Journal of Engineering and Applied Sciences 12 (7): 1896-1901, 2017
ISSN: 1816-949X

Improved Detect and Report Incident Systems Toprevent Congestion and Chain Accidents in VANET

[1]Abbas Ali Rezaee, [2]Zahra Rouzegar and [3]Mohammad Hadi Zahedi
[1]Department of Computer Engineering and Information Technology, Payame Noor University, P.O. Box 19395-3697 Tehran, Iran
[2]Department of Software Engineering, Asaluyeh international University, Asaluyeh, Iran
[3]Department of Computer Engineering, K.N. Toosi University of Technology, P.O. Box 15875-4416, Tehran, Iran

Abstract: Traffic on the highway reduces security and increases rate of accidents and victims in many countries. One aspect of recent research in the field of intelligent transportation systems is focusing on diagnostic techniques accident. With advances in sensor networks and wireless technologies, modern vehicles have the ability to communicate with each other and with roadside infrastructure units to enhance the safety. Automotive safety applications which use vehicle-to-vehicle and vehicle-to-infrastructure deploy short-range communications. In this study, an analytical model is presented to ensure the control channel dedicated short-range communications applications due to high mobility vehicles and hidden terminal problems. This model provided to handle the car's and ad-hoc safety networks which established on AODV routing protocol due its packets sending with features of lower latency and reliability compared to existing methods.

Key words: Vehicle Ad-Hoc Networks (VANET), Dedicated Short-Range Communications (DSRC), chain accidents, collision warning, information dissemination, latency of periodic broadcast applications

INTRODUCTION

Vehicle Ad-hoc Networks (VANET) is a certain type of Mobile Ad-Hoc Networks (MANET). This kind of networks can be used to improve vehicle safety, announce Emergency vehicle warning, increase traffic efficiency and provide tools for advertising and entertainment media in cars, manage toll collection, etc. VANET has several outstanding features that distinguish them from the ad-hoc networks. VANET topology due to the car's highe speed is very dynamic (Laouiti *et al*., 2014).

Blum and Eskandarian (2005) stated in their research that multi-hop paths are very short-lived because the vehicle has higher speed motion in compared to ad-hoc networks. Unlike ad-hoc networks, mobility in vehicle network is regular and predictable and is notrestricted by power and energy consumption. Vehicles can be equipped by some positioning systems such GPS in the same way that their movement could be predictable. This feature provides forecasts improved route selection. Figure 1 shows the difference between VANET and MANET (Laouiti *et al*., 2014).

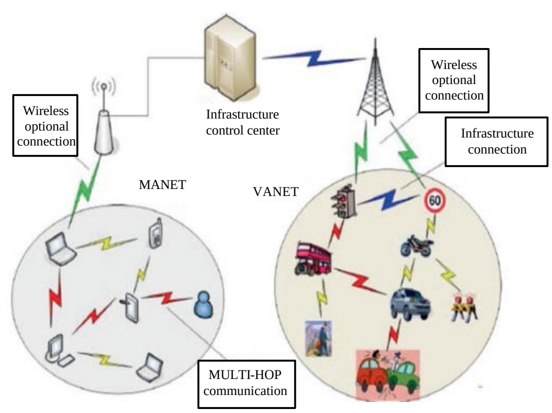

Fig. 1: Difference between VANET and MANET

VANET considered as a class of MANET with some distinct characteristics. Gillani *et al*. (2008) discussed some of these features such high mobility nodes, dynamic network topology, enough battery power, enough storage capacity, high processing power and availability of global positioning.

VANET architecture: Communication between vehicles or between a vehicle and a Road Side Unit (RSU) is

Corresponding Author: Abbas Ali Rezaee, Department of Computer Engineering and Information Technology, Payame Noor University, P.O. Box 19395-3697 Tehran, Iran

provided through a wireless environment called waves. This way of communication provides a wide range of information for drivers and passengers and enables applications to increase roads safety and more comfortable driving (Torrent-Moreno *et al*., 2004). The main elements of this system are ApplicationUnits (AU), On Board Units (OBU) and Roadside Units (RSU).

Typically RSU is the host of program that provides services and OBU is a peer device that use of the provided services. Applications may be positioned in OBU or RSU. The device which host the application called provider and device which apply application called user. Each vehicle is equipped to an OBU, a set of sensors to collect and process information and then send it as a message to other cars or RSU via wireless environment. The kind of accidents that included the bulk of traffic fatalities are accidents chains. Accidents chain refers to accidents in which several cars back together deal. The use of radio communications between vehicles provide additional time for the reaction of drivers. Evaluating results show that equipping vehicles inside the chain with inter-vehicle information technologyby only 50% will result in huge reduction of the accident probability.

On Board Unit (OBU): OBU is a device that works with waves and install on the car portably and used to exchange information with other OBU or RSU. It also includes: Resources Command Processor (RDP), read/ write memory for storing and retrieving information, a user interface, a special interface to connect to other OBU and a network device for short range wireless communication based on radio technology IEEE 802. 11p as well. It may also include other network devices for non-safety applications based on other radio technologies such as IEEE 802.11a/b/g/n as well.

Furthe rmore OBU is connected to other RSU OBU via a radio frequency channel wireless link IEEE 802.11 p and is responsible for communicating with others or RSU OBU. It also provides a communication service for the AU and forward data on network on behalf of OBUs. The main functions of OBU are: wireless radio access, geographic and ad-hoc routing, network congestion control, reliable message transmission, data security and IP planets (Torrent-Moreno *et al*., 2004).

Application Unit (AU): AU is a car inside equipped device whichusepresented applications by providers to use communications capabilities of OBU. AU could also be a dedicated device for safety application or a common device such as a Personal Digital Assistant (PDA) for accessing. It can access connect to the OBU via. a wired or wireless connection or may be deployed along with the

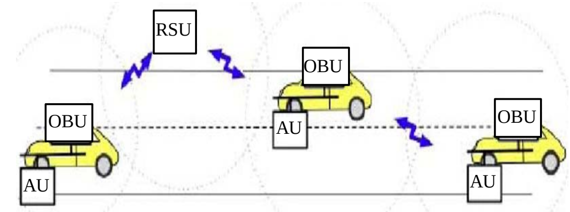

Fig. 2: RSU increases ad-hoc network range by forwarding OBU data

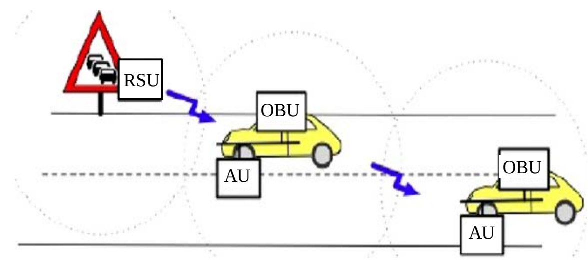

Fig. 3: RSU as resource of information

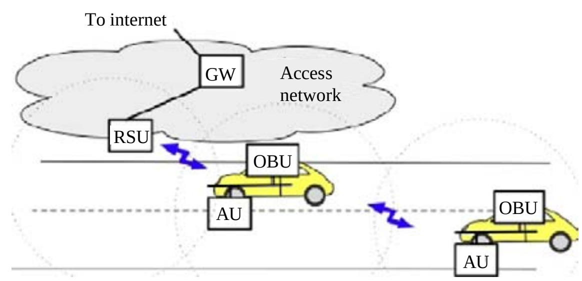

Fig. 4: RSU provide internet connection for all OBUs

OBU in one physical unit. AU communications with network is solely through an OBU which is responsible for all movement and networking functions.

Roadside Unit (RSU): RSU is a wave-based device that usually fixed in specific places such as intersections or parking or near the road. It equipped with a network device for dedicated short-range communication based on radio technology IEEE 802.11 p. RSU can also be used with other network devices to communicat across infrastructure network as shown in Fig. 2. The main functions and procedures related to RSU include: expanding the scope of ad-hoc network communication by redistributing data to other OBU (Fig. 3) and send data to other RSU for forwarding to other OBUs as shown in Fig. 4, executing safety application such as allowable height warning for bridges, accident alerts or work area by using the communication infrastructure (Torrent-Moreno *et al*., 2004).

MATERIALS AND METHODS

In order to present a model for detecting and reporting accident an analytical model is proposed to measure the reliability and latency. In this study, according to same researches, components of the proposed model have determined.

Component: Today, sensors consist of a set of hardware with limited resources. A typical sensor node is composed of four modules:

- Supplierunit, responsible for providing energy to other member
- A measurement unit which actually consists of a sensor such, light, humidity, temperature, sensors
- A computing unit which consists a RAM, ROM and processor that normally using a set of analog-to-digital converters to obtain data from sensors
- A communication unit used to send and receive radio signals

In Fig. 5 and 6, a sensor node and schematic overview of typical sensor hardware are shown (Akyildiz *et al*., 2002; BECHER *et al*., 2012). In this study, sensor unit is particularly important. In fact, the most important part of this work is related to measurement unit. By studying the various methods and different types of existing sensors to detect the incident the best solution is to use the accelerometer sensor. This type of sensors is high sensitivity and precision.

Methods of this sensor is that if an incident or accident occurs the detector sensor of strike impact produce signals which create a flag bit in microcontrollerand microcontroller realizes that an accident has occurred. The sensor which used to distinguish the impact can be chose among accelerometer sensors ADXL 335. Figure 7 shows the internal components of the sensor.

This sensor hassmall 3-axis accelerometer with low power consumption. This sensor can be measure gravity static acceleration such as anglemeasurement applications. Using capacitors c_y, c_x and c_z can be adjust bandwidth of accelerometer Proportionally for each 3-axis need. In Fig. 7, diagnosis and announcement of incident process is clearly shown.

Analytical models to measure the eliability and latency of DSRC: In the standard IEEE 802.11p, vehicles do not send any acknowledgment message. Thus the sender cannot find a failure of message sending and hence will not send it again. This is a serious issue in which all

Fig. 5: Overview of a wireless sensor node

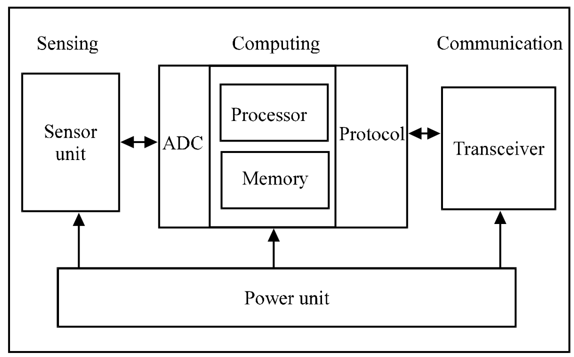

Fig. 6: Schematic overview of the hardware wireless sensor node

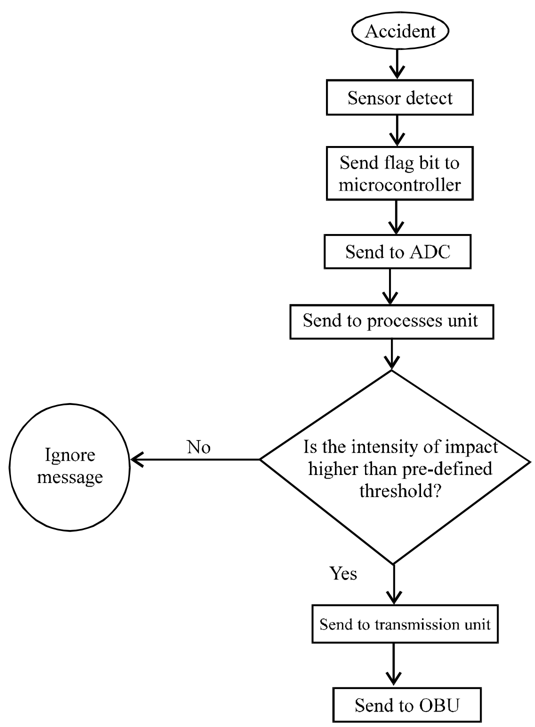

Fig. 7: Processe of detectiong and announcment of incident

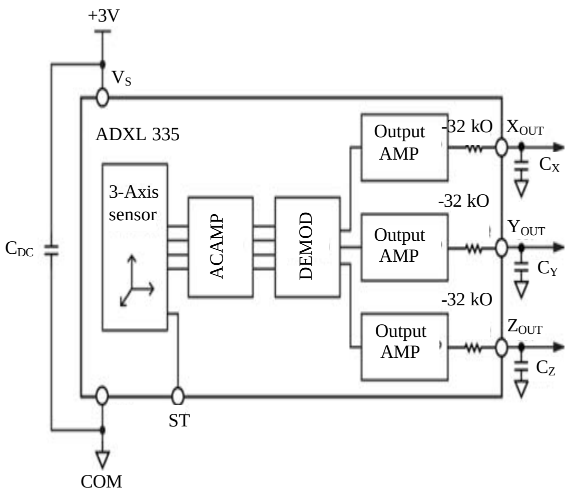

Fig. 8: Hardware schema of sensor ADXL 335

vehicles must be repeatedly receiving the warning message successfully in a short time to avoid achain accident. This problem cause that an analytical model presented to measure the reliability and latency of DSRC, fade the multi-path channels in VANET, high mobility vehicles, hidden terminal problems and conflicts oftransmission.

In VANETs safety applications, vehicles broadcast two types of messages: alert (event-driven) and status messages. While alert messages usually contain information about the safety, status messages periodically sends to all vehicles in its range the vehicle state information such as speed, acceleration, direction and position. So the alert message has the highest priority while the status message has the lowest priority (Fig. 8).

In proposed model, vehicles produce status message with λ_s rate which indicates that the synchronization interval is SI = 1 λ_s. Assume that all packets are L bits in length and the whole distance SI is dedicated to safety applications which is equivalent CCI = SI. Each vehicle randomly chooses asplit in the range of SI to transfer its status package while emergency package only in crisis status such as an accident will send warning of danger or congestion. Based on these assumptions the DSRC protocol is analyzed to find the smallest channel distance to maximize reliability in safety applications and therefore reach a high probability of successfully receiving status messages from each vehicle in this distance.

With assuming that all vehicles have the same Power transmission (P_t), if the received power be above than a particular threshold P_{th}, each vehicle receives the signal successfully. Since, the fading is a significant characteristic of the channel in VANET, strength of received signal is random and therefore the domain of communication is also a random variable and we know that two cars can only communicate within the communication area of each other. Thus the probability of success for receiving a packet is depends on the relative velocity between the transmitter and the receiver the packet transmission time and the range of transmitter. So the first assumption is that the receiver located in a desired distance from the transmitter but in range of communication at the beginning of the packet transmission. Also to get the packet successfully from another vehicle labeled in R domain, it is imperative that no vehicles have transmissionin the specified range of channel.

The sent packet should also be error-free and strength of received signal should be higher than the threshold P_{th}. In addition the car should be remainingin the dispatched vehicle area during the whole communication. The higher the success rate the more cars are able to receive emergency and status packets successfully. So the driver's information about potential dangers on the way goes up.

Based on the above analysis it is observed that there are many conflicting parameters that affect system reliability and the success rate. The conditions will be worse especially in areas where vehicles moving at very high speed and density of them on the road are constantly changing.

So the vehicles have to change its sending rate (λs) the communication Range (R) or power transmission, carrier sense range (LCS) or at least its competitive Window Size (WS) based on the road conditions for compromising to increase the success rate and reliability of VANETs. Therefore, the proposed algorithm is suggested where vehicles parameters change on the road according to their density and velocity with the following assumptions:

- The vehicles already are aware of their average speed and speed limit on the road
- The maximum (or maximum power transmission) and minimum communication range is set to R_{max} and R_{min} in this scenario
- Carrier sensed parameter (ρ) can have three values: $\rho\epsilon(1, 0.5, 0.25)$
- Rate of sending status packet of vehicles can be in the range (1-10)
- The minimum size of competition window W_s, can adopt value in the range (1023- 15) with step size of sixteen
- Average speed, range, carrier sensed parameter the rate of packets sent and at minimumcompetition windows size in current vehicle is determined via. V_c, R_c, ρ_c, λ_{sc}, W_{sc}

Algorithm considers the vehicle current density, average speed and maximum speed V_{max}. The smaller the current average speed of the vehicle the vehicle density will be higher around the vehicle. This algorithm divides the domain (R_{max}-R_{min}) into ten steps. At any time the vehicle speed is reduced by one-tenth of the maximum speed the vehicle reduces its domain and therefore regulates a set of other parameters.

The vehicle computes its delay from time it's prepared for packet transmission until the packet is transmitted. If the new value is higher than the old value the vehicle increases its minimum competition window size W_{sc}, otherwise it decreases or keeps the same size as before.

Due to the computed density the carrier sense domain is set. When the vehicle density is high the range of carrier sense is reduce in order to decrease the waiting time for each vehicle to send status message. Although the reduction of carrier sense range increases the hidden terminal area but algorithmic behaviorfaces problems by reducing the communication domain. Therefore the proposed algorithm allows more vehicles to send their status message in the synchronization interval with high acceptance rate.

RESULTS AND DISCUSSION

Simulation and evaluation: The proposed idea employed ns-2 and MOVE simulator for motion model based on traffic Constructor SUMO for Simulation. Simulation scenario consists of a four-lane, 8.000 m highway where vehicle speedis considered between 85 and 120 km/h.

It is assumed that all vehiclesare synchronized in control channels distance at all times and production length time for each status packet is distributed consistently throughout the time. Since the recipient in ns2 receives the signal when power is above the threshold P_{th} the transmission power is embedded in a way which the strength of receivingin the range of R communications is in threshold P_{th}.

Each simulation has been implemented for a period of 400 sec in real time. The following four criteria for evaluating the accuracy and precision of the presented model and reliability of DSRC protocol in VANETs are defined. First, effective communication range that is an area in which many vehicles that are located around the sender will receive a transmitted message successfully. Second the success rate which is defined as the proportion of the number of vehicles that have successfully received packet by the total number of vehicles that are located in range of the transmitter. Third, it is the average latency of a vehicle to send its status message and compare it with the obtained time delay. Fourth, that is system reliability which defined as a proportion of number of vehicles which managed to send their status message during the distance interval of synchronization by total number of vehicles in the defined area.

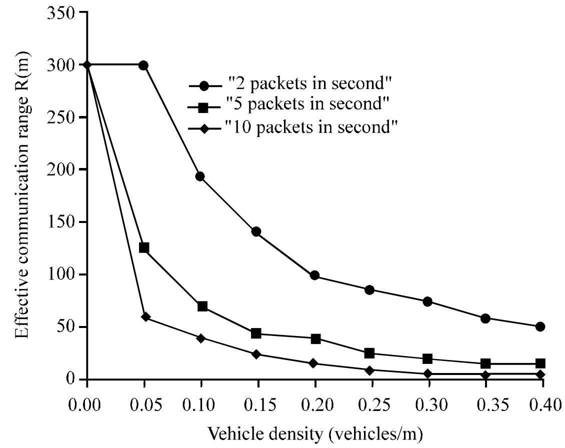

Fig. 9: Effective communication range in front of the vehicle density

Effective communication range vs. The vehicle density: The result shown in Fig. 5 is extracted based on vehicle density and average speed of compression. In particular, Fig. 5 shows that the effective range of communication versus density of vehicles has different status packet production rates. It is clear when the vehicle density increases the effective range will be reduced. At the same time as the numbers of vehicles that have the opportunity to send their status message are reduced, status packet delay will increase and thus cause the reduction of system reliability. This means that all vehicles have not the opportunity to access a channel and send their status packet.

In order to improve system reliability the status packet production rate decreased from 10-5 and then dropped two packages. This improves system reliability and success rate but still it is below the threshold of 95%, especially when the vehicle density is high. In order to meet this threshold for each car density, vehicles must reduce the domain of their communications based on the criteria which are shown in Fig. 9 and 10.

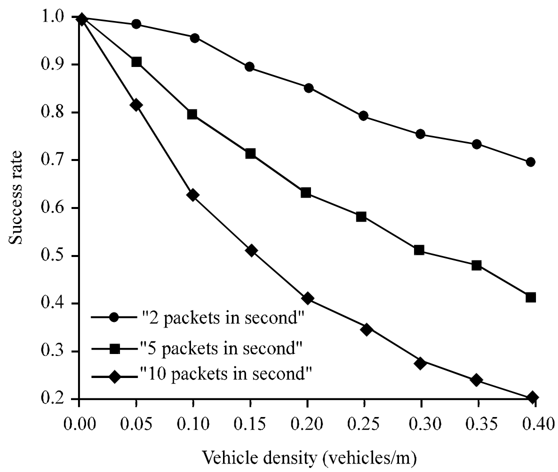

Fig. 10: The success rate in contrast with vehicle density for varies packet sending rate

CONCLUSION

In this study, a model for reliability analysis of IEEE 802.11p in safety VANETs and warning program is suggested. This analysis is based on a dynamic model in which the relationship between the density of vehicle, speed and distance are traceable and derivable. In previous research relations between the range of communications and network congestion the rate of messages passing, message size, data speed and channel conditions is extracted (Becher *et al*., 2012) and (Robinson).

In this analysis, a various factors including the impact of mobility on the link availability between sender and receiver, cars distribution on the road and the average number of automobile in the range of the transmitter were investigated. This model is based on the fact that the vehicles send their status message during the synchronization interval. In this study, analytically and by simulation the maximum effective communication range which can be used in particular conditions to reach success rate are shown.

The analysis and simulation show that currently characteristics of DSRC may lead to poor performance under strictand inaccessible vehicle environments. Therefore, a new adaptive algorithm is introduced in order to increase the VANET reliability. Using this algorithm the automobile is able to estimate the density of vehicles and modify the transmission parameters according to its current average speed to enhance the VANETs performance.

The simulation results which are coincident with analytical results indicate that the proposed model is quite accurate in calculating the reliability of the system. The proposed idea for future study will be focusing on routing. Using AODV routing protocol and using clustering techniques the average delay package will be reduced and it will enhance reliability.

REFERENCES

Akyildiz, I.F., W. Su, Y. Sankarasubramaniam and E. Cayirci, 2002. Wireless sensor networks: A survey. Comput. Networks, 38: 393-422.

Becher, A., Z. Benenson and M. Dornseif, 2012. Tampering with motes: Real-world physical attacks on wireless sensor networks. Proceedings of the 3rd International Conference on Security in Pervasive Computing, April 1-3, 2012, UK., pp: 104-118.

Blum, J.J. and A. Eskandarian, 2005. Adaptive space division multiplexing: An improved link layer protocol for inter-vehicle communications. Proceedings of the 2005 IEEE Conference on Intelligent Transportation Systems, September 16, 2005, IEEE, Vienna, Austria, ISBN:0-7803-9215-9, pp: 455-460.

Gillani, S., I. Khan, S. Qureshi and A. Qayyum, 2008. Vehicular Ad Hoc Network (VANET): Enabling secure and efficient transportation system. Tech. J. Univ. Eng. Technol., 13: 1-8.

Laouiti, A., A. Qayyum and M.N.M. Saad, 2014. Vehicular Ad-hoc Networks for Smart Cities: First International Workshop, 2014. Springer, Berlin, Germany, ISBN: 978-981-287-157-2, Pages: 93.

Torrent-Moreno, M., D. Jiang and H. Hartenstien, 2004. Broadcast reception rates and effects of priority access in 802.11-base vehicular ad hoc networks. Proceedings of the 1st ACM International Workshop on Vehicular Ad Hoc Networks, Oct. 1, ACM Press, Philadelphia, PA., USA., pp: 10-18.