Enhanced Collision Avoidance Method (ECAM) in VANET

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ABSTRACT

VANET (acronym for Vehicle Ad-hoc Network) is a rising star technology that enables communication between vehicles. Road accidents are on the increase. Cause apart, an effective way to avoid accidents would be provision of congestion free communication between vehicles on the move. It is here that VANET comes in handy. VANET is of specific assistance in enabling wireless communication between vehicles and road side units. In VANET, vehicles are connected with each other and RSU to form a network. Vehicles are open to pass information within a network. Messages can be sent in vehicles intense or with RSU’s. Accident happen in the twinkling of an eye, before the driver is able to understand what is happening. The problem does not stop here. Traffic congestion follows and there is congestion. Tooting of horns produces noise pollution. Things came to a standstill and are thrown out of gear. ECAM is the right method that can help avoid accidents and control traffic jam. Use of ns2 simulations is a feature in this work.

KEY WORDS: VANETs, accident avoidance, congestion control.

1. INTRODUCTION

Vehicle on the road shows a phenomenal increase in number. Accidents too are on the increase. Research on improving road safety devices is a subject for sustained focus. Communication between vehicles via wireless can be of immense help. VANET’s have been found to answer the problem. MANETs can be considered as a special type of MANET where a group of moving vehicles keeps comprehensive communication using the network, endowed with the ability to extend a spacious region through a basic mobile service and internet facility. VANET, in other words, is a subset of MANET. VANET does not need any sub-station or switch in mobile network. Actually it is capable of forming a network by itself. Two types of communication are feasible between the vehicle intense (V2V) which enables communication between vehicles without the help from any device. The other is vehicle to infrastructure (V2I) i.e. RSU.

Vehicles requires a transceiver, a global positioning system (GPS), an on board diagnostic (OBD) and an interface to help communication. RSU’s are fixed at intersection points on the road. A vehicle can send a message to the RSU which in turn can pass it on to another vehicle. The transceiver is coming in here. GPS helps identification of the location of the respective vehicles. OBD helps to determine the speed of the vehicles. It has a resource. Command processor and a read/write memory, which helps storing information and retrieve it when needed. The main functions of OBD are accessing wireless radio, ad-hoc and geographical routing, control of network congestion, transfer of reliable message, provision of IP mobility and data security.

Increase in vehicle population is among the cause of road accidents, through increased road use. VANET provides information on the traffic and weather condition. It routes the vehicles and helps the drive to find a good route that can avoid accidents. VANET brings in an effective and useful transport system.

Collision occurs as a result of ignorance of a driver about what is happening to the vehicle proceeding before his vehicle. Such information could be of help even for vehicles remotely placed. Communication on this matter is very important. It helps drivers to avoid taking an accident prone area in emergent situations.

The proposed work focuses on the detection of congestion or large vehicle density relating to dynamic routes “critical” road segments can be identified, helping avoiding congestion and collisions. Our methodology is meant to help vehicles deviate from highly congested route.

Background: This section discusses earlier work in the field of cooperative collision warning systems and decision making for collision avoidance. A review is made of simulation environment for vehicles on roads. Use of wireless communication has the potential advantage of making the drivers more intelligent and better informed. Several studies are on record about cooperative collision warning system using wireless communication.

Sengupta (2007), have proposed a CCW prototype that proves the driver both warning and situation awareness through displayed fixed in the vehicles. The prototype has been tested in low speed in an urban office campus with poor GPS coverage, and at high speed on an unused airfield. It is able to provide 360 degree awareness through use of GPS and wireless communication. However, the warning system has only a limited application. It informs the driver of the current situation but not suggest any alternative action. In other words, the analysis of the information provided by the system is left to the driver. Also this approach does not mean the use of a map, but only a paucity of information on road geometry.

The GpSense Car, a Collision Avoidance support system, starts horning with different tones depending on the estimated degree of danger as calculation from a pedestrian’s smartphone. The user having a WiFi enabled cell phone is a requirement of this system.
particularly when vehicles are moving slowly or in a difficult situation (Sok-Ian Sou, 2011). The model describes the vehicles the vehicles moving on a highway wherein traffic is rather heavy. The objective is to avoid collision of vehicles in the rear, focusing on headway process. A collision avoidance system is a must for the vehicle as a major device for transmitting a warning message.

Huang has proposed a joint rate-power control algorithm for broadcasting of a self-information message that enables neighbor tracking in VANET’s. This algorithm decides on the frequency for broadcast of its own situation or state and the extent to which such information should be broadcast for obtaining the best performance. Evaluation of this algorithm is done through a realistic network and microscopic traffic simulations (Huang, 2010). However, frequent sending information on the state can mean consumption of bandwidth.

In (Hayder Salman Dawood, 2013), introduced a system wherein the warning message is generated from a vehicle in a specific collision site. The message is sent to a moving vehicle which has a high priority of signal reception. This forms the reason that requires the first checking of the vicinity pool for specific vehicles. The received signal is displayed on the device for transmission to follow. The process is extended till all the participating vehicles and kept alert, free from the danger of getting clashed with promoting vehicles. This helps avoiding rear-end collision and increase in alert time.

Elbatt (2006), has studied the suitability of the standard DSRC protocol for inter-vehicle communication applications and, more specifically, cooperative collision warning system. In this paper, two innovative latency metrics are introduced for assisting the performance of CCW systems using DSRC protocol. Packet Inter-Reception time (IRT) at the vehicle for packet sent by a given transmitter and cumulative number of packer Receptions at the vehicle from a given transmitter.

A. Lakas (2009), has proposed a traffic jam detection system which uses wireless communication for information exchange. This system emerges each vehicle periodically sending a request message to other vehicles. Response to such a message can detect road congestions. Then a modified version of the Dijkstra algorithm can be used for finding a better route from the requested vehicle (Lakas, 2009). The problem with this system lies in the frequent sending messages by every vehicle to other vehicles for detecting and avoiding road traffic congestion.

There have been decision making methods implemented and made use of in some sensor based or vision based collision avoidance system. Jansson (2002) have presented a decision making system which uses a modern tracking theory along with a decision making module. This prototype system presented in this paper has the ability to make a significant reduction in the impact speed in frontal collisions (Jansson, 2002). The decision making model has to predict how the position of the tracked object is supposed to follow a straight line segment and a circle segment.

Jansson (2002) has indicated a novel framework for a collision avoidance system. This framework uses statistical decision making and stochastic numerical integration (Jansson, 2008) and also sensors to detect and track other vehicles. Inaccurate sensor information can lead to uncertain state information and can influence the performance of the collision avoidance system, with statistical decision making having been used for dealing with estimation uncertainties through calculation of the probability for each action.

There are two trade-off issues that Hillenbrand (2006), has attempted dealing with. They are potential benefit of using sensor-based collision mitigation systems and the prediction uncertainties of systems of these kinds (Hillenbrand, 2006). The author has proposed a decision making approach for allowing an intuitive trade-off between two activities, viz, the potential benefit and the readiness to take and face risk in respect of product liability and acceptability of the driver. Three different situation have been the subject matter for investigation of the performance of this system. These are: rear-end collision due to braking that could not be expected, cutting in vehicles and crossing the traffic at intersections.

Gruyer (2012), has presented a cooperative system architecture developed within the inter-connection of the sensor simulation platforms (SiVIC – Simulateur Vehicle-Infrastructre-Capteurs, Vehicle –Infrastructure-Sensors-Simulator) and the prototyping platform RTMaps (Real Time Multi-sensor advanced prototyping software) (Gruyer, 2012). There is interface of the SiVIC simulator in real time with RTMaps software that permits prototyping and testing ADAS (Advanced driver assistance systems) and behavioural analysis application in a simulated environment.
There is another system, viz Adaptive (Intelligent and Smart) Cruise Control which is a combination of collision warning technology and the vehicle that follows the allowed vehicle using an adjustable range control feature. The Lane Tracking or Lane Departure warning System provided an audible in the vehicle sounds for alerting the driver, when the vehicle moves to the edge of the roadway.

2. PROPOSED METHODOLOGY

On the happening of an accident, there is a heavy traffic congestion more particularly in an urban area. So, traffic control becomes an important issue, apart from accident detection and use of an intelligent system for avoiding collision. Calculation of the distance of his vehicle from an accident affected vehicle within a second or a fraction thereof is no easy job for a driver and hence he cannot take the right decision. This brings out the need for an appropriate communication system. The importance is not only for the specific vehicle, currently nearest to the accident scene, but also for other vehicles that are totally unaware of the accident. An accident in such a situation can trigger collisions and traffic congestion.

In order to provide communication in the V2V type and send information to a destination, each vehicle sends a message to one nearest to it. Location is indicated in the message and the receiving can repeats the process to send the message to its destination. This helps the destination vehicles comes to know the route from which the message has emerged as each car indicates the location in the message (Gruyer, 2012). But, there is duplication involved which becomes a problem.

We propose a unique method with V2V and V2I communication for solving these problems. It helps accident detection, and post-accident activities. An emergency message travels faster. It can therefore help VANET for avoiding collision and controlling traffic jam, congestion. This is based on the assumption of one RSU (Road Side Unit) in each road intersection and all such RSU’s connected by wire to enable speedy communication. In the event of any failure in links, RSU to vehicle communication will be wireless but not between RSU’s. In V2V communication, each vehicle will have a On Board Unit (OBU) attached to it. OBU is capable of sending and receiving messages. Each OBU can communicate with its nearest OBU and RSU, while the latter can send messages to OBU’s within its coverage area.

Messages of two types can be send by RSU, they are caution message and free message. The former is send when RSU senses an abnormal condition on road (eg. when two vehicles are involved in an accident leading to road block and traffic jam. Free message is sent when the situation becomes normal.

Our innovative approaches has the following phases: accident detection, broadcast of alert messages, verification of identical message, re-routing of decision strategy, leading ultimately to collision avoidance as shown in Figure.1.

Figure 1. Overview of the Proposed System

In many cases road accidents occur when one vehicle comes from another road side which is visible to another vehicle. Hence the RSU at the junction plays a vital role in accident avoidance. The various stages in the proposed approach are outlined below.

The starting point is the detection of the accident using vehicular movement and traffic density variation. The second step is the broadcast of the alert message followed by third step involving check of identical message. The fourth step is the re-route decision making. Collision avoidance is the result from the melting point.

Figure 2. Architecture of Enhanced Collision Avoidance method

Figure 2. shows two vehicles involved in an accident. The RSU at the intersection road segment sends a caution message to the vehicles nearest to it and also to RSU’s. The vehicle broadcast the message to other nearby vehicles. In the picture, the grey car receives the message. Vehicle near the accident spot receive the same message from RSU and the blue car. So a message redundancy is very likely. This issue requires a solution. The blue car which is close to the accident cannot escape from waiting as it does not have an alternative route. But the other cars
in different lanes can escape collision and traffic density with this proper communication. Hence ECAM, is proposed for resolving these issues involved in accident and collision.

**Accident detection:** Each RSU has to send information to the vehicles in the vicinity of the junction. Information relates to matters like: traffic density, average speed of the vehicle, accident or any misbehavior that has happened. This will be of help to the driver in adjusting the speed of the vehicle to the current situation, thereby avoiding incidents found unnecessary. RSU’s get involved in continuous monitoring of the speed, direction, traffic density of the vehicles around the coverage area. Traffic density is computed by calculation of the speed of the vehicles. Following calculation of the average speed, information is sent to the server for further processing.

Assuming the average speed as Savg and the average as Davg. Where there is deviation in the density of the vehicles or the speed, it sends a warning message to the vehicles in the coverage area or nearby RSU’s.

The behaviour of the vehicles in every intersection is determined from the direction of the vehicle for detection of any possibility of an accident. The information is transmitted to other vehicles to alert them. On the happening of an accident, the speed of vehicles in the vicinity is reduced, while the density increased. RSU can sense the accidents using these deviations.

**Broadcast of Alert message and Message Duplication check:** As mentioned before, the happening of an accident, a RSU sends an alert messages to another RSU nearest and the vehicles nearby. The vehicle involved in the accident can also send a alert message to the nearest RSU and the vehicle in the vicinity. The alert message will hold the V_id, Loc, a_time. Flooding of messages can be avoided by a vehicle receiving the same message from one or two vehicles or one or more RSU’s.

The finish message received by a vehicle or RSU is stored. If the message that follows has the same V_id, or RSU_id and loc and the time of an accident, it is ignored. The vehicle then broadcasts the message to the other vehicle in the coverage area.

**Rerouting Decision strategy:** The vehicles which receive the alert message are of two types.

- The vehicles which on the same road and closer to the vehicle involved in the accident cannot change route. They have to wait for the clearance of the road.
- The vehicles that are far from the accident vehicle can change their route. The vehicles need to check the availability of alternate route, the road conditions, traffic information regarding that route.

The vehicular node calculates the travel time through an alternate path. It compares waiting time and chooses an optimal decision of waiting or rerouting. Once the road block due to accident is cleared, the nearest RSU sends a free message to the vehicular nodes of its range. The happening of broadcast of free message is similar to the caution message.

The waiting vehicle starts moving as soon as it receive the free message. The vehicles that has altered its route discard the message.

The algorithm for the collision avoidance system is given below.

**Stage.1: Accident Detection and broadcast**

If (Si < Savg) or (Di < Davg) or (Dir-var)
Then Ubn condn
Process Info
If Acc happened
Alt msg sent
For every node, RSU
Receive alt msg
Store it
Check for identical msg

**Stage.2: Identical message check**

For every node
Check the time, loc, id of received msg and st_msg
If different accept it
Else discard
Broad cast Alt msg

**Stage.3: Rerouting and Collision Avoidance**

For every node
if (victim location in route)
check alternate route availability
Get info
Calculate travel time
If (wait-time>traveltime)
Reroute
3. PERFORMANCE EVALUATION

We have selected network simulator 2 (NS2) for purpose of simulation. Figure.3, shows the plot between the vehicle density and the traffic density. Improvement in the performance of the network is evident with the proposed collision avoidance method. The traffic density is greatly reduced using the ECAM.

![Figure 3](image)

**Figure 3.** Probable number of crashes and Average Response time

The figure 4 shows the performance of network in terms of probable number of crashes and average response time. It is proved that the probable number of vehicle crashes will be reduced using the proposed method.

4. CONCLUSION

Improvements in road safety are possible through VANAET’s. Safe journey is offered through inter-vehicular communication. In this paper, accident detection and collision are proposed for obviating vehicle collision. Accident occurrence is detected through variation of direction, speed of vehicles and traffic density. When an accident happens, a caution message is sent to the vehicle to enable other vehicle changing their routes on the basis of the re-routing strategy. This helps in substantial reduction in traffic density and further collisions. The proposed simulations and analysis will ensure evaluation of the performance of the proposed system, proving its effectiveness.

REFERENCES


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