COLLISION AVOIDANCE IN VANET TO MAINTAIN INTER-VEHICULAR DISTANCE AND ALERTS ON HIGHWAYS

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Abstract

In Inter-Vehicular Adhoc Network (IVAN) does not have a fixed network topology but is highly dynamic. The topology of the network changes frequently because wireless links are established and broken down due to certain factors such as the velocity of the vehicles, their mobility patterns and their spatial density. These high dynamics also cause very short times for data transfer. This paper presents Inter Vehicular Collision Avoidance System on Highways to ensure that the vehicles perform safety communication with each other for which can alert the drivers before accidents. This can be done by defining a critical "Inter-Vehicular Distance" to be maintained between and any two vehicles on highways. Moreover, certain vehicles such as ambulance, fire service vans, police patrols need to be given a high priority, as their requirements are crucial during emergency situations. By giving vehicular priorities and providing group communications, our proposed System results vehicular collision avoidance in Inter Vehicular Adhoc Network.

Index Terms: *IVAN, IVC, Collision Avoidance, GPS*

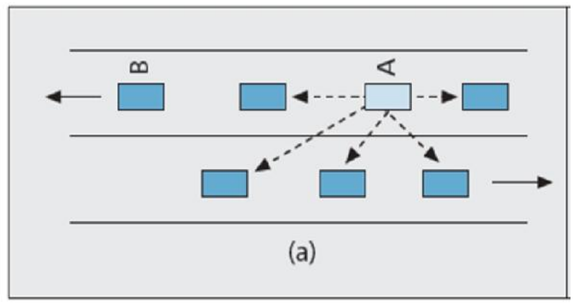
1. INTRODUCTION

Recently much attention has been devoted to the research in the field of Inter-Vehicular Adhoc Network (IVAN) communications. Indeed, the advances in wireless technologies are making it possible to deploy new services: some of the most interesting ones aim at increasing safety over highways and streets by delivering warning messages, or through cooperative or assisted drive. The study done by the U.S. National Highway Traffic Safety Administration (NHTSA) shows that developing automotive collision warning and avoidance systems will be very effective for reducing fatalities, injuries and associated costs. The goal of the Automotive Collision Avoidance Systems (ACAS) is to detect and warn the driver of potential hazard conditions [1], [2].

Inter - Vehicular Ad Hoc Networks (IVAN) are emerging wireless networks established between vehicles, and can enable many safety applications. One of these safety applications is a collision warning avoidance system. The architecture for a reliable vehicular collision avoidance system on highways that operates in VANETs is developed in this paper. The system relies on GPS for position information and the vehicle's speed information [3]. Each vehicle broadcasts this information using the Inter Vehicle Communication Network to all vehicles in the neighbourhood [4]. Each vehicle broadcast, periodic broadcast message which represent the position, speed, acceleration & time information of vehicles. With this PBM messages every vehicles calculate and scanned for proper distance between vehicles. Finally, vehicles having less inter vehicular distance then warning messages are broadcast to predict collisions few seconds beforehand on highways.

In this paper, inter vehicular collision avoidance system is proposed on highways to maintain Inter-Vehicular Distance. The Inter Vehicle Collision Avoidance system relies inside each vehicle to obtain its position from the GPS, its speed and acceleration from other vehicle respectively. Furthermore, the system uses VANETs to broadcast speed and position information to all vehicles that are in the area. Similarly, the rest of the vehicles in that area will gather and broadcast their respective information. Hence, all vehicles in an area store the information about all vehicles in that area. This information is constantly updated; moreover, the vehicles constantly check for inter-vehicular distance as well as intersecting vehicles. In Inter Vehicular Collision Avoidance system constantly proceeds in calculating distance segments from the received information (each segment represents a vehicle). Road segments that intersect and none intersect with each other are noted. These distance segments signify possible colliding vehicles and broadcast warning message to the possibly colliding vehicles. It becomes necessary that on highways the vehicles exchange dynamic information such as speed,

acceleration, position and direction in real time. Wireless communications do not require line-of-sight. Thus, using wireless communication technologies, the vehicles can inform each other about how far they are from the distance of vehicle and receive the dynamic information of the signal lights and the status of the intersection as well as on highways. The goal of inter vehicular collision avoidance protocol is to warn the driver about the condition of the vehicle and the signal to avoid the collision.



In the next section, the motivation behind proposing inter vehicular communication is discussed. The proposed system for collision avoidance is given in section 3. Section 4 discussed the various simulations for inter vehicular collision avoidance scenario. Finally, section 5 concludes the paper, and discuses a future work to provide a security for broadcasting the messages.

2. INTER VEHICLE COMMUNICATION

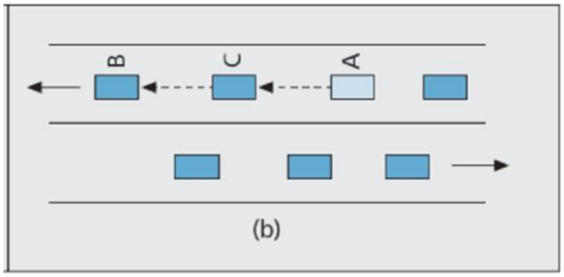
Inter-Vehicle Communication Systems (IVCs) rely on direct communication between vehicles to satisfy the communication needs of a large class of applications (e.g., collision avoidance, passing assistance, and platooning). IVC systems can be supplemented or, in some situations, replaced by roadside infrastructure, allowing for Internet access and several other applications. The term vehicular ad hoc network (VANET) was introduced for multihop networks of vehicles not relying on roadside infrastructure. To use the term IVC as it is more general, including single-hop networks.

Furthermore, the term IVC is extensively used in the existing and focuses on Medium Access Control (MAC) and routing issues, in particular pointing to the mismatch between the need of IVC applications for group communications and the services offered by Mobile Ad hoc Network (MANET) routing protocols. IVC systems are completely infrastructure-free; only Onboard Units (OBUs) sometimes also called in-vehicle equipment (IVE) are needed. IVC systems are the main focus of this paper.

Depending on whether the information is retransmitted at intermediate hops or not, we can further distinguish between single-hop and multihop IVCs (SIVCs and MIVCs). SIVC systems are useful for applications requiring short-range communications (e.g., lane merging, automatic cruise control). MIVC systems are more complex than SIVCs but can also support applications that require long-range communications (e.g., traffic monitoring). The main difference between SIVC and MIVC systems is shown in Fig. 1.

a. Single-Hop IVC System

In an SIVC system vehicle A can send a message only to the cars that are in its transmission range (i.e., vehicle B never receives the message) as shown in Fig. 1a. On the other hand, in an MIVC system another vehicle (vehicle C in Fig.. 1b) can relay the message such that vehicles not in the transmission range of vehicle A (e.g., vehicle B) can also receive the message. Therefore, an MIVC system requires a network layer capable of multihop routing [5].



b. Multihop IVC Systems **Fig-1:** Inter Vehicle Communication System

3. PROPOSED SYSTEM FOR COLLISION AVOIDANCE

Existing routing protocols, where each node is required to select the next one or to continue route discovery, result in high delays in reaching the destination [6]. Several routing protocols developed for Ad-hoc wireless networks have been modified and adapted for use in transportation systems. In order to improve the communication between the inter vehicles, and to improve the safety and efficiency of the traffic, this proposed system for collision avoidance is developed.

3.1 Broadcasting

Collision warning in a VANET is achieved by either an active or passive approach. First, the active approach is event driven and messages are only exchanged when an emergency event occurs [7]. In this each vehicle periodical broadcasts its status (e.g. location, speed, and acceleration), in the form of PBMs, to its neighbours so that vehicles will be able to avoid emergency or unsafe situations even before they appear. Broadcasting wireless unit is installed at each vehicle should have the wireless unit which can communicate with another vehicle. Vehicles do not know position, speed, acceleration, time of neighbour vehicles. With the help of PBM message every vehicle get the status of the signal, to avoid collision. Transmission interval is assumed to be small enough to ensure safety.

3.2 Dynamic Clustering of Vehicles

To accurately estimate the current geographical location, each vehicle in the platoon consists of global positioning systems (GPSs) or similar tracking modules [8], [9]. It should be noted that the knowledge pertaining to the real-time coordinates of the vehicular nodes is an assumption made by most protocols and applications. To facilitate communications, two distinct wireless channels are considered to exchange signaling messages to formulate vehicles' clusters and to issue/forward warning messages, respectively. The vehicles' clusters are formed with different parameters such as direction of vehicle movement, and its speed shown in Fig. 2. Each vehicle is considered to have knowledge on its maximum wireless transmission range. Depending on its wireless transmission range, vehicle direction and speed, which has highest priority then would elected as a cluster head.

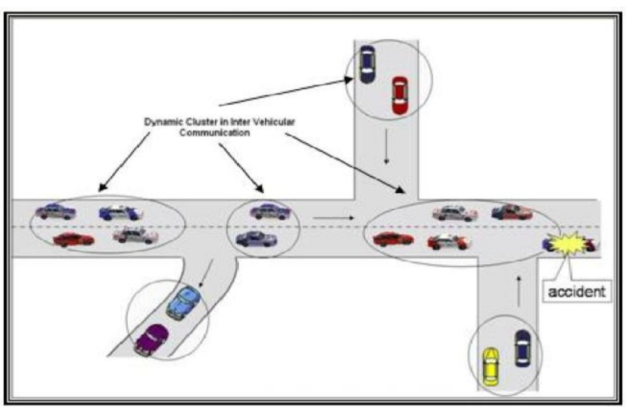


Fig-2: - Vehicles' Cluster Formation on Highways

3.3 Inter Vehicular Collision Avoidance System

This collision avoidance system is used for safety improvement [10], [11]; the transmission performance of this system has stringent requirements. The collision detection and warning system is installed at on board unit. This system works in non line of sight situations and system assumed to give a warning message to the driver, to avoid collision. In this system architecture it is assumed that every vehicle is equipped with a system which is able to get the geographical position of the vehicle. It is also assumed that the vehicle has a wireless transceiver. All vehicles use the same IEEE 802.11 standard and share a common channel.

The system inside each vehicle continuously carries out the following algorithm:

1) Collecting data from the GPS:

In this phase, the position (longitude, latitude) of the vehicle is gathered from the GPS. Then each vehicle obtains its speed and acceleration from the speed meter. In order to ensure synchronization between all vehicles, current-time is obtained from the GPS. The aforementioned information is placed in a packet which is stamped with the identification number of the vehicle. The packet is broadcasted to nearby vehicles through multi-hop IVCs. The structure of the packet is as shown in following Fig. 3 which consists of Identification number of the vehicle (V_ID), GPS time when the GPS position is obtained (V_Gps_time), Position coordinates obtained from the GPS
(V_Gps_Position), Vehicle's speed (V_speed), Vehicle's acceleration (V_accel).

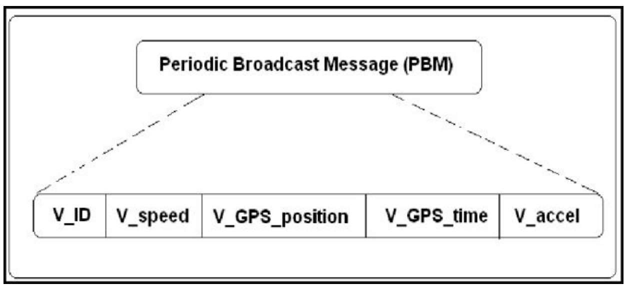


Fig-3: - Packet Structure

2) Processing Information gathered from other Vehicles:

All vehicles in a predefined area will receive the before mentioned packet. Each Receiver Vehicle, and for each packet received, system will calculate distance that represents the neighbour vehicle it received the packet from. Then, the Receiver Vehicle will obtain its time from the GPS.

3) ***Collision Avoidance algorithm***

In this vehicle distances are calculated and stored in a dynamic table. Possible collisions are detected by running Collision Avoidance algorithm to warn and report Collision between Vehicles to dynamic clustering mechanism. If the distance between two or more vehicle is less, then warning message is generated and broadcasted to the nearby vehicles to avoid the possibility of collision. The algorithm is as follows;

Step1 -Plot VNode on the simulator.

Step2 -Vnets count and forms the Adhoc Network of Vehicles. Step3-Each VNode is in running condition and forming dynamic cluster.

Step4-Each VNode broadcast the PBM message.

Step5-Get Distance from each VNode and calculate inter vehicular distance.

```
                    vnets(i).Speed = 0
      End If End If
End If
                    v node data transfer to other node PaketTransfer(g, vnets(i), vnets(j)) vnets(i).Network.Add(vnets(j))
          Else
                    Other wise Broadcast data
                    vnets(i).dataTr = VNode.DataTransfer.BC
          End If
End If
Next
Next
```

Step8 – Repeat steps from 4 to 7 for every vehicle (VNode).

```
 "Distance Method for 2d"
          GetDistance(ByVal N1 As VNode, ByVal N2 As VNode) As Integer
                    X = Math.Abs(N1.X - N2.X)
                    Y = Math.Abs(N1.Y - N2.Y)
                    D = CInt(Math.Sqrt(X * X + Y * Y)) Return D
```

Step 6- Collision warning condition

```
If vnets(i).NodeID < > vnets(j).NodeID Then If D < 100 Then
           If D > 30 Then
                    Data Transfer to other Node in Network
          Else
                    Warning of Collision Codition
          EndIf
     End
End
```

Step 7- Collision Avoidance

```
 If vnets(j).Move = VNode.mov.Right Then If vnets(j).X > vnets(i).X Then
                    Speed measure Set to 0 ,and
                    Message Transfer to Other vnode to Speed vnets(j).Speed = 0
                    Other data transfer to speed ++
     Else
                    vnets(i).Speed = 0
     End If Else
                    If vnets(j).Y > vnets(i).Y Then vnets(j).Speed = 0
          Else
```

4. SIMULATIONS

In Inter Vehicular Adhoc Network nodes (vehicles) can only move long streets, prompting the need for a *road model*. Another important aspect in a vehicular network is that nodes do not move independent of each other; they move according to fairly well established *traffic models*. In the literature four types of road models are often considered: the straight highway, the circular highway, the road grid, and real road maps.

The straight highway shown in Fig.4 is a reasonable model for highways outside cities. In this model vehicles move in lanes, in either one or two directions.

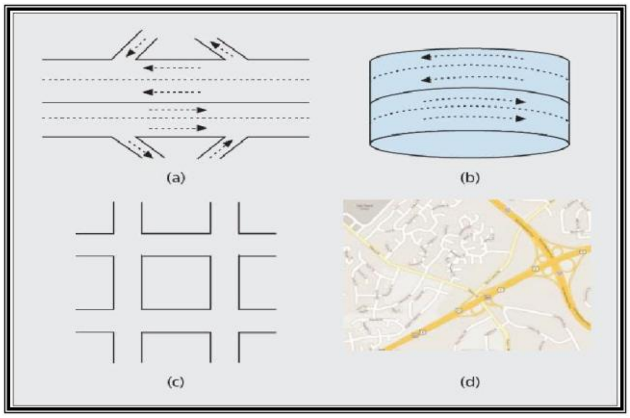


Fig-4: - Road Models

Exchanging vehicle's dynamic information such as speed, acceleration, position, direction, etc. is necessary to build collision warning and avoidance systems on highways [12].

Therefore it is necessary to present a system for maintaining communication links among intelligent vehicles on the road. Each vehicle periodical broadcasts its state (e.g. location, speed, and acceleration), in the form of PBMs, with maintaining inter-vehicular distance, to its neighbours as shown in following simulation Fig.5. Following parameters are considered for the carrying out the simulations;

1. Simulation Area - 1024 * 768 (m)
2. Node Size - 15
3. Mac Interface - 802.11
4. Antenna Type - Omni directional
5. Spacing (V2V) - 70m
6. Node Speed - 5 TO 10 m/s
7. Transmission Range - 250 meter
8. Interface range - 550 meter
9. Protocol - AODV

Simulations are complied with Microsoft Visual Studio .NET 2005.

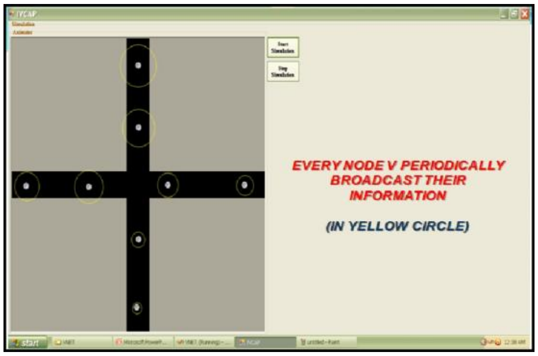


Fig-5:- Vehicles broadcasting their own Information indicating in yellow circle in simulator

The system calculates the source and destination for every vehicle. The roads and the vehicle follows to reach the destination are computed randomly among all the possible shortest paths between source and destination. The velocity of vehicles varies from 5 m/h to 10 m/h (in pixels) depending on the traffic conditions. Every vehicle knows its transmission range which is 250m. Collision zone radius of vehicle is assumed at 30 pixels.

All vehicles in a predefined area will receive the before mentioned packet. Each Receiver Vehicle, and for each packet received, will calculate distance that represents the neighbor vehicle it received the packet from. In dynamic cluster, if the distance between two or more vehicles has the less inter-vehicular distance then collision will occur between vehicles as shown in simulation Fig. 6.

Fig-6:- Collision Warning Scenario due to less Inter-Vehicular Distance indicating in red circle

Using the Inter Vehicular Collision Avoidance algorithm, the collision between vehicles can be avoided as shown in our simulator Fig.7.

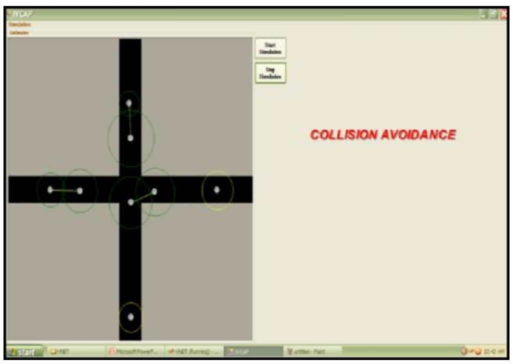


Fig-7:- Collision Avoidance Scenario

In dynamic clustering of inter-vehicular network, any vehicles want to share or exchange the information then by using wireless technology they can communicate each other as shown in Fig.8. The interface range data transfer for the vehicle is 550m. It is also possible for vehicle to vehicle communication with the help of inter vehicular collision avoidance system to maintain the distance between vehicles as shown in Fig.8. Here the green circle shows the data transfer range.

Group formation can be predefined or dynamic [13]. In the first case, specific vehicles are part of specific groups. This approach is clearly too harsh and not scalable, thus not suitable for VANETs, but might be of use in some corner cases like having all public transport vehicles be part of a group. In the second case, groups are formed dynamically, presumably based on how close they are or what their driving pattern is.

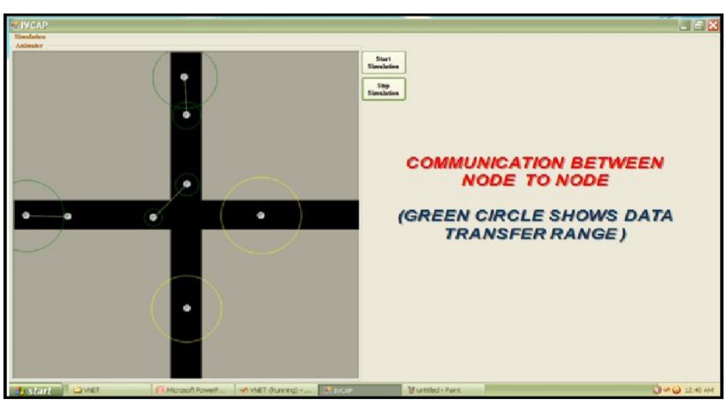


Fig-8:- Communication between Vehicles to Vehicle

In this scenario, if the interface range of every vehicle has 550m and having same direction movement then it is possible to communicate with each other by forming group to the dynamic cluster mechanism shown in Fig.9.

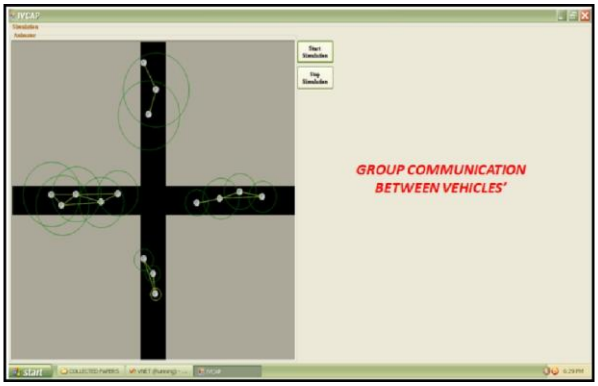


Fig-9:- Group Communication between Vehicles

Using this group communication, certain vehicles such as ambulance, fire service vans, and police patrols has given a high priority as their requirements are crucial during emergency situations.

5. CONCLUSION

The reliable Inter vehicular Collision Avoidance system that operates in VANETs on highways is developed in this paper. The system relies on GPS for position information and the vehicle's speed information. Each vehicle broadcasts this information using the Inter Vehicular Adhoc Network to all vehicles in the neighbourhood. In each vehicle, a structure of packet which represent the vehicle ID, position and speed information of vehicles are calculated and scanned for inter-vehicular distance. Based on the Inter Vehicular Collision Avoidance algorithm, vehicles having less distance will warn by broadcasting the warning messages in the form of PBM to predict collisions few seconds beforehand. The collision and

avoidance is verified through extensive simulation. It is also simulated if vehicles are in the interface range then they can communicate in group which is advantageous to Inter-Vehicular Adhoc Network. The work can be extended and simulated by providing security to the broadcasting message in IVAN.

REFERENCES

[1] U.S. Dot National Highway Traffic Administration (Nhtsa). Traffic Safety Facts. *Http://Www-Nrd.Nhtsa.Dot.Gov/Pubs/811402ee.Pdf, 2009.*

[2] U.S. Dot National Highway Traffic Administration (Nhtsa). Crash Factors In Intersection-Related Crashes: An On-Scene Perspective. Http://www.nrd. *Nhtsa.Dot.Gov/Pubs/811366.Pdf, September 2010.*

[3] The Vehicle Collision Warning System Based On Gps Sehun Kim, Sunghyun Lee, Inchan Yoon, Mija Yoon And Do-Hyeun Kim 2011 *First Acis/Jnu International Conference On Computers, Networks, Systems, And Industrial Engineering .*

[4] Increasing Broadcast Reliability In Vehicular Ad Hoc Networks Nathan Balon And Jinhua Guo University Of Michigan – Dearborn 2006.

[5] Inter-Vehicle Communication Systems: A Survey Mihail L. Sichitiu, North Carolina State University Maria Kihl, Lund University *IEEE Communications Surveys & Tutorials 2nd Quarter 2008.*

[6] Vanet Routing Protocols: Pros And Cons Bijan Paul, Md. Ibrahim, Md. Abu Naser Bikas *International Journal Of Computer Applications (0975 – 8887) Volume 20– No.3, April 2011.*

[7] The Challenge Of Broadcasting At Intersections In Vehicular Adhoc Networks Samaneh Khakbaz Mahila Dadfarnia *2010 International Conference On Electronics And Information Engineering (Iceie 2010) IEEE 2010.*

[8] Performance Evaluation Of A Cca Application For Vanets Using Ieee 802.11p Juan-Bautista Tomas-Gabarron, Esteban Egea-Lopez, Joan Garcia-Haro, Rocio Murcia-Hernandez 2010 IEEE.

[9] Toward An Effective Risk-Conscious And Collaborative Vehicular Collision Avoidance System Tarik Taleb, Member, Ieee, Abderrahim Benslimane, Senior Member, Ieee, And Khaled Ben Letaief, IEEE 2010

[10] A Collision Pre-Warning Algorithm Based On V2v Communication Chung-Ming Huang, Shih-Yang Lin, And 2009 IEEE

[11] A Vehicle Collision Warning System Employing Vehicle-To-Infrastructure Communications Shie-Yuan Wang, Yow-Wei Cheng, Chih-Che Lin, Wei-Jyun Hong, Ting-Wei He 2008 IEEE

[12] A Multi-Hop V2v Broadcast Protocol For Chain Collision Avoidance On Highways Shouzhi Xu, Huan Zhou, Chengxia Li, Yu Zhao 2009 IEEE

[13] A Survey Of Inter-Vehicle Communication Protocols And Their Applications Theodore L. Willke, Patcharinee Tientrakool, And Nicholas F. Maxemchukieee *Communications Surveys & Tutorials, Vol. 11, No. 2, Second Quarter 2009*

