Collision Avoidance System for Safety Vehicular Transportation in VANET

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Abstract—**A Vehicular Ad Hoc network (VANET) is an emerging technology among the scholars and vehicular industries in recent years. The wireless collision Avoidance (CA) system sends early message to drivers before they reach accident zone on the road. This paper proposed an analytical model for warning messages through collision avoidance (CA) system. Use the Dichotomized head way model, the Braking model, and Greenberg's logarithmic model to make vehicular mobility traces. The main concern is reduce delay while transfer message from one vehicle to another vehicle. Using minimum number of road side units (RSUs).The major concern related to VANET is congestion control (CC), and rapidly changing topology and lack of central coordination. We use collision avoidance system for the safety transportation and receive periodic messages and reduce traffic in highways.**

Keywords— **collision avoidance, vehicular ad hoc networks, early message, congestion control**

I. INTRODUCTION

A Vehicular Ad hoc Network (VANET) is a technology that creates a mobile network by using moving vehicles as nodes. In VANET every vehicles in the routing network is considered as wireless router or node in Fig 1. The future of transportation system is the Intelligent Transportation Systems (ITS). The dedicated short-range communication with the emerging standards such as 5.9 GHz allows vehicles to communicate each other and also with the environments [1] [2]. Various applications are available for the vehicular ad hoc network that mainly improves the overall safety of the transportation systems. The intelligent transportation system makes it possible to monitor the traffic signals to coordinate traffic lights for the smooth traffic flows. Sensors fixed in the vehicles are used to detect traffic jams by giving the feedback signals. These signals are broadcasted through the wireless channel, for the vehicles to respond quickly for emergency to change traffic signals. By avoiding collisions and improving efficiency, the vehicles communicate with each other providing cooperative driving on the roads. With the use of DSRC standard in the vehicles there are many possible applications in the future [3] [4].

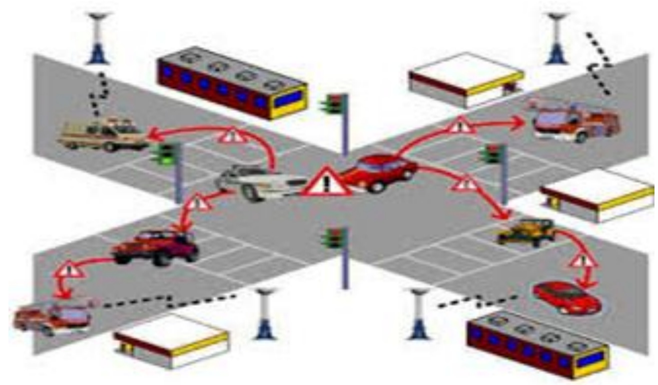


Figure 1: VANET architecture

There are huge benefits in the vehicular communications by the vehicular ad hoc networks (VANET), which is more relevant to the mobile ad hoc networks realization. Many opportunities raises in the vehicular networks which leads to the research challenges by the appropriate use of on-board units, roadmaps, and GPS positioning devices. The vehicular ad hoc network characteristics are mostly unique when compared to the mobile ad hoc networks [5]. Though VANET offers various opportunities to increase the performance of network performance, it faces various challenges at the same time. The characterization of VANET has rapidly changing topology but only somewhat can be predicted. Frequent fragmentation of the network occurs. The network diameter is small for VANET. It has limited redundancy both temporally and functionally. It poses many security challenges apart from other networks. Because of the high vehicle mobility, the topology changes often in VANET and the communication link between the vehicles is more complex. Since vehicle travels at high speeds, the link between the vehicles is of short lifetime.

By increasing the transmission power, the link duration between the vehicles can be increased. But by increasing the transmission power, the throughput of the network decreases. The vehicle's movement is limited in the road and is also the reason for frequent link failure. The future movement of a vehicle is predictable. It may take many years for the majority of vehicles to be equipped with a transceiver, the VANET protocols should work such that all vehicles cannot communicate [6]. There will be poor connectivity between the vehicles since the effective diameter of the network is small. The traditional routing protocols used in VANETs are either proactive or reactive.

The proactive routing algorithms maintain the vehicular routes by using tables. To maintain valid routing information frequent changes are needed between nodes or the vehicles. But the route maintained in the proactive algorithm tables quickly becomes invalid, because of the rapidly changing topology. The DSDV approach which is the traditional table-based routing uses a large amount of bandwidth. But this is different in the case of reactive routing which establishes the route only when needed.

The problem that is common with the reactive approach is that it takes increased amount of time to send a message since the route must be discovered before transmitting the first packet. Thus both of these two approaches don't particularly perform well in a VANET. The proactive approach lacks in the scalability. The problem with the reactive approach must have the routes of short lifetime because of mobility when transmitting a message from a route to a destination. With the increase in the number of hops, the expected path life decreases. Routing error may occur while sending a message to a greater distance involving with more than three or four hops using traditional ad hoc routing algorithm. Redundancy is must in VANET for providing security services. But it is difficult to implement redundancy at any form since links between the vehicular nodes does not exist more than a significant period of time. These characteristics of VANET give a basic understanding of some of the problems in a VANET.

II. RELATED WORK

In recent years there is significant growth in VANET research and Collision Avoidance systems [7]-[10]. *Tonguz et al*. [7] uses intelligent broadcast mechanism is required to distribute warning messages in case of emergency. Two major problems must be considered in order to design a broadcast protocol. When many nodes attempt to transmit the data at the same time, collision of several packets occur causing delay at the medium access control layer. This is known as the broadcast storm problem. In an area when the number of nodes tries to disseminate the broadcast message is not sufficient, then it known as the disconnect network problem. The distributed vehicular broadcast protocol (DV-CAST) helps to rectify those problems. The DV-CAST protocol also clears the problems in the dense and sparse traffic regions. In dense traffic region because of high vehicular density the number of hop increases and hence collision occurs. In sparse traffic regions since the traffic density is low there is no availability of forwarders and hence there occurs a delay in data packet transmission between the nodes. The broadcast protocol overcomes these problems.

Yang *et al.* [8] Due to various mechanical failures of vehicles or unexpected hazards in road the vehicle can become an abnormal vehicle (AV). Also with the reaction to the nearby abnormal vehicle can also make the vehicles a dangerous one [8]. When the abnormal vehicles resumes to its regular movement, it is said to be normal and safety vehicle. Generally the abnormality of the vehicle's behavior is detected by the use of various sensors fixed within the vehicle. But detecting the vehicle's behavior is not much important than providing collision warning messages between the vehicles [9]. The dynamics of the vehicle is automatically monitored by the vehicle controller, which activates the collision warning communication module when the vehicle reaches an abnormal state. During this stage the sensors and the controllers in the vehicle gives either the audio or visual warnings or advices to the driver.

The broadcast message transmission is used to transmit messages in emergency cases as a group of receivers are involved and also these receivers keep changing fast due to high mobility of the vehicles. The emergency warning messages are repeatedly transmitted to ensure reliable delivery of messages over the unreliable wireless channel. Based on the channel feedback, the congestion control adjusts the transmission rate to achieve network stability. The transmission rate is increased, when the packets are transmitted successfully, while the rate is decreased, when some packets gets lost during transmission. The channel feedback is not available in the emergency warning messages because of the broadcast nature of EWM transmissions. More application-specific properties are used to help EWM congestion control. The Vehicular Collision Warning Communication Protocol provides emergency warning dissemination methods that make use of both natural response of human drivers and EWM message forwarding.

Yizhen Zhang et al. [10] describes Time-to-last-second-braking *(Tlsb).* Tlsb is a time-based measure that is newly proposed for rear-end collision threat assessment. It is defined as the time left over for the driver or the control system to act at the current situation to take the hard to pin down actions at the last extreme level, such as braking at the maximum level, to avoid a rear end collision [10]. The *Tlsb* measure provides a quantitative assessment of the current urgency and severity levels for the potential threats which makes it highly useful for threat assessment analysis in collision warning and avoidance systems. For the current dynamic situation, the *Tlsb* measure provides straightforward and quantitative threat assessment techniques. When the control system reacts within the time to last second braking system, the potential collisions would be avoided.

Hence it is needed to set the warning timing little late to reduce the interference level, and little early to provide enough time for the drivers to react to the situations. But the collision avoidance system is only satisfactory which only relies on human drivers to take action in an emergency, because of different variations in driver's behavior. To overcome this, an overriding system is used at critical moments for applying automatic brakes at the maximum level to avoid collisions. The advantages of this override system and the *Tlsb* measure provides an accurate estimate of how much time is left for the overriding system to react by the vehicles in the emergency situations. Though, some problem in the message delivery from vehicle to vehicle and delay will occur while emergency and it cause rear end collision.

III. PROPOSED MODEL

Collision avoidance (CA) system is improved by the DSRC based wireless communication [11] [12]. We discussed an analytical model to offer the probability of rear end collision among two vehicles running in the same way when a sudden event occurs. Traffic flow theory was formulated for this system [13]. To study the performance of the collision avoidance system VANET model is developed. Several parameters for driver vehicles are considered for analysis. The feature of dichotomized headway model is developed in addition to vehicle braking model [14]. Considered a scenario depicted in Fig. 2. The safety message is generated and distributed to the following vehicles by the source node. The vehicle braking model is explained by flow theory and chain collision probability is calculated. Let $D^*_{ssd,\ n}$ be the minimum stopping sight distance (SSD) required for S_n without crashing into S_{n-1}. In Fig. 2 (a), S_0 issued warning message at the time u_n represents the starting distance between S_0 and S_n. S_n initiate the brake after receive message from S_n and stops the vehicle behind S_{n-1} see Fig. 2(b). In this X_n represent maximum distance S_n desired without crashing its previous vehicle we $^\gamma$classify the indicator random variable L_n.

$$L_l m = \{_l(0,\ \text{otherwise})^{\uparrow}(1,\ \text{vehicle } s_l m \text{ crashes into } s_l(m-1))$$

(1)

The random variable L_n equals to probability that S_n crashes in to V_{n-1}. We have

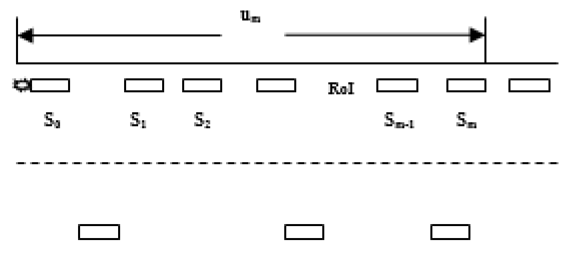
$$E[L_m] = P^\gamma [L_m = 1] = P^\gamma [u_m - x_m < D^*ssd,\ m] \quad (2)$$

The minimum stopping sight creates two parts from the traffic flow theory, (1) the distance z_{RT} traversed during the brake reaction time $z_{RT.}$ (2) the minimum braking distance D^*_{brake} wants to stop the vehicle without any collision with previous vehicle and it follows that

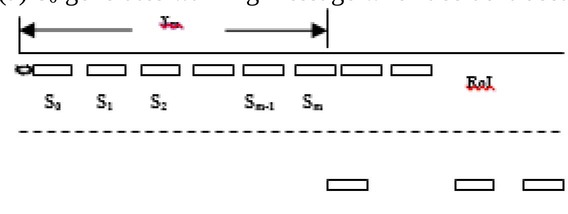
$$D^*_{brake} = \frac{v^2}{2b_{D,max}} \quad (3)$$

The break reaction time vRT is time between the object in the highway and the application of brakes. The traveling speed v and deceleration rate $b_{D,\ max}$ managed by driver character and vehicle traffic.

$$D^*_{ssd} = vz_{RT} + \frac{v^2}{2b_{D,max}} \quad (4)$$

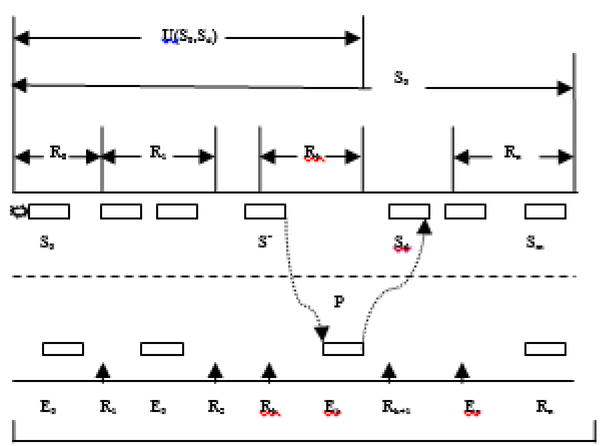


(a) S_0 generates warning message when accident occurs



(b) Vehicle S_m safely stops behind vehicle S_{m-}

Fig 2: Design for deriving number of accident vehicles



Region of interest

Figure. 3: Finding failure situation in CA through VANET

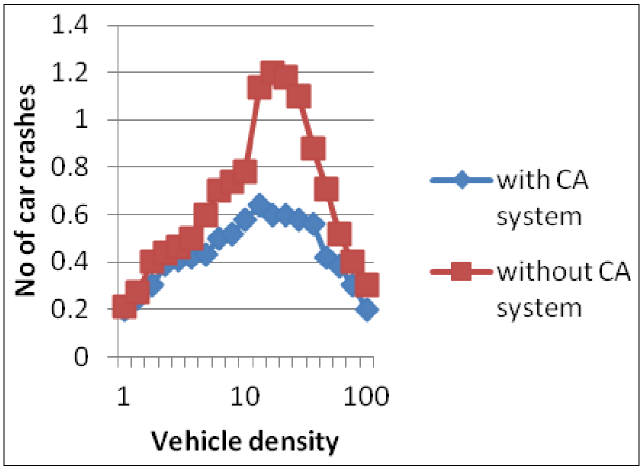


Figure 4 (a): Number of vehicle collision against traffic density

3.1 Analytical Model for VANET with Roadside Deployment

In this model, we can find the effectiveness of a collision avoidance system with or without roadside units (RSUs) deployment [15] [16]. Many reason to deploy RSUs in roads.

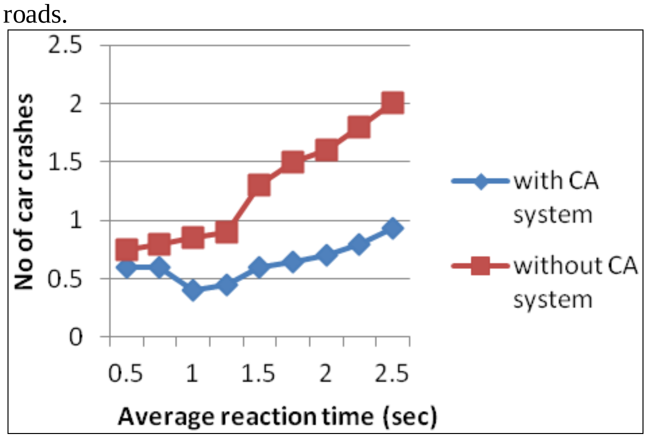


Fig 4 (b): Number of vehicle collision against driver's reaction time

First, increase network connectivity. Second, it improves the message delivery options. Third, reduce the delay of the disconnected vehicle. Other benefits of RSUs are given in recent works [15] [18]. In wireless CA system some vehicles outside the dangerous zone can get the warning message

The warning message received with or without RSUs deployment is created as follows. Fig.3. VANET having two-lane architecture in which vehicle travelling in both directions. A source node S_0 met an accident and it suddenly generate warning message to subsequent vehicles which present in Region of interest (RoI) R. The RoI is divided in to m+1 sub segments by RSUs $R_1 \ldots R_n$. For $0 \leq l \leq m$, let e_l represent the l-th subsegments. We include $|R| = \sum_{l=0}^{m} e_l$ if no RSUs deployed on R. It follows that m=0 and $|E|=|e_0|$.

It is also to calculate performance of CA system with no RSUs that is m=0, another one for m>0 with successive RSUs not required to similar. Imagine all vehicles with DSRC. Let S^* and S_d vehicles are disconnected for this store-carry-forward mechanism which connect the vehicle D on another lane.

IV. RESULTS AND DISCUSSION

The customized event driven monte-carlo C++ simulator for evaluation purposes in vanet topology, mobility model and data traffic model. To find vehicle location use dichotomized headway model. In Fig. 4(a), this result which computed by below equation,

$$E[m_c] = \sum_{m=1}^{\infty} [P\gamma[L_m] = 1] \qquad (4)$$

Compare with and without CA system when accident occurs, without CA system cause more serious problem.

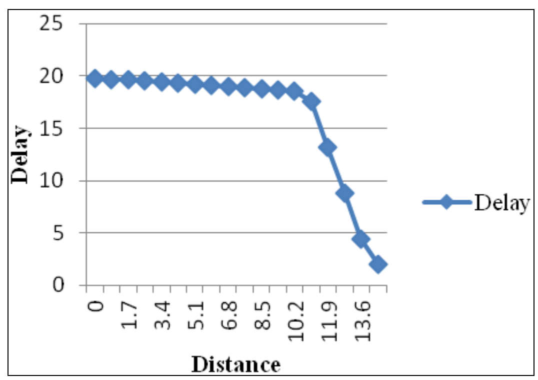


Fig 5: Message delivery time between vehicles

Wireless latency is reduced by CA system and the traffic density is predetermined by VANET application. In Fig. 4(b), this driver reactions time is reduced and improve the car safety. Light condition, visibility range and driver age according to this driver reaction time varies. In Fig. 5, Delay and distance between the vehicles while the message received from one to another vehicle in all this CA improves the car safety.

Table 1: The parameters used for simulation

Number of nodes	100
Region of Interest	1km
RSU deployment rate	4 RSU/km

Message payload	214 bytes
Carrier frequency	5.9 GHz
Channel bandwidth	10 MHz

V. CONCLUSIONS

The important aspect of VANET is inter vehicle communication considerably improve road safety and travel comfort while using a CA system. In this driver can receive warning message immediately from the VANET through direct transmission. From this driver can enough time to react the accident zone appropriately and quickly changes the lane. This paper evaluates the deployment of RSUs with or without collision avoidance system. In this driver receive latest road information and vehicle density by the VANET.

REFERENCES

[1]. F. Bai, T. Elbatt, G. Hollan, H. Krishnan, and V. Sadekar, "Toward characterizing and classifying communication-based automotive applications from a wireless networking perspective," in Proc. 2006 IEEEWorkshoAutomotive Netw.

[2]. Q. Xu, R. Sengupta, and D. Jiang, "Design and analysis of highway safety communication protocol in 5.9 GHz dedicated short range communication spectrum," *IEEE Trans. Veh. Technol*, vol. 57, no. 4, pp. 2451–2455, 2003.

[3]. Society of Automotive Engineers, SAE J2735 Standard: Dedicated Short Range Communications (DSRC) Message Set Dictionary. Q. Xu, T. Mak, J. Ko, and R. Sengupta, "Vehicle-to-vehicle safety messaging in DSRC," in *Proc. 2004 ACM VANET*.

[4]. Q. Xu, T. Mak, J. Ko, and R. Sengupta, "Vehicle-to-vehicle safety messaging in DSRC," in *Proc. 2004 ACM VANET.*

[5]. J. Yin, *et al.*, "Performance evaluation of safety applications over DSRC vehicular ad hoc networks," in *Proc. 2004 ACM International Workshop Veh. Ad Hoc Netw.*, pages 1–9.

[6]. S. Biswas, R. Tatchikou, and F. Dion, "Vehicle-to-vehicle wireless communication protocols for enhancing highway traffic safety," *IEEE Commun. Mag.*, vol. 44, no. 1, pp. 74–82, Jan. 2006.

[7]. O. K. Tonguz, N. Wisitpongphan, and F. Bai, "DV-CAST: a distributed vehicular broadcast protocol for vehicular ad hoc networks," *IEEE Wireless Commune. Mag.*, vol. 17, no. 2, pp. 47–57, Apr. 2010.

[8]. X. Yang, J. Liu, F. Zhao, and N. H. Vaidya, "A vehicle-to-vehicle communication protocol for cooperative collision warning," in *Proc. 2004 International Conf. Mobile Ubiquitous Syst.: Netw. Services*, pp. 114–123.

[9]. M. Torrent-Moreno, J. Mittag, P. Santi, and H. Hartenstein, "Vehicle-tovehicle communication: Fair transmit power control for safety-critical information," *IEEE Trans. Veh. Technol.*, vol. 58, no. 7, pp. 3684–3703, Sept. 2009.

[10]. Y. Zhang, E. K. Antonsson, and K. Grote, "A new threat assessment measure for collision avoidance systems," in *Proc. 2006 IEEE Intelligent Transportation Syst. Conf.*, pp. 968–975, Sept. 2006.

[11]. G. Bianchi, "Performance analysis of the IEEE 802.11 distributed coordination function," *IEEE J. Sel. Areas Commun.*, vol. 18, no. 3, pp. 535–547, Mar. 2000.

[12]. P.-J. Wan, K. M. Alzoubi, and O. Frieder, "Distributed construction of connected dominating set in wireless ad hoc networks," in *Proc. 2002 IEEE INFOCOM*, pp. 1597–1604.

[13]. D. R. Choffnes and F. E. Bustamante, "An integrated mobility and traffic model for vehicular wireless networks," in *Proc. 2005 VANET*, pp. 69–78.

[14]. R. J. Cowan, "Useful headway models," *Transportation Research*, vol. 9, no. 6, pp. 371–375, Dec. 1975.

[15]. S.-I. Sou, and O. K. Tonguz, "Enhancing VANET connectivity through roadside units on highways," *IEEE Trans. Veh. Technol.*, vol. 60, no. 8, pp. 3586–3602, Oct. 2011.

[16]. P. Li, X. Huang, Y. Fang, and P. Lin, "Optimal placement of gateways in vehicular networks," *IEEE Trans. Veh. Technol.*, vol. 56, no. 6, pp.3421–3430, Nov. 2007.

[17]. S.-I. Sou, "A power-saving model for roadside unit deployment in vehicular networks," *IEEE Commun. Lett*, vol. 14, no. 7, pp. 623–625, 2010.

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