

Prioritized Emergency Messaging of a Car Accident in Vehicular Ad-Hoc Network

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Abstract—This paper is focused on Vehicular Adhoc Network (VANET) in which the wireless Collision Avoidance (CA) system issues warning message to drivers before they reach a dangerous zone on the road. The Priority-based Emergency Message broadcasting protocol (PBEMB) is used for broadcasting the Warning Message (WM) to all the vehicles connected in Region of Interest (RoI). The proposed protocol has a wireless Collision Avoidance system in all the vehicles. The purpose of Warning Collision Avoidance System is for priority based emergency message generation. The WM in the form of signal will avoid the rear-end collision between two vehicles that travels in the same direction. By using the distance tracking method, the message is delivered rapidly while comparing with hop by hop message transmission, thus reducing the delay in EM delivery.

Index Terms— Collision avoidance system, dangerous zone, Warning message, hop by hop message, rear-end collision, region of interest, vehicular ad-hoc networks

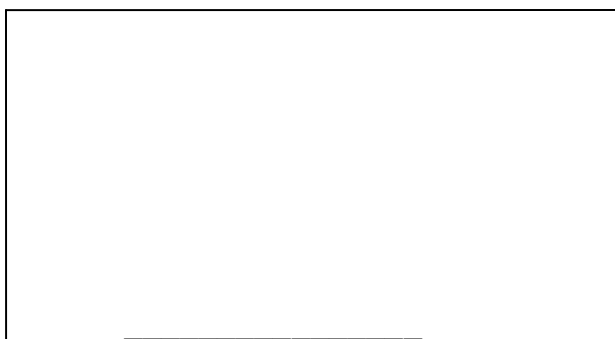


INTRODUCTION

Vehicular Ad hoc Networks (VANET) is the subdivision of Mobile Ad Hoc Networks (MANETs). Each device in a MANET is allowed to move independently in any direction, and will frequently therefore change its links to other devices [1]. VANET is one of the determining areas for the development of ITS (Intelligent Transportation System) in order to provide safety and effectiveness to the vehicle users [2]. VANET aid drivers to communicate and to correlate among themselves in order to avoid any rear-end collision through Vehicle to Vehicle (V2V) communication e.g. road accidents, traffics, controlling speed, free route for emergency vehicles and unseen barrier etc [3]. VANET also provide comfort applications to the road users besides safety applications for example, mobile e-commerce, internet access, weather information and other multimedia applications [4]. Vehicle collision avoidance system is recently has become a major area in VANET research [5].

In a Vehicular Ad hoc Network (VANET), vehicles communication is achieved through Dedicated Short Range Communication (DSRC) wireless devices [6]. These wireless devices equipped with many number of smart sensors, so that road condition and their own moving status can be detected by vehicles [7]. A medium-sized effective application range (i.e., few hundred ms to 1 km) in most of the safety applications is implied. Vehicles need to be conscious of the motoric status of other vehicles in their same vicinities (i.e., few hundred ms) or in a stretch of road that lies ahead (i.e., up to 1 km) in the potential for hazardous conditions [8].

To design a wireless CA system perfectly, it is important to evaluate whether vehicles located in the potentially risk zone (i.e., the Region of Interest) are connected to VANET [9]. While vehicles are connected in the VANET, the drivers can immediately receive warning messages priory [10]. In such cases, drivers have appropriate time to react for hazards.



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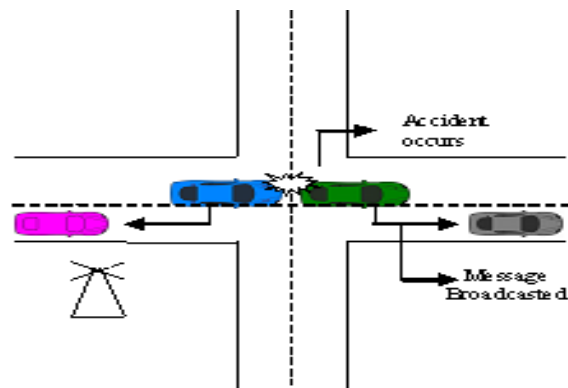


Fig. 1. Communication Architecture of VANET

This paper makes the following steps, 1) Initially it is proposed with a wireless CA systems to estimate the probability of a rear-end collision between two vehicles that travel in the very same direction.

2) Then various useful facts are taken, is developed by traffic flow theory, consider into account to generate vehicular mobility traces for evaluation and analysis. 3) The probability of vehicles derived, are located in the RoI failing to receive warning messages. For determining the vehicle density for transformation of warning message, its block size and number of times for message generation is calculated [11]. For achieving the safety message delivery, formal verification of a safety message transformation is implied [12]. The deployment of Road Side Unit (RSU) and broadcasting message generation is investigated to improve the VANET environment [13].

2 WARNING MESSAGE GENERATION

2.1 VANET Vicinity Check and Connection Establishment

Vicinity check is the state of vehicles moving in the particular risk zone is checked for VANET connection.

Dichotomized Headway (DH) Model: This model emulates the topology change pattern of vehicle on highways which are moving in forward direction [8]. It can be useful in estimation the direction between vehicles and to reroute the direction according to the traffic in that area.

Important Characteristics: The model used in this process describes the vehicular mobility traces in heavy traffic. The mobile vehicle is allowed to move in safe zone and also can route the lane change and intimate those changes to other vehicles. According to the divided categorizes the vehicle can move in the safe position to avoid collision.

Continuously pools the availability of active VANET: The vehicles are considered to move in a forward direction. In heavy traffic on highways there is a possibility of facing rear-end collision between forwarding vehicles. In such case if any accidents are occurred then the VANET connection is needed to be established. This connection checks the vicinity of the moving vehicle to form a connection.

Connection with the VANET on availability: As soon as the vicinity check is over it connects accordingly to that traffic. The connection will be established to some particular distance by which the vehicles in dangerous zone are covered [2]. The vehicles in that zone which are in other platoon is also checked and connected in VANET.

Sense nearby vehicles and establish connection: Connection is sensed completely in traffic and all the moving vehicles connected. It is considered that without loss of generality, the vehicles are traveling at a speed of 90 km/hr (25 m/s) and with an inter-vehicle spacing (headway) of 50 m. The headway denotes the distance between the front of one vehicle and the front of the subsequent vehicle.

Communication of transmitter and receiver through the port: This vicinity connection will act as a port through which the transmitter and receiver communicates to the external world. VANET is used for communication between vehicles through the network connection. Vehicles will be connected to wireless connection in which each assigned with an IP address. Those IP helps in transmission of signal [12].

2.2 Collision Avoidance System Transmitter

This module is responsible for communicating (Tx) to the external world through VANET vicinity check and connection establishment. It transmits the message on priority which is received from the Message generator pool. The message which is received can be of any form as signal or text message. This makes decision based on the signals received from the Sensor signal receiver. Then performs Tx message prioritizing function.

The function will be acted according to the priority of the message to which the vehicle has to be received. The transmitter will receive the signal as the alert from previous vehicle, which will make broadcast.

The following process will be generated to transmit the message for further vehicles. These alerts are much safety in the event of avoiding accidents or collision between rear end vehicles. Tx message allows the priority The collision avoidance system is explained through a two car highway platoon example [5]. Thus the Dichotomized headway model is also expected to have high spatial dependence and high temporal dependence. This too imposes some restriction on vehicle movement. However, it differs from the freeway model in giving a vehicle some freedom to change its direction.

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Transmits the message on priority: The signal is generated while rear-end collision occurs will be generated initially from the transmitter of the vehicle which is near to risk zone. The message which is received can be of any form as signal or text message.

Decision making on Sensor Signal: As the signal is received from Collision Avoidance system Transmitter it is estimated from where the signal is sent and it analyze the collision spot. This helps in changing the lane or reroute the movement.

Function using prioritization: The Warning Message (WM) in the form of signal is given to message pool in which it performs the priority function. The message is sent to receiver of nearby vehicle in the particular zone where the vicinity connection is established.

2.3 Collision Avoidance System Receiver

This module is responsible for communicating (Rx) to the external world through VANET vicinity check and connection establishment. It receives the message on priority which is received from VANET. The message which is received can be of any form as signal or text message. It makes Display decision based on the priority attached with message. This performs Rx message prioritizing function.

Receiver will receives the message as per display options in the device which notifies the driver in timely incidents. Such a message which is received will be continuously running to the display device which can be broadcast the further message to other vehicles in precedence manner [3]. The message generation pool which is located in certain device will be generally notifying the region of interest where all the vehicles are residing. The following process will be generated in receiver

Message received on Priority: The signal which is sent from the transmitter will be received in receiver as per the priority function done in message pool. Then the vehicles estimates the signal strength and location from which the signal is sent, it reroute the plan.

Display decision: The vehicles makes display decision based on the priority attached with message. It checks the signal and it further process the transmission. It generates two processes after receiving the signal. First it displays the EM to the device, which is visualized by the driver and reacts accordingly. Second it broadcast the signal to all other vehicles, by which the vehicles receives the emergency signal for avoiding collision.

2.4 Sensor Signal Receiver

Sensor signal receiver is a signal which acts as an alert message for all the vehicles either in broadcasting or in hop by hop. Sensors are of many types, but in this method sensor signal will be nothing but intra-car wireless sensor, transmit signals from transmitter and receiver. Signal is classified into two main parts, periodic message and event driven message. In the periodic message, message will be delivering in each and every period, where in event driven, the message is deliver only when the event occurs. Signal which is received from various sources would actively participate and generate the entire vehicles according to the priority algorithm. Sensors from both the transmitter and receiver would generate the both side message by which the vehicles are in moving state [7].

This module acts as an interface between the various sensors attached to the vehicle. The sensor signal which is received in receiver will be any format and thus it is needed to be changed. Thus it performs digital to textual transformation. After transformation it feeds input to the Message generator pool. From that pool it feeds input to the Collision avoidance system transmitter.

The following process will be generated in Sensor Signal Receiver,

1. This module acts as an interface between the various sensors attached to the vehicle. As mentioned it can be either transmitter or receiver.
2. It performs digital to textual transformation, that the message can be in signal form and it transfers the signal into textual format by which the pool can generate priority function.
3. This Feeds input to the Message generator pool as it is sensor signal which can notify the other vehicles.
4. It also feeds input to the Collision avoidance system transmitter of other vehicles by which the signal is transferred continuously.
5. Finally the sensor signal vehicles will continuously generates the message to all the vehicles according the algorithm which is mentioned in given region of interest.
6. This will also carries two kinds of alerts in same state either in even driven or periodic driven.
7. As soon as it receives the signal, vehicles react according to the message.

2.5 Message Generator Pool

Message generator pool is a database which stores the entire message from various vehicles. This will generate the message to receiver along with priority function. Priority function is a function which is generated according to the location of vehicle near the transmitter. Pool is the huge package to store all the alerts and make the easy process of sending message to priority vehicles. This also handles the entire digital signal to textual format of message that is supported by all the vehicles.

This pool mainly implements the prioritization algorithm, in which the preceding vehicles are to be received the signal in priority. It is a database which stores the entire message from various vehicles. This will generate the message to receiver along with priority function. Priority function is a function which is generated according to the location of vehicle near the transmitter. Pool is the huge package to store all the alerts and make the easy process of sending signal to priority vehicles [12]. This also handles the entire digital signal to textual format of message that is supported by all the vehicles.

The following process will be generated in Message generator pool is,

1. This implements the message prioritization algorithm, which handles the message which has to be prioritized for all the vehicles.
2. It attaches priority to the generated messages received from the Sensor signal receiver. The message which is in signal format is converted and attached.
3. Then it sends the priority attached message to the Collision avoidance system transmitter.
4. After the message is generated CA system will check the availability in order to broadcast the entire message.
5. The Warning Message is now broadcasted.

3 PARLANCE OF PBEMB PROTOCOL

Priority-based Emergency Message broadcasting protocol (PBEMB) is used. Unlike hop by hop delivery of signal (Warning Message) in which some vehicles lacks in receiving the signal in advance for avoiding rear-end collision, in prioritized broadcasting vehicles will receive the signal before reaching the risk zone. Thus Collision Avoidance System is used to generate the signal with priority function [1]. Priority algorithm will check on the vehicles which is moving in precedence according to the vehicles available in particular risk zone. The vehicles which receive the signal will react as soon as the driver applies brake. In such case braking model is implied, that checks the time and reaction of vehicle.

This protocol uses dichotomized headway model for dangerous zone scenario on the road. This model is the classification of headway process (i.e., forward movement or progress of vehicles, especially when vehicles are slow or difficult) [8]. The vehicles which are moving in heavy traffic on highways are described deeply by this model. The main goal of this model is to avoid rear-end collision as it concentrate on headway process.

The prioritized function creates the priority signal to the vehicles which are leading towards the risk zone. It uses the Collision Avoidance System as a main device in each vehicle for transmission for the Warning message. First the message is generated from vehicle in particular collision spot and it is sent to precedence vehicle which has the priority of receiving the signal. For this it initially checks the vicinity pool for VANET connection for particular vehicles. As soon as the signal is received it is displayed in the device and also it is broadcasted. This process is continued until all the vehicles are given alert from being collided with forwarding vehicles. Therefore it reduces the rear-end collision and also time of alert is increased [10].

Most VANET research coincides with IEEE 802.11p is power and flexible device, a wifi variety is for communication in the vehicular environment as part of wireless access in vehicular network standard.

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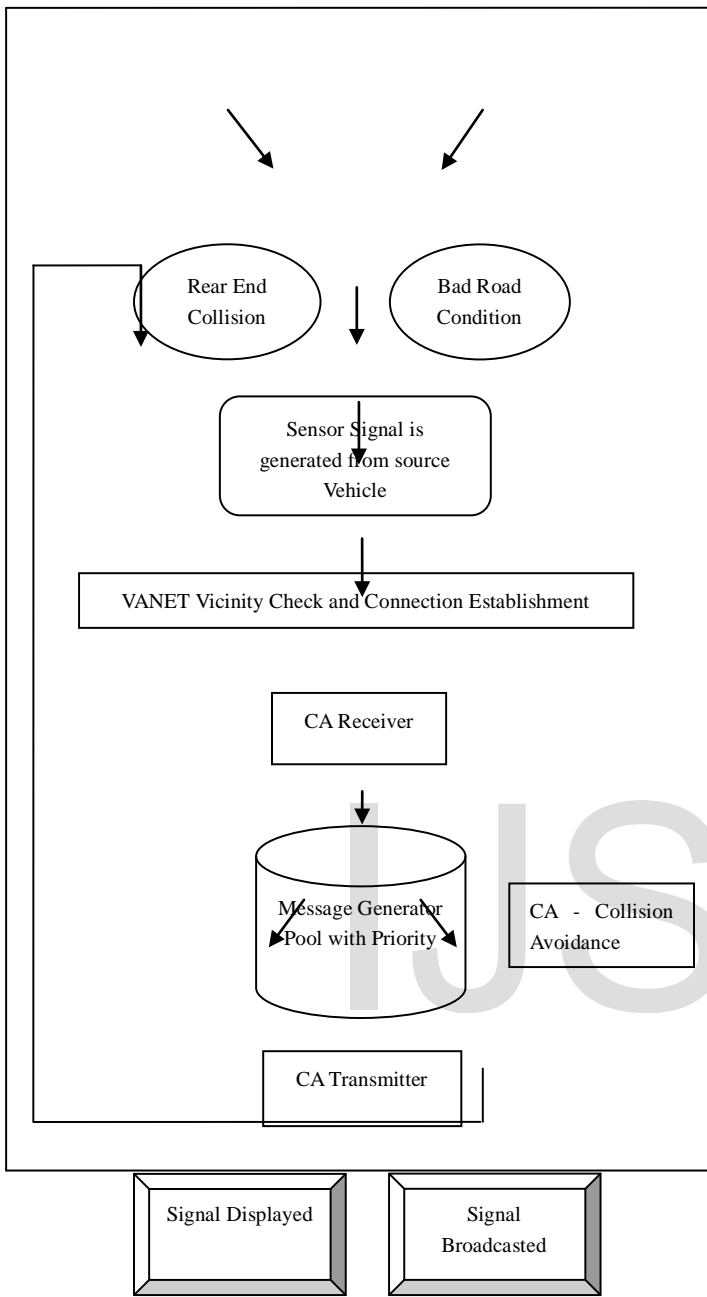


Fig. 2. System Design

Each channel is separated for different occurrence of vehicle movement such as, accident avoidance, service channel, and control channel and high power long range. The following table shows the maximum communication range in the order of 1km is,

TABLE 1
 Channel assignment

Ch 172	Ch 174	Ch 176	Ch 178
5.850	5.860	5.870	5.880

In process of the connection among RSUs, two kinds of different RSU deployment can be established. Due to the maintenance cost and deployment of the RSUs, ad-hoc based RSUs are considered for road deployment. However, the maintenance cost and deployment of the RSUs are deployed with fiber or broadband wireless links, which might be impractical and expensive [9]. Thus RSU and OBU will be much helpful for arrangements of vehicle distance and placement. Related approaches are followed for maintaining the channel frequency for connection of networks in RoI.

4 DICHOTOMIZED HEADWAY MODEL

Mobility is one of the key characteristics of a class of wireless ad hoc networks called mobile ad hoc networks (MANETs). In order to trace the vehicular mobility Dichotomized Headway Model is utilized. This divides the headway model into two traffic flows which consider some range [12]. The DH model gives the vehicles locations that are then used to simulate the distance to the accident site. The source vehicle (i.e., the vehicle nearby the accident site) is responsible for issuing the warning message via the CA system.

Headway is nothing but the measurement of the time or distance between two vehicles while transmission occurs.

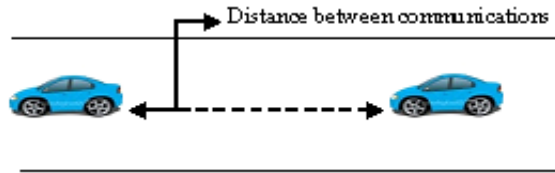


Fig.3. Headway model

For the transformation of message the following three models are implied in this protocol,

1. Priority based model
2. Collision Avoidance System model
3. Braking model

Under all the above DH models, each vehicle moves independent of the other vehicles in the network.

4.1 Priority Based Model

The model will define the following steps for priority based messaging to vehicles. The priority algorithm is followed in following steps,

1. Initially the vehicles are considered to be randomly moving on the highways in forwarding direction.
2. If a sudden rear-end collision occurs, then the vehicle near that accident will generate the Warning Message.
3. The signal which is generated will check in Message Generator Pool for priority function.
4. The pool now sends the message as signal with priority attached in it to transmitter.
5. The EM which is received in precedence vehicle from source vehicle is displayed to driver.

The message generation pool will checks the vicinity check and details of all the vehicles located in particular region of interest. The vehicles are connected only while movement in that region. According to that movement of each vehicle it connects for particular distance in which collision is avoided in particular risk zone. The preceding vehicle will be benefited as soon as it receives the Warning Message. The EM will be mainly in the form of signal from which the vehicles are alerted immediately. Finally priority based algorithm assist in CAS. The sensor signal which is generated by the source vehicle will be broadcasted in the form of priority function. Accordingly, the vehicle receives signal in precedence and also the vicinity connection is formed in risk zone. Such vehicles in the RoI accommodate the wifi connection between each vehicles travelling in the same direction.

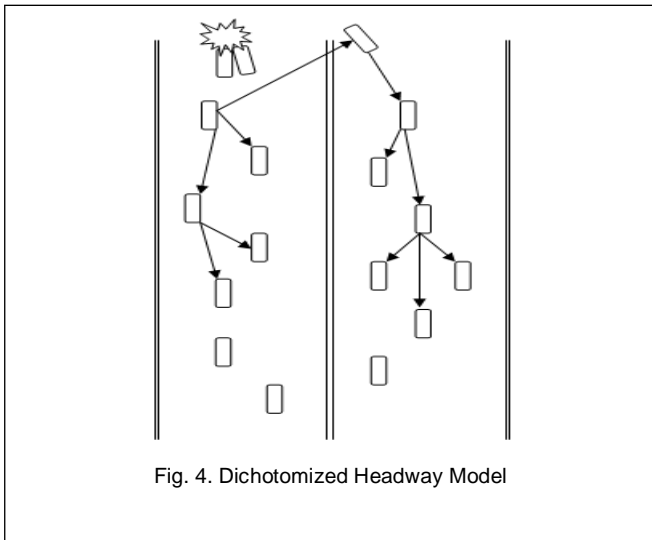


Fig. 4. Dichotomized Headway Model

4.2 Collision Avoidance System Model

In this model, leverage of DSRC-based wireless communication is first illustrated to improve the efficiency of collision avoidance applications. Next, Collision Avoidance System (CAS) Model is proposed to provide the possibility of a rear-end collision between two vehicles traveling in the very same direction when a quick braking situation occurs. The CAS is explained through an example of two car highway platoon [6].

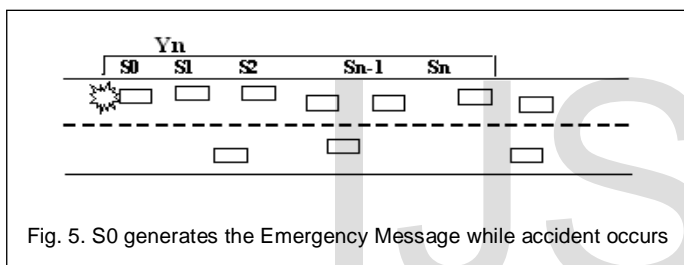


Fig. 5. S_0 generates the Emergency Message while accident occurs

In Case I, vehicle S_2 does not have a CA system. The driver of S_2 saw the light of its leading car at $t_0 + 1.5$ s (accident time t_0); Driver took 1.5s of brake reaction time. Consequently, S_2 initiated an emergency deceleration (at 4 m/s^2) at time $t_0 + 3$ s.

The accident occurs initially and the source vehicle S_0 generates the EM to the nearby vehicles to avoid collision in advance. Without CAS the probability of collision occurrence is high and that is illustrated in above fig.6. Braking model depends on the CAS and thus it is analyzed according to that rules. In the above fig Y_n is the distance of Region of Interest.

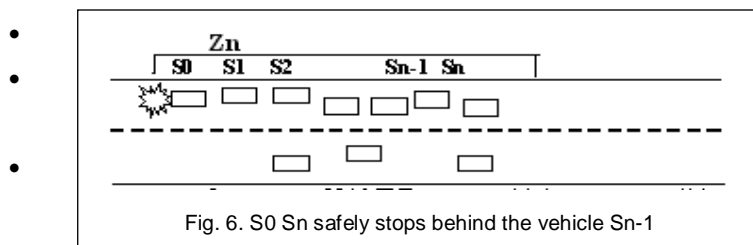


Fig. 6. S_0 S_n safely stops behind the vehicle S_{n-1}

In Case II, both vehicles S_1 and S_2 have wireless CAS. S_1 issued a Warning Message at time t_0 , and S_2 received the message at time $t_0 + t_l$. The wireless latency t_l is less than 100 ms usually (0.1s) in DSRC std. As a result, when S_2 received the EM, the driver of S_2 took 1.5s of braking reaction time and immediately initiated (at 4 m/s^2) an emergency deceleration at time $t_0 + 1.6$ s. Finally, S_2 stopped before crashing into S_0 and S_1 . The maximum distance S_n needed without crashing into the following vehicles is determined by Z_n [8].

The accident scenario is illustrated by generating the source message to proceeding vehicles S_1 , S_2 , S_n and so on. The chain collision probability of S_n is to be computed, the review of the vehicle braking model is described initially by flow theory. Fig.7 shows the CAS process of wireless CA device in which the rear-end collision is completely avoided by analysis.

4.3 Braking Model

In sparse VANET, two vehicles are possibly disconnected and the message delivery is generated by the store carry-forward scheme through opposite vehicles. If the delay is not occurred in SCF scheme then driver can react to the hazard as soon as

possible.

In the traffic flow theory, the Minimum Stopping Sight Distance ($d_{ssd,n}$) composes of two parts: (1) the distance traversed d_{BRT} during the brake reaction time t_{BRT} and, (2) the min braking distance d_{br} wanted to stop the vehicle without colliding with the following vehicle [3][7]. It gives,

$$ssd = d_{BRT} + d * br \quad (1)$$

The braking reaction time elapsed between the reorganization of a hazard or an object is t_{BRT} , this is happened in application of brakes and roadways.

$$br = v^2 / 2ad, max \quad (2)$$

The vehicle deceleration at the maximum rate of ad, max with the initial speed of v , from the above equation. The brake reaction time's length varies widely among each driver. Concernlier, the brake reaction time is significantly affected by many factors, such as the age and gender of the driver, the driver impairment, vehicle type and the cognitive load. Also the distraction made to a driver will reduce the ability to respond to an emergency signal and the reaction time is increased. A driver who is alert reacts in less than one second, while other drivers may need up to few seconds.

A vehicle crash can significantly be avoided by reducing the braking reaction time t_{BRT} . The wireless propagation latency is calculated in terms of milliseconds, is preferably smaller than the cumulative driver's braking reaction time that is calculated in terms of seconds. When a driver receives a priory warning, driver has more time to react to collisions or any hazards. We assume that the initial vehicle S_0 is the one that first sees the collision and is responsible for delivering the collision alert. By combing the chain collision and braking model it is easy to evaluate the S_n . Headway model in flow theory that will explain distance between free vehicles and cluster of vehicles.

5 RELATED WORKS

The distributed applications in the form of VANET will need to agree on a common understanding of background for interoperability, therefore, it is necessary to create a standard structure which permits data interoperability among all the different establishments involved in transportation systems [1]. The vehicles can participate in reporting and collecting useful traffic information such as density, section travel time and flow rate [2]. The vehicle-to-infrastructure communication scenario is distributed; where an end-to-end path is exist between the nearest road side unit and a vehicle [3]. Road side infrastructure is purposely using the technique to avoid driving hazard in particular circumstances [4]. The sparse or low density vehicular ad hoc networks are focused, where reliable transmission and timely message delivery are of much importance [5].

The sensors can generate a traditional sensor network and sheer amount of data, approaches for data reporting become unachievable [7]. To reduce traffic jams and to avoid multiple accidents by broadcasting EM at low overhead and with high speed, EEMB scheme is implemented [10].

6 CONCLUSION

The existing system has proposed analysis of vehicle cooperative collision avoidance based on the newly emerging DSRC devices. This work shows how vehicle-to-vehicle communications can enhance highway traffic safety and efficient movement of vehicles. It also demonstrated the need for data prioritization for safety-critical applications. This allows the drivers to immediately receive warning messages through direct transmission when vehicles are connected to VANET [7]. In such cases, drivers have enough time to react for dangerous situations appropriately.

For example, vehicles near the accident site can slow down or stop before colliding with the following vehicles, while the vehicles further away can quickly detour/reroute decisions or change their lanes accordingly. This paper developed for implying PEMB protocol in order to achieve the generation of Warning Message in form of signal for the antecedece vehicles [11]. The deceleration rate and traveling speed vary depending on traffic on road, driver behavior, and country and vehicle type. The constraints and requirements for collision avoidance system are based on practical limitations and engineering insights. The efficiency of the proposed model has been validated and analyzed by extensive simulation outcome.

The CA system must keep broadcasting new road information very frequently to drivers when the detection of density of traffic by the safety application in VANET is within this collision range. This was a initial process to implement the Priority based protocol for DSRC safety applications by combing flow theory and network, so that the analysis is realistic for transportation planning and are more comprehensive. The form of broadcasting will much imposed for Collision Avoidance in vehicles which are moving in forward direction [2].

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