

Rsadb - Road Safety Accident Detection and Prevention in Vehicular Adhoc Network



Saurabh Patil, Lata Ragha

Abstract: Vehicular Ad-Hoc Networks (VANETs) is evolving into highly developed systems that improve driver experience in terms of security and offer much-needed tranquility on the roads as well. VANET makes it possible for a vehicle to communicate, (vehicle to vehicle communication) V2V, beyond its visual coverage region for an advance alert. Vehicle accident alert depends on data received from sensors, cameras, onboard units, wireless communication, global positioning systems, and Roadside Units (RSU) placed on equidistance along the roads. It collects data from all entities, i.e., RSUs or OBU, and processes it, leading decisions subsequently. In V2V communication, vehicles support different services such as declaring an accident with their exact coordinates and traffic status updates. In this paper, a protocol is discussed and reviewed and studied about on-vehicle wireless communication capabilities in terms of handling accident alerts for road safety applications. Accident detection in an early stage can help in saving life on the road and enhance medical support probability. Providing the accurate time of accident and locality to the approaching vehicles to reduce down further mishaps on the road. This proposed protocol is flexible enough to adapt real-time environmental adjustments, including road density and speed, traffic state, and network dynamics.

Index Terms: Vanet, V2V, V2I, Accident detection, Accident avoidance, Traffic status, Onboard Unit, Wireless Communication

I. INTRODUCTION

A Vehicular Network (VANET) is a framework of Ad-hoc networks. VANET presents the infrastructure for scaling new methods to improve driving comfort and safety. Self-organizing VANETs formed between on-road vehicles equipped with wireless transmitters. So vehicle networks are being enhanced as part of intelligent transportation services for significant upgrades to vehicle systems routines. The ultimate aim of vehicle networks is to provide better safety measures on the road and reduced traffic, congestion, prolonged delays, and fuel consumption. Vehicular Ad-hoc networks are disseminating networks that incorporate random topology because of the way infrastructure like streets, roads, highways, and signals functions. High speeds and density offer unique aspects that make VANETs different from other networks. Also, background information gets complex in instantaneous situations to transform fast. Improved VANETs are meant to make driving more reliable and relocate estimates with details such as accident warnings, damages, blockages, conflicts, environmental complications, and road specifications.

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All this information gets exchanged through wireless communication between vehicles having On-Board Unit (OBU) and raises awareness on safety, especially as it concerns to vehicles in the rear can draw suitable conclusions before turning up at a disturbing location. Also, having information on the current situation on the highways makes it comfortable to drive. It offers options such as using a different route in case of traffic jams, thus lessening trip time and fuel consumption. Apart from road safety packets, RSUs assist in V2V communication, as shown in Figure 1. They can share music/videos and other data, including internet usage, road view maps, environmental climate conditions, and toll information applications with the necessary quality metrics.

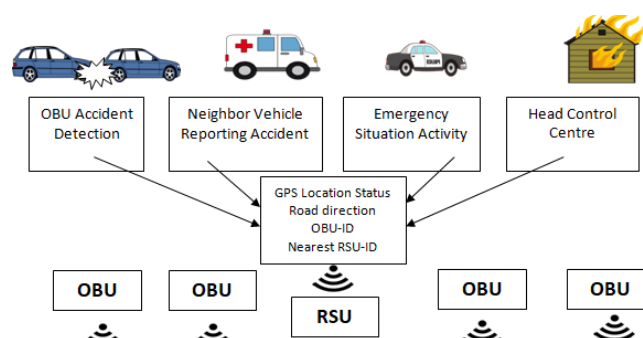


Fig. 1. Vehicular Network with OBU and RSU for V2V and V2I communication.

Incorporating attached sensors, global positioning navigation techniques, road maps, computing devices, as well as wireless transmitters and receivers, along with sharp protocols, always support road safety mechanisms. Up-to-date details offered by incorporating such information give vehicles the relevant information needed in the circumstances, allowing them to respond in an instant.

A proposed protocol identifies an accident and generates alert packets, which are communicated of a roadside unit to a vehicle in range to notify a driver about the critical condition. Along with an alert message, after detecting accident nearest ambulance allocation is further taken care of in the proposed protocol. Vehicles connectivity with RSUs keeps the network updated with all movement on the road, which in turn reduces fatalities. The most unfortunate accidents involving several vehicles that crash into each other appear as follow-on of a single accident, resulting in an unexpected halt to the total traffic, considering the characteristic of decreasing the velocity of vehicles in an accident scenario, help in detecting an accident.

After detection protocol, begins the dissemination of alert messages along with accident location to vehicles nearby. The same alert is propagated using multi-hop communication to other vehicles approaching the accident location.

In this way, vehicles that are far behind getting an alarm signal and are warned in extent before they can coincide with an unforeseen accident, thus circumventing risk. Apart from this, vehicles can exchange vehicle violation notifications - including those to do with potholes/sinkholes, dead ends, road lane details, flooding on roads, and the like - with vehicles nearby, as shown in Figure 2.

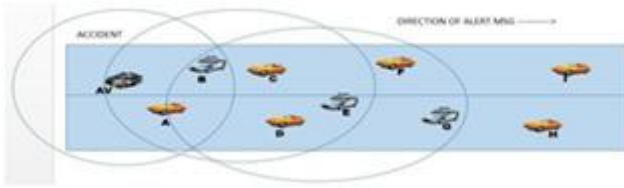


Fig. 2. Accident notification exchange in V2V network

This information exchange may help handle, in no small degree, life-threatening accidents. In practice, several accidents have occurred as a result of a lack of interaction between vehicles. As a result of collisions and road blockages, real-time traffic delays increase. Notable reductions in these numbers could be attained through the proposed RSADP. Transport authorities should utilize a particular protocol to relieve and control the traffic dynamically. This rest of the paper is arranged as follows. Section II presents a short view of existing VANET characteristics. The aim and implementation methodology of the Road Safety Accident Detection and Prevention in Vehicular Adhoc Networks (RSADP) are described in Section III. In Section IV, the results and discussion are analyzed. The conclusion is discussed in Section V.

II. RELATED WORK

A message considered reliable only if the vehicle that generates it has an excellent reputation [1]. The ratio between the area covered by sensors and the entire monitored region is an essential metric in terms of the Quality of Service of the sensing coverage [2]. The hardware required for these schemes is substantial in large-scale networks. A more acceptable choice is to affix a MAS at the anchors, let the anchors estimate the AOA, following which feedback can be sent to the sensors [3]. Finding an appropriate standard revision in design, a simulation of the car accident alert system was proposed using the NS2 network traffic simulator, paired with the SUMO road traffic simulator [4]. The performance of data dissemination in VANET terms of delivering an Emergency Warning Message(EWM) to vehicles in need, within the stipulated time, was assessed [5]. At present, most of the research on WSNs has concentrated on the design of energy- and computationally-efficient algorithms and protocols, and the application domain have been restricted to simple data-oriented monitoring and reporting applications [6]. In multi-hop wireless ad-hoc networks, designing energy- efficient routing protocols is critical, since nodes have minimal energy, computing power, and communication capabilities [7]. A Vehicular Adhoc Network (VANET) is a form of Mobile AdHoc Network (MANET) that communicates with vehicles nearby, as well as between vehicles and the nearest piece of fixed

equipment, usually described as Roadside Equipment. VANETs offer passenger's safety and comfort [8]. Pedestrian deaths in urban areas frequently occur during late nights, early evenings, on rainy days, curvy roads, foggy times, and different low visibility conditions [9]. A vehicle tracking system combines the installation of an electronic device in a vehicle or a fleet of vehicles, with specifically-designed computer software to enable the owner or a third party to track the vehicle's location, collecting data in the process [10]. The design of such a network is to achieve vehicle-to-vehicle and vehicle-to-roadside unit wireless communication. Using On-Board Units (OBUs), vehicles can communicate with each other as well as with Roadside Units (RSUs) [11].

Disputes in VANET:

Concerns have raised when efforts have focused almost solely on vehicle enhancements, buoyed by efforts to reduce losses incurred in accidents. The significant challenges faced in in-vehicle networks and technological approaches are as follows:

Vehicle Communication Signals Loss: Substances positioned as obstacles between two vehicles sharing data are one of the biggest challenges that can limit the ability of the network on account of issues with the bandwidth. Another critical issue in the network is the lack of a monitoring device that handles broadcasts between vehicles and is liable for handling the channel rate and packet authenticity.

Vehicle Connection: Given the high velocity and rapid changes in the network that affect to intermittent failures in communications, the duration of time must be extended to lengthen the existing connection between vehicles. Communication should be extended as far as it can be established a connection. This can be accomplished by expanding the broadcasting range though that could lead to throughput deprivation. Hence, channel usage and adjacent connections are measured as significant subjects in this network.

Validation and Isolation: Establishing stability between validation and isolation is a primary challenge in this network. The provision of verifiable proof on the part of the sender is significant for the destination. Owing to rapid vehicle speed and changes in connections, an original routing method must be implemented that can distribute packets in the shortest possible time with the minimum loss. This is considered a serious issue and needs serious attention VANETs.

III. PROPOSED RSADP PROTOCOL

The VANET protocol intends to offer the most suitable routes between vehicles and RSUs with the less packet loss and with control overhead. Several implementations have been tested for VANETs and classified in line with different perspectives, as in, for instance, network uniqueness, methods used, path selection, quality of communication, environmental structures, and so on. This categorization is established on the network environment at various levels and are location-based, geographically-based, and facilitates group broadcasts as well.

Apart from these, VANETs gets classified as V2V and V2I hierarchical-based routing with reactive, proactive and hybrid techniques.

Proposed Methodology:

A vehicular area network created with a set of RSUs and vehicles. In a VANET, each vehicle converses through broad-casting wireless channels built within. Here, every vehicle is a node act like a transmitter, receiver and intermediate router in the network. Hierarchical communication is established between a road-side unit RSU and a vehicle. The node locates roadside units (RSUs) through the cellular interface access points. Initially, the RSU sends periodical beacon messages as broadcasting packets "RSUAnnouncement (RSUA)", along with its location (L), timestamp (TS), and RSU-ID. All vehicles listening to the RSUA updates the current RSU-ID to register with V2I-ID. Thus infrastructure-based VANET is established. The RSU inform nodes by sharing announcements on the status of the roads, road collapses, traffic, roadblocks, parking areas and accidents.

To create the V2V communication shown in Figure 6, a device in network broadcasts a "V2V announcement (V2VA)" with its ID and TS as a beacon message to announce its proximity to its one-hop neighbor vehicles. Broadcasting beacon in following equation 3.1

$$V2VA \rightarrow (ID, TS) \quad (3.1)$$

Nodes movement is random on highways. Their dynamic movement rapidly changes the communication topology and disrupts the connection. Due to randomness of network topology, each V2VA announcement with different TS carries up-dated speed S (S_{min} , S_{max}) and angle $A(2\pi, 0)$ autonomous of all earlier updates. Thus, the movement (M) is shown in equation 3.2 below,

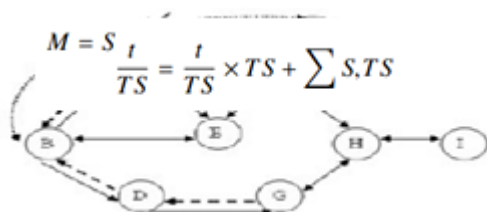
$$M = S \frac{t}{TS} = \frac{t}{TS} \times TS + \sum S, TS$$


Fig. 3. Link disconnection between vehicles

Each device updates its movement direction based on the last updated location and current location.

To be specific, the node, traveling direction and velocity are selected at random and are independent of nodes in a network. We determine the steadiness of a corresponding node path, which is subject to disconnections occurred by random node velocity.

```
1 if(lastX < vehicle X)
2   direction=2;
3 elseif (lastX > vehicle X)
4   direction=1;
```

Code Snippet 2. Defining direction for vehicle x.

We represent time duration link (TDL) by setting a path connection period (CP) as on connection is formed until one of the connections turns to out of connection (OC). Protocol broadcasting a beacon to connected nodes in a route of 'active connection' for a known moment m .

$$TDL = (OC - CP) \quad (3.2)$$

Accident sensors are attached to the vehicles to sense the accident and to trigger alert message for prorogation. A node in accident starts disseminating accident messages to nearby vehicles and following vehicles so that they can start performing the re-routing process to avoid congestion. The following immediate vehicle after receiving accident

$$= TS_t \times TS + S, TS \quad (3.2)$$

alert initiates calculation and controls the accidents with the sensors support. The sensors transmitters are used to convey out the wireless message along with its position that can be

$$d = \sqrt{|X - X_1|^2 + |Y - Y_1|^2}$$

Where the least time $t < TS$, and TS is the current time, each vehicle drives dynamically. In the vehicle-to-vehicle V2V mode, recurrent link disconnections occur, as shown in Figure 3, in the context. The rapid link changes in the nodes make packet routing so much more demanding.

```
1 Destination - Dst, Locations L - X,Y;
2 Update Dst(X,Y);
3 Broadcast Source (X,Y);
4 f{Dst Y==Y1 &&Dst X !=X1}
5 If ( Dst X > X1)
6   Return1;// Left To Right 1
7 Else
8   Return1;// Right To Left 2
```

Code Snippet 1. Vehicle Moving Direction Update
useful to compute the distance d (equation 3.3) between two vehicles. $((3.3))$

The nearby vehicle within coverage area receives the message and sends a response back to that transmitter with its current position. If the position parsed in the received message from approaching vehicles toward accident vehicle need processing for distance calculation. This distance calculation derives whether a vehicle is quite adjacent, and may get affected by accident, or else vehicle distance is sufficient to avoid collision area. The same result is used to produce the warning in a network. The critical reasons for the accident/congestion on the road or junction are because vehicle nodes were having less information about movements. Even if RSU or V2V communication intimate the position of the accident, the direction added a vital role. Vehicles in both directions receives the message on the road. Suppose accident occurred to road moving toward the north, opposite direction vehicles need to ignore message helps in congestion avoidance.

```
1 If (AccidentVehicle!=VanetID)
2 If (d (X1,Y1-X2,Y2)<Accident Distance)
3 "VEHICLE ACCIDENT" Event == ACCIDENT
4 Include AnnouncementList.Add(SenderID, Seqno)
```

Code Snippet 3. Accident detection and warning announcement

In a protocol, message or beacon dissemination by vehicles are updated with the direction value.

A compass sensor can extract the direction in a vehicle concerning the North Pole. Now, updated beacon with direction can help in sending announcements, and a vehicle in the opposite direction can avoid mishap alerts. RSU also maintain a record of vehicles nearby accident site. As all vehicle OBU establish a connection after getting in a range of RSU and become a part V2I network. The first step after the connection is the validation process for vehicles, and it gets approved by RSU. Following validation, vehicles are added to the network, and further can receive information from RSU and other nearby vehicles. RSU now can update accident spot information in the network and wide-awake vehicle drivers to take precautionary steps.

```

1  for(int i=1 ; I <  Vehicles; Vehicle++)
2  if(i != vanetID)
3  if(( (d(X1,Y1)>CriticalDistance)
4  && (d(X2,Y2)<CriticalDist +5) )
5  NextX=Vehicle→X
6  NextY=Vehicle→Y
7  X2=Vehicle→Y1
8  if(Direction==2)
9  Y2=Vehicle→Y1-20
10 else
11 Y2=Vehicle→Y1+20
12 Vehicle→X2,X1, Y2,Y1, →Speed
    
```

Code Snippet 4. Accident avoidance beacon

Further, RSU calculates the distance for a vehicle in its trans- mission range to find out the nearest vehicle to accident spot; to alert the same vehicle repeatedly regarding the accident to avoid the mishap. Also, the V2V network, a vehicle in an accident, inform all nearby vehicles about its location and render time for avoidance. Not only RSU or accident victim vehicle disseminate acci- dent alert message for avoidance, but nearby vehicles OBU receiving messages also perform distance computation. All vehicle's OBU in-network parse the accepted accident alert message and extract accident location coordinates. Vehicle OBU also fetches its owns coordinates of the sensor and esti- mates the distance between fetched coordinates and accident place. The calculated distance provides adequate knowledge to the vehicle motorist regarding the distance between his vehicleand accident spot. The avoidance measures can be taken to ensure that the corresponding vehicle is not a part of mishap and take transit in advance. The accident sensors perform a crucial role in sensing accident had occurred to vehicle or not. Sensors sense the accident by confirming the accidental changes such as crash, unusual movement, or any other event by the external condi- tions. If the collision had occurred suddenly, then there must significant deviations in relative location based on a vehicle moving direction. Taking an example, suppose we consider three vehicles X, Y, and Z. Suppose vehicles are traveling in a direction toward the east, then Z is in front followed by Y, and X is behind Y. If we consider moving direction as the west, then X is in front, followed by Y and Z. In this case, the minor change of angle encountered in a moving vehicle, which can help in identifying the relevant position of vehicle and collision impact on it. Now consider an accident situation

where vehicle Y met with an accident while driving in a direction to the east. Now subsequently, after computing the angle of X and Z as following and upfront vehicle, respectively. We concern Z's angle to have more diversion with Y. In contrast, the small-angle difference noted with X. Therefore, Z is the leading vehicle, and X is a succeeding vehicle, so warning is adequate for X. Once the sensors sense the accident, it starts transmitting warning messages as an emergency event to notify the accident to following vehicles. The warning message gets broadcast in both networks (V2I and V2V), first validation of message performed, and then processed. For multi-hop forwarding of the alert message, the device maintains the rebroadcasting timeout limit by checking the time gap in the last rebroadcasting time and the current time. The reasonable time delay between the last broadcasting and current broadcasting time of the same message can reduce the rebroadcasting overhead and collision process. Moreover, after receiving the rebroadcast warning message, the device validates the location of the accident and its current location. If the accident location is a nearby distance of the vehicle, then the OBU of vehicle suggest the alternative way to avoid approaching the accident place. Accident detection and faster alert propagation.

IV. RESULT AND DISCUSSION

We conducted simulations in a network simulator (ns-2.34) based on the average set vehicles with 200 seconds of time duration. To evaluate the output of the application, we tested the communication delay and data loss rate. The aim set to validate and conclude the data transfer rate against the time required to deliver the packets and intimate for accident avoidance. We design a coverage area using six RSUs at a specified distance adjacent to the road for V2I communication. We even set up V2V communication among multiple vehicles to validate the output of the application. Speed limit set for all vehicles in the simulation was 60 kmph. We appended vehicles on both sides of the road, i.e. two-way flow of vehicles range randomly between 1 to 200.

The packet delivery ratio is shown in Figure.4. The ratio of receiving packets of the percentage computed in this output.

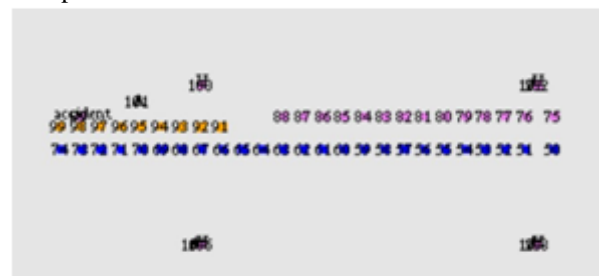


Fig. 4. Simulation with accident and ambulance allocation from nearest RSU

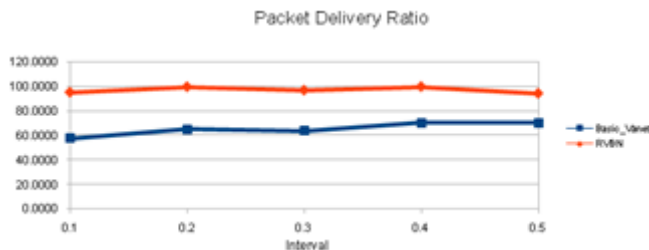


Fig. 5. Packet Delivery Ratio

Depend on network density, speed of vehicles, and b coverage area packets affect delivery of packet towards receivers. Maxi- mum PDR signifies more reliable communication in a network. The graph shows the high PDR for RSADP, same indicates the faster warning message dissemination occurred in V2I and V2V network. RSADP ensures the network provides safe and traffic managed driving on the road.

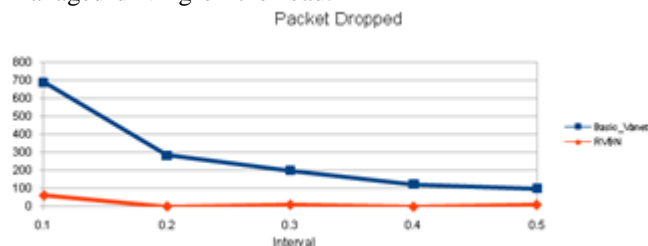


Fig. 6. Packet Dropped

Figure 5 explains the average packet loss attained by the underlying VANET protocol against RSADP. The density of vehicles on the road affects the packet count in a network, in high-density vehicle scenario more packets flow in a network and can result in packet loss. High packet loss cannot confirm delivery of emergency communication over a network, so need precise addressing. In proposed work, minimum packet loss recorded against the basic model of VANET. And also, a basic version of the routing algorithm does not consider prioritiza- tion of accidents and critical messages. So the possibility of road collisions and overheads due to rebroadcasting are more if the emergency message gets delayed or lost.

Figure 8 shows the packet delay for default routing of

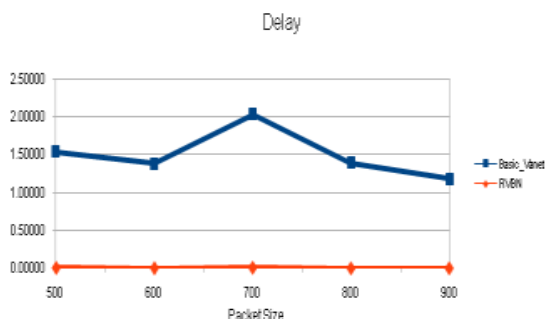


Fig. 7. Packet Size Vs Delay

VANET versus proposed accident avoidance RSADP. We observed with low density of on-road vehicles, RSADP obtains improved outputs in contrast with basic VANET. As density increased of on-road vehicles, yet proposed model concerns a minimum delay, reducing the standard delay almost 28% in association with basic VANET.

$$AD = \frac{\sum (receivingTime - SendingTime)}{\sum Number\ of\ vehicles}$$

Within minimum average delay (AD) period as above equation 4.1, the accident announcements need to be broadcast around the network to avoid road collisions, and avoidance notification needs to be exchanged among vehicles. To obtain the most beneficial feature in VANET with minimum delay.

V. CONCLUSION

In today's world, vehicles are equipped with a variety of sensors on-board (Anti-lock Brakes, Air-bag deployment sen- sors, accelerometers, gyroscopes). Sensor values evaluation at vehicles OBU can recognize collision. Vehicles in an accident immediately notify alert messages to neighboring vehicles and the nearby roadside unit. Accident alert messages get pro- cessed by the nearest RSU and allot ambulance or emergency services to assist causality at the accident spot. In the proposed protocol, we are accompanying detection with avoidance. For avoidance, propagate accident alert to surrounding vehicles on the same route in a small radius by forming a cluster. It helps to slow down and stop at a safe distance, hence avoiding a pile-up and saving more people from injuries and loss of life. Our protocol simulated over high-density vehicles with default VANETs routing and propagation algorithms; results found holding less delay, minimum loss, and high delivery ratio in proposed work.

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