in VANETs*

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Abstract. One of the major challenges in vehicular ad hoc networks (VANET) is link failure due to vehicle mobility. It is because that VANET is a dynamic mobile network in which network disconnection occurs very often. It causes repeated link breakages and increasing the packet loss rate. Therefore, most traditional broadcasting protocols cause fail in delivering packets. Prediction of the location of a moving vehicle in VANET became an interesting and challenging problem. This paper proposes a mobility prediction scheme to achieve a reliable broadcasting. The proposed scheme predicts the moving direction, whether on the same road, the relative speed, and inter-vehicle distance to select the reliable relay vehicle for safety message broadcasting.

Keywords: Mobility Prediction, Safety Message Broadcasting, Moving Direction, Moving Velocity, VANET

1 Introduction

When an accident happens on the road, a safety message should be disseminated to all vehicles in the area exposed to potential hazards [1-2]. Flooding is the simplest broadcasting mechanism. It introduces the redundant message retransmission and the broadcast storm problem because all vehicles rebroadcast the received messages [3-5]. The selective flooding can overcome the redundant packet retransmission by only selected relay vehicles, which perform a rebroadcasting of the received message among the vehicles included in the same radio range. Selective retransmission broadcasting protocols can obtain saved-rebroadcast, high reachability, and low end-to-end delay time by introducing the contention wait time in each vehicle [6-9]. However, they cannot promise enough reliability for VSC because of the highly dynamic topology and frequent disconnections of VANET, which causes frequent link failures, and results more packet loss and low throughput. In VANET, fast movement and frequent topology changes cause repeated link breakages and

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increasing the packet loss rate. Therefore, mobility prediction for VANET safety message broadcasting is required.

The proposed algorithm can calculate the movement of vehicles in VANET because they are usually restricted in just single direction constrained along roads, and are able to get their speed, location and moving directions. Therefore, it is possible to predict the future location of the neighbor vehicles. To do this, the proposed algorithm uses the relative speed, moving direction, and the inter-vehicle distance.

2 Mobility Prediction

This paper assumes all vehicles can obtain their location with GPS receiver and vehicles move in the one-way road. The mobility prediction can be acquired through periodical beaconing. The mobility includes that neighbor's position, inter-vehicle distance, relative speed, and moving direction. The moving direction θ is calculated by Eq. (1) based on the current position (x_2, y_2) and the previous position (x_1, y_1).

$$\theta = \begin{cases} \arctan \dfrac{y_2 - y_1}{x_2 - x_1} \times \dfrac{180}{\pi}, & x_2 > x_1 \\ \arctan \dfrac{y_2 - y_1}{x_2 - x_1} + \pi, & x_2 < x_1 \\ \arctan \dfrac{y_2 - y_1}{1e - 6} \times \dfrac{180}{\pi}, & x_2 = x_1 \end{cases} \quad (1)$$

If the difference of two vehicle's moving direction θ_i and θ_j is less than 45 degree as shown in Eq. (2), it is determined that the vehicle *i* and *j* are in the same straight road. Otherwise, they are in the different road.

$$\left|\theta_i - \theta_j\right| \leq 45 \quad (2)$$

On receiving a position message, the vehicles calculate the relative speed and the inter-vehicle distance. They are calculated by Eq. (3) and Eq. (4). The inter-vehicle distance is derived from the Pythagorean Theorem.

$$\vec{\Delta v}_{ij} = \vec{v}_i - \vec{v}_j \quad (3)$$

$$D_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (4)$$

3 Conclusion

This paper proposed a scheme to predict the vehicles mobility information effectively by using the relative speed, moving direction, and the inter-vehicle distance with

periodical beaconing in VANETs. Mobility prediction based broadcasting can be one of the most promising solutions for safety message broadcasting in VANET.

In the future, we will study on the method of detecting the behind moving vehicles in the same straight road. And we will evaluate the performance of the algorithm proposed in this paper.

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