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Design of Internet of Vehicles Routing Protocol based on Prior Probability

Yuming Zhang *

College of Physics and Information Engineering, Fuzhou University, Fuzhou, Fujian 350108, China
*** Corresponding author Email:** 112101228@fzu.edu.cn

Abstract: With the continuous development of the interactive system and the wireless heterogeneous network, the intelligent transportation system plays a key role in the modern transportation, especially in the construction of the Internet of vehicles. The important position of routing protocol in building the vehicle communication network is self-evident. V2V (Vehicle to Vehicle) network also has irreplaceable advantages in eliminating traffic accidents and reducing the harm of traffic accidents. Therefore, it is very necessary to study the optimization of the routing protocol. However, in the previous vehicle since the organization network routing protocol research, mostly focus on the method of data fusion, for the improvement of the conflict in the routing protocol, and through machine learning Q algorithm to optimize the real-time transmission model, etc., ignore the different degree of preference for different information. With the help of this kind of information, the routing protocol can be optimized, and the complexity of the routing protocol can be further reduced. Improve the efficiency of Internet of Vehicles communication.

Keywords: Internet of Vehicles; Routing Protocol; Prior Probability; Bayes' Theorem; Vehicular ad Hoc Networks.

1. Introduction

With the development of artificial intelligence and driverless technology, the current Internet of Vehicles system increasingly relies on the communication between vehicle to vehicle and vehicle to roadside facilities. There's no doubt that routing protocols play an important role in these scenarios. According to my questionnaire survey on traffic, more than half of the respondents believe that many traffic accidents are caused by drivers' inability to observe relevant information, which will be greatly improved with the help of V2V network.

A lot of people and teams have done some research on the routing protocols of the Internet of the vehicles. Zhang Jingwen in the wireless car networking routing method research based on node estimation theory of ZRP-QoS algorithm (Zone Routing Protocol-Quality of Service), by combining the regional routing protocol ZRP, combines the advantages of on-demand and according to the table drive method, combined with active and passive routing methods' advantages, introducing the concept of cluster head, reduce the node density on the convergence speed and accuracy [1]. In The Research on Vehicle Network Routing Algorithm Based on Q Learning, Liu Chao used Q learning algorithm to improve the problem of discarding data packets due to the limited storage space of vehicle nodes in VANET [2]. Through QLCC, Q learning algorithm was used to alleviate the congestion, improve the success rate of delivery, reduce the end-to-end delay, and reduce the network load. Aya Tareef and his team Compared the various improved protocol of VANET in Comparison and Classification of VANET Routing Protocols [3]. Zhang Jianfeng in The Research on V2X Communication Protocol based on Channel Communication Model, by optimizing channel selection by comprehensively considering the roadside unit RSU (Road Side Unit) and interruption probability make the information transmission between vehicles faster [4]. In the Research on V2V Route Protocol based on Visible Light Communication, Zhao Ning took advantage of the differences and characteristics of visible light frequency spectrum and radio frequency spectrum to overcome the time delay based on traditional radio frequency communication routing protocol [5].

This paper will be constructed according to the following structure, the first part, I introduced the relevant background and related work, in the second part, I will discuss the design of the routing protocol related preparation, the third part will explain the workflow of the routing protocol, the fourth part introduced the prior probability and prior probability of comparison, and qualitatively analyzed the performance of the design routing protocol, the fifth part I summarized my work.

2. Preliminary Preparation and Prior Probability Drawing

2.1. Prior Probability of the Data

As mentioned in the introduction section, previous routing protocols did not consider environmental information, which can be used to optimize the algorithms of routing protocols. However, due to the lack of quantitative expression form of the driver's preference for a certain information, I used the questionnaire and statistical methods to complete the determination of the prior probability.

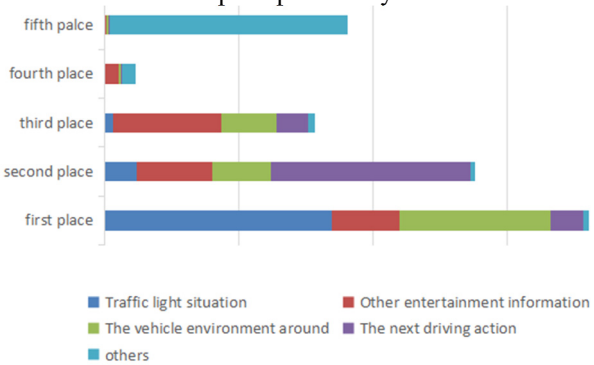

Figure 1. Information preferences for driving on a general road

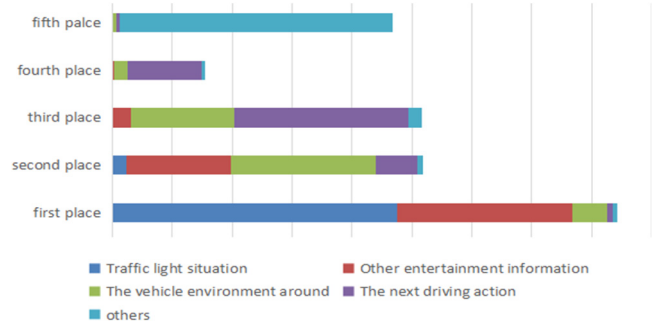

Figure 2. Information preferences when driving at intersections

According to the survey results, the final proportion of each part will be obtained through the following formula, and the corresponding probability will be allocated according to the proportion to form an array of prior probability.

Average comprehensive score of options = (Σ frequency weight) / person to fill in this question [6].

The protocol divides the information in V2V network to directly from RSU traffic light information, sensor distance information from other vehicles, lane change information, multimedia information from the network, satellite navigation information and other information each information in packaging for data packets with its classification identification, the specific protocol for the processing of each packet will be explained in detail in the third part.

2.2. Vehicle Distribution Model of the General Roads

For the Internet of Vehicles, the dynamic topology is the major feature, and the vehicle distribution model at different times and in different regions will have a huge impact on the final experimental results. The sending and passing process of packets in the protocol can be regarded as the process of packet diffusion throughout the network (even if the node does not receive the packet). The diffusion needs to consider the distance between various nodes. According to the central limit theorem and vehicle flow theory [7,8], the distance between vehicles under a large number of samples will show a normal distribution, while due to the special limitation of driving, vehicles are limited to drive in a certain area. In fact, the distribution of vehicles on general roads (without natural disasters and traffic accidents) can be represented by the following formula [9].

$$f(x,\mu,\sigma)=\begin{cases}\frac{1}{x\sqrt{2\pi}\sigma}e^{-\frac{1}{2\sigma^2}(\ln x-\mu)^2}, & x>0\\ 0, & x\le 0\end{cases} \quad (1)$$

which can also be set as

$$\ln X\sim N(\mu,\sigma^2) \quad (2)$$

The distribution of vehicles can be roughly uniform at the waiting position. Can be expressed by the following formula.

$$f(x)=\begin{cases}\frac{1}{b-a}, a<x<b\\ x=0, \ else\end{cases} \quad (3)$$

3. Composition of the Routing Protocol and the Operation Process

3.1. Four Basic Messages in the Routing Protocol

Message transmission in V2V network is divided into four types: ADV (advertise), REQ (request), REF (refuse), DATA (data). ADV message is used to ask whether the node needs the correspond the related DATA package, ADV contains the node ID of the source (possibly other vehicles under the network, or possibly roadside infrastructure), package identification (indicating the message type in the corresponding DATA package, DATA package's size). Both REQ and REF messages are used for the node to reply to agree or disagree to receive the corresponding DATA package. There are only one of the REQ or REF messages in the same network, which is related to the prior probability of the corresponding message. The REQ message is sent when the rejection rate is large, and the REF message is sent when the reception rate is large. And the corresponding data are included in the DATA package.

3.2. Routing Protocol's Working Ways

When the routing protocol is initialized, the appropriate transmission mode is selected according to the corresponding road environment. When the corresponding information is detected by the sensor at a certain node of the network. Pack it as the corresponding DATA message. And generate the corresponding ADV message. Pass the ADV to the nodes around it, the surrounding nodes, after receiving the ADV message, reply with the REQ or REF message based on the selected route pattern, and then deposit the identity of the ADV message in the message list. After obtaining the corresponding DATA package, it diffuses to the surrounding according to its own energy and transmission, until all the nodes under the network respond to the message. It is worth noting that in the later transmission, some nodes may already have the DATA package or has responded to the ADV message, so when they received the same ADV message (same to the message list), they will reject to transmission and receive the packet, to prevent flooding in the network.

At the same time, the limitation of forwarding messages will be introduced in order to adapt to the limited communication capacity of the on-board computer in the physical environment. When a certain number of messages are transmitted through the node to its neighbours, this node will be turned off not to send messages to the periphery.

4. Route Protocol Performance Analysis and Comparison

In order to simulate the real situation, every kind of message have a different energy cost, at the same time a certain communication distance is set for each node, so does an upper limit of energy transmission (RSU class node is not limited by this), within the communication distance, the energy cost will in a low level which is about quadratic of the distance, the transmission cost between nodes will increase with the increase of the distance, in the area beyond the communication distance it will reach a higher level which is about biquadratic of the distance.

At the end of the experiment, I compare the total number of messages completed by a message transmission and the total energy consumption in the network at different number of vehicles and road positions, and qualitatively analyze the performance of the routing protocol.

4.1. Comparison with Routing Protocols Without Prior Probabilities Introduced

It is obvious from the figure that there is a significant difference between the number of messages without introducing the prior probability with the increasing total

number of vehicles, and the protocol with introducing the prior probability is significantly better than the protocol without introducing the prior probability with the larger number of vehicles.

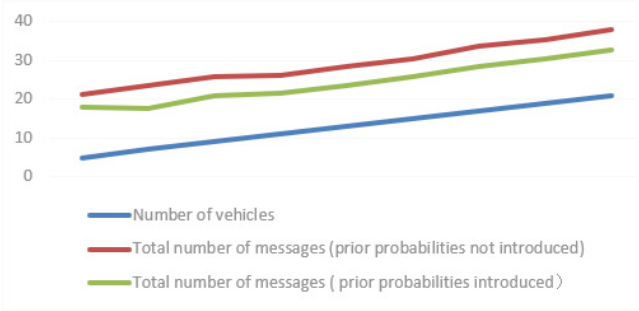

Figure 3. Comparison of the protocol introducing the prior probability with that without the prior probability on the total number of messages (the probability of refuse is 0.7)

4.2. Analysis of the Routing Protocols

If the prior probability that a message is received in the network is p1, the probability that the receiving node does not do any external action (manifested as rejection, including existing information and not accepted information) is p2, P1 + P2=1 can be obtained. Considering whether a vehicle receives the ADV as a source, it can be concluded that the total number of messages with and without prior probability is roughly the same when p1 is about 0.5 [10]. However, when p1 is closer to 1 or 0, the protocol with introduced prior probability achieves the maximum optimization effect relative to that without introduced prior probability.

5. Conclusion

After the introduction of the prior probability optimization routing protocol, the number of messages decreased to a certain extent, with the increase of the number of vehicles. The decrease in the number of messages directly improves the performance of the routing protocols, and multiple prior probabilistic models for different scenarios also enable the protocol to adapt to a more variable environment, and improves the defect that previous protocols can only adapt to a single environment.

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