# A distributed, bandwidth-efficient accident avoidance and Secured Mobility Pattern in VANET

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*Abstract*— **This paper focuses on the Wireless Collision Avoidance (CA) system which is essential for a Vehicular Ad Hoc Network (VANET) that distributes emergency warning messages to drivers ahead they enter a dangerous area on the road. We proposed a Collision Avoidance- Emergency Message Broadcasting (CA-EMB) protocol is employed for issuing the warning message to all vehicles which are connected in the Region of Interest (RoI). All vehicles are equipped with the wireless CA system in order to execute the proposed protocol which is based on the priority based emergency messaging. To avoid rear and end collision between any two vehicles travelling same direction, the warning messages are used which is in the form of signals. Theses warning messages are delivered frequently by employing the distance tracking method which reduces the delay. Finally, the simulation is done and the performance of proposed protocol is evaluated and the simulation results are shown below.**

*Index Terms*— **CA system, VANET, Region of Interest, CA-EMB, warning message and Safety application.**

## I. INTRODUCTION

Vehicular Ad hoc Network (VANET) is major classifications of Mobile Ad hoc Network (MANET) and in VANET vehicular nodes are communicate with each other using some wireless devices known as Dedicated Short Range Communication (DSRC). The vehicular

nodes or vehicles are fitted with number of smart sensors in order to detect its own motion status like acceleration, breaking system and changes in lane. These sensors are also used to detect weather conditions and road conditions (like icy roads). Vehicular Ad hoc Networks possess more number of attractive applications and our main aim is to enhance the efficiency and road safety by communicating the vehicles with each other. The size of Region of Interest (RoI) may vary for different types of vehicular network applications. Effective application range of various safety applications possesses a medium size which may vary from a few hundred meters to 1 km. Each vehicle must aware of the kinematic status of other participating vehicles in its intermediate vicinities (few hundred meters). [1].

Besides it is necessary to discuss an important feature of this vehicular application called convenience application which needs a medium to large effective application range since it is critical for drivers to recognize the traffic condition at current place in order to make important decisions and trip plans. Driver performance is believed to be the major cause of accidents. [2]. The VANET application must fulfill the following requirement: it must allow drivers to predict hazardous conditions or risky traffic areas. Nevertheless, data communication in vehicular network is a challenging task due to high mobility and frequent topology changes of vehicular nodes. In VANET, collision avoidance has earned more concentration in the field of research in which we mainly focus wireless Collision Avoidance (CA) system in order to alert drivers before they enter a dangerous area on the road.



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The wireless Collision Avoidance system that is equipped with the vehicles is used to generate urgent or emergency message to vehicles before the vehicular crash or emergency breaking occurs which are otherwise known as sudden events. Since, the propagation delay of wireless devices is significantly lesser than cumulative response time of drivers. So, the driver who obtains an early emergency message can provide more time to respond in an emergency condition. Thus, the number of road accidents can probably be reduced if the vehicles are equipped with Collision Avoidance system that generate emergency warning to drivers before reaching potentially dangerous area. There are various researches have been conducted on the safety applications of VANET and here we mainly focus on the simulation without depth mathematical analysis. [3]. It is necessary to evaluate the location of vehicles whether it is in dangerous zone i.e., RoI is connected to VANET. This is an important network design of wireless collision avoidance system. When the vehicles are fitted with CA system, VANET provides emergency messaging system to drivers who have more time to respond to hazards. This paper is organized as follows.

## II. RELATED WORK

Over past few yew years, there has been significant interest in VANET related researches. There are various researches have proposed the study of DSRC technology which can provide better road safety. For example, Biswas et al. [2] proposed an overview of Collision Avoidance Application of vehicle cooperation which is based mainly based on the DSRC devices. This work clearly explains the improved highway traffic safety through vehicle to vehicle communications. It also showed the requirement for data prioritization that is used for safety application in critical situation. Xu et al. [4], presented chain collision reaction of vehicles which mainly focused the severity of chain collision. This severity can be reduced by decreasing the delay between the emergency event time and time at which the vehicles after informed about the emergency. Mak et al. [5] evaluated the performance of Medium Access Control (MAC) at periodic safety message mechanism which in terms of the channel busy time and the data reception probability. Yin et al. [6] presented a study of delay-critical VANET road safety applications based on DSRC technology. Xue et al. [7] presented a communication protocol for CA system which evaluated the delay of MAC transmission.

Li et al. [9], investigated the gateways placing problems in order to reduce the number of hops between access point to gateway and the power consumption in VANET. Lochert et al. [10], presented an infrastructure of VANET through which the travel time of data transmission is improved over very large distances. M. Artimy [8] proposed a Local density estimation and dynamic transmission-range assignment in VANET in which local density is estimated. The estimated local density is separate between free flow and congested traffic phases. Depending on the traffic density in local traffic conditions a vehicular node can assign a suitable transmission range in a dynamic manner in accordance with the traffic density. In this research, we proposed a Collision Avoidance (CA) system to avoid vehicle collision and analyze the quality of performance of proposed CA system which regarding the realistic vehicle headway model and communication disconnection troubles in VANET.

## III. PROPOSED PROTOCOL

Collision Avoidance - Emergency Message Broadcasting (CA-EMB) protocol is used to avoid collision of any two vehicles by transmitting emergency message before it reaches the risky zone. The existing VANET protocols transmits warning messages in a hop-by-hop manner which increases delay and some of the vehicles lack in obtaining the transmitted warning messages. This may leads to rear and end collision of vehicles. But the proposed protocol utilizes the priority based broadcasting of warning messages to vehicles before reaching dangerous zone. Hence, this CA-EMB protocol is used to generate the warning message with a priority function. [11]. The proposed CA-EMB protocol has a priority algorithm that check on the vehicles and the vehicles are moving in priority according to the vehicular nodes available in specific dangerous zone. When the vehicle receives warning message then it suddenly reacts as soon as the vehicle driver applies brake and this system require braking model which checks the braking time and vehicle response.

Dichotomized Headway (DH) model is used in our proposed protocol for risky zone structure on the road. This model is classified based on the headway process like forward moment of vehicles, particularly when the vehicles are slow or they are in difficult situation. [12]. This DH model is used to describe the vehicles that are moving on highways with heavy traffic condition. The main aim of this protocol is to avoid collision of



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vehicles at rear-end and it focus on headway process. Each vehicle must contain a Collision Avoidance System as a major device to transmit the warning message. At first, the warning message is generated from a vehicle in a specific collision site which is sent to a moving vehicle that has high priority of signal reception. For that reason it first checks out the vicinity pool for specific vehicles. When the signal is received then it displayed on the device then it is transmitted. This process is extended until all of the participating vehicles are established alert from being clashed with promoting vehicles. Thus, the rear-end collision is reduced and the alert time is increased. [13].

## IV. DICHOTIMIZED HEADWAY MODEL

Mobility is a vital characteristic of wireless ad hoc networks known as Mobile Ad hoc Network (MANET) in which Vehicular Ad hoc Network (VANET) is a classification. In VANET, vehicular mobility is traced using Dichotomized Headway model which divides the DHM into two traffic flows that has some range. [14]. Location information of vehicles is given by this DH model which is then utilized to simulate the distance to the site of accident. The DH model assumes a source vehicle which is responsible for distributing the warning message through the Collision Avoidance system. The vehicle which is nearby the accident zone is known as source vehicle. Headway model is used to measure the accident time the distance between accident zone and vehicle or between any two vehicles where rear-end collision will occur. The following two models are implied in our proposed protocol.

1. Priority Based model
2. Collision-Avoidance System model

### *A. Priority Based Model*

This priority based model is based on the following steps that provide priority based signaling or messaging to participating vehicles. The algorithm for priority model is given below.

1. At first, assume the vehicles are randomly moving on the roads i.e., highways in promoting direction.
2. If a vehicle's rear reaching a vehicle's end at a particular distance, then the vehicle near the accident zone will create a warning message to driver.
3. Message Generator Pool is checked by the signal that generate warning message in order to check the priority.
4. Now the pool sends the message by checking the signal priority by CA transmitter.
5. The received emergency message from source vehicle is then displayed to the driver.

### *B. Collision Avoidance System Model*

The collision avoidance system module is used to communicate the vehicle to the external world by vehicular ad hoc network. A message generation pool is present from which e can collect the message to transmit and the collected messages are in the form of text messages or signals. By using the sensor signal receiver important decisions are made and then message prioritizing function is performed. This message prioritizing function is operated according to the message priority to which the vehicular node has to be obtained. To make broadcasting, the transmitter must obtain the alert signal from previous vehicles. This alert is much safety to avoid accidents or collision of any two vehicles between rear and end.

In order to explain the Collision Avoidance System (CAS), it is necessary to illustrate the leverage of DSRC-based wireless communication to enhance the efficiency of CA vehicular network application. Then, the CAS model is presented to issue the possibility of rear and end collision between any two vehicles moving in the same direction while a frequent braking situation occurs. The collision avoidance system is clearly explained in [15] by an example of two car highway platoon.



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## V. EXPERIMENTAL RESULTS

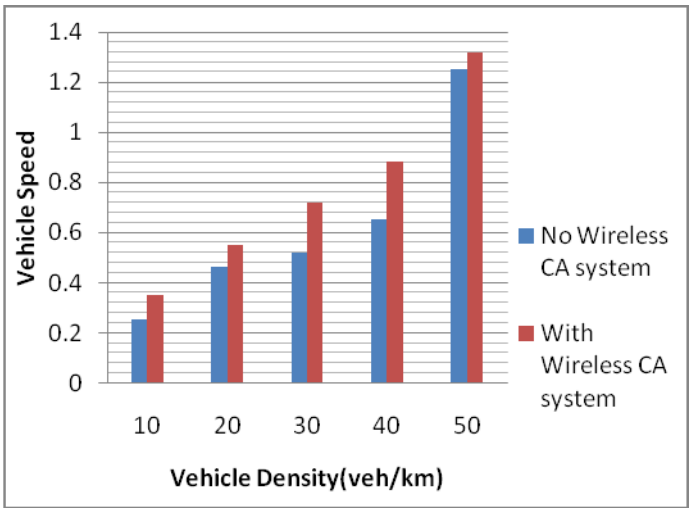


**Fig. 1 Vehicle Speed Vs Vehicle Density**

In Fig. 1, red line shows the performance of network With Wireless CA System and blue line shows the performance of network without or No Wi Collision Avoidance System. These plots are between Vehicle Speed and Vehicle Density. Vehicle Density is reduced the Vehicle Speed network gets increased. Generally, the network Wireless CA System has reduced Vehicle D provides better performance.

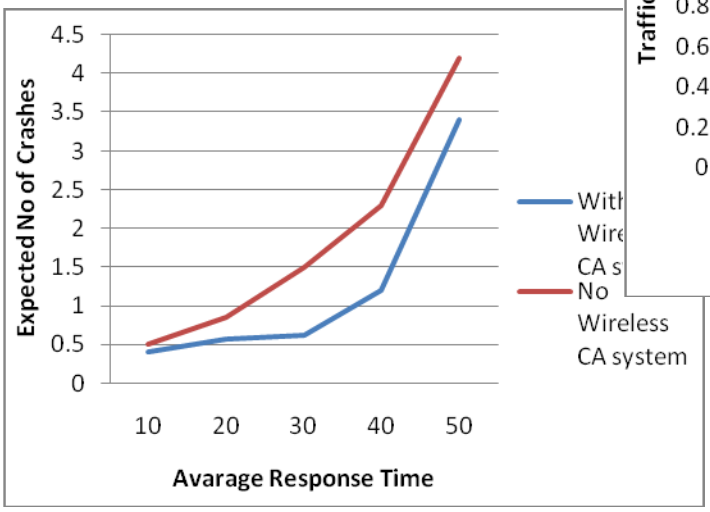


**Fig. 2 Expected No. of Crashes Vs Average Response Time**

In Fig. 2, red line shows the performance of network With Wireless CA System and blue line shows the performance of network without or No Wireless Collision Avoidance System. These plots are drawn between Expected No. of Crashes and Average Response Time. While Expected No. of Crashes is reduced the Average Response Time of the network is also reduced. The network with Wireless CA System has reduced Expected No. of Crashes provides improved network performance.

In Fig. 3, red line shows the performance of network With Wireless CA System and blue line shows the performance of network without or No Wireless Collision Avoidance System. These plots are drawn between Traffic Density and Vehicle Density. When Vehicle Density is increased the Traffic Density of the network is also increased. Generally, the network with Wireless CA System has reduced Vehicle Density which provides better network performance by reduced Traffic Density.

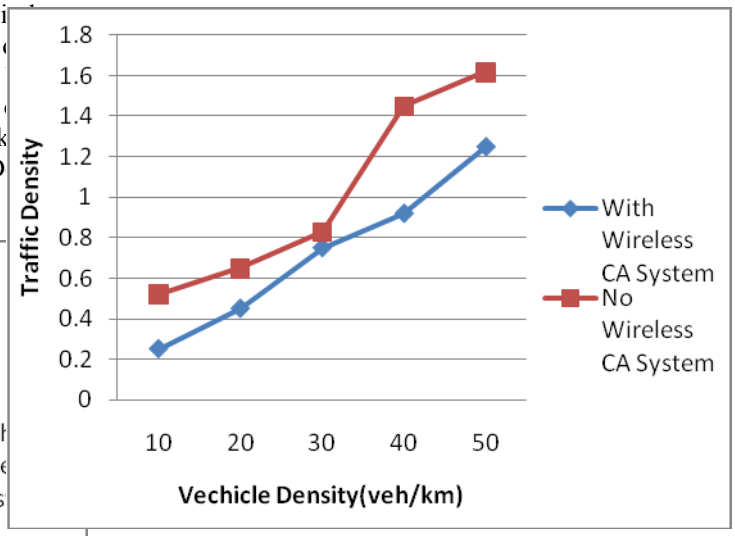


**Fig. 3 Traffic Density Vs Vehicle Density**

## VI. CONCLUSION

Thus, VANET can significantly enhance road safety and provides travel comfort by permitting inter-vehicular communication which is the promising aspect of vehicular network. In this paper, CA-EMB protocol is proposed to avoid vehicle collision by generating emergency warning message in the form of signal. The vehicle speed and deceleration rate change



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depending on driver behavior, traffic density of the road and vehicle type. The requirement and limitation of collision avoidance system is mainly based on the practical constraint and engineering perception. New road information and traffic information must broadcast frequently to drivers by CA system of VANET safety application. The performance of the proposed system has been evaluated and analyzed by the simulation and the simulation result is shown which provides the efficiency of proposed system.

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