International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 2 Issue 5, May - 2013

Car To Car Communication For Enhancing Highway Safety And Cooperative Collision Avoidance

Avanish. H, B. Anand Naik, Praveen Kumar Gaonkar, Asstproff. Basavraj

Abstract

This paper proposes a vehicle-to-vehicle communication protocol for cooperative collision warning. Emerging wireless technologies for vehicle-to-vehicle (V2V) and vehicle-to roadside (V2R) communications such as DSRC are promising to dramatically reduce the number of fatal roadway accidents by providing early warnings. One major technical challenge addressed in this paper is to achieve low-latency in delivering emergency warnings in various road situations. Based on a careful analysis of application requirements, we design an effective protocol, comprising congestion control policies, service differentiation mechanisms and methods for emergency warning dissemination. Simulation results demonstrate that the proposed protocol achieves low latency in delivering emergency warnings and efficient bandwidth usage in stressful road scenario**s.**

Introduction

Recently, Inter-Vehicle Communication Systems (IVC) has attracted considerable attention from the research community and automotive industry. Many automobile manufacturers started planning to build communication devicesinto their vehicles for purposes of safety, comfortable driving, and entertainment. In IVC systems, broadcast is a frequently used method. Possible applications relying on broadcast include sharing emergency, traffic, weather, androad data among vehicles, and delivering advertisements and announcements. These applications generate packets of various lengths at different rates. For example, accident warnings are short packets that are generated infrequently. Another type of warning packet generated when the road is slippery because of ice or rain is also short but these packets may be sent in bursts. Finally, advertisement packets of restaurants or hotels can be broadcast in very long packets that carry pictures, directions, or even small videos. When a message is disseminated to locations beyond the transmission range, multi-hopping is used. Unfortunately, interference, packet collisions, and hidden nodes can stop the message dissemination during multi-hop broadcast. Moreover, multi-hop broadcast can consume significant amount of wireless resources because of unnecessary retransmissions. These facts increase the importance of a MAC layer design for efficient and reliable multi-hop message dissemination. In addition, broadcast communication has another challenge in urban areas. Especially in an urban area crowded with tall buildings around intersections, it is difficult to disseminate the packets to different road segments shadowed bythese buildings. The topology and the node movement of an IVC network is constrained by roads. The resulting communication network is a special kind of Mobile Ad-Hoc Network (MANET) where the mobility rate is high but movement direction and speeds are predictable. In MANETs, oozing the network blindly is the first approach to achieve broadcasting sinceAbove limitations result in large delay in propagating emergency warnings when depending on brake lights and human responses. Environmental conditions such as badweather or curved roads may further impair human perceptionin cases of emergency.

Contributions of this paper include:

- Identifying application requirements for vehicular cooperativecollision warning.
- Achieving congestion control by developing rate adjustmentalgorithms for emergency warning messages basedon the application requirements.
- Showing that the proposed protocol can satisfy application requirements without causing too much communication overhead, allowing cooperative collision warning application to

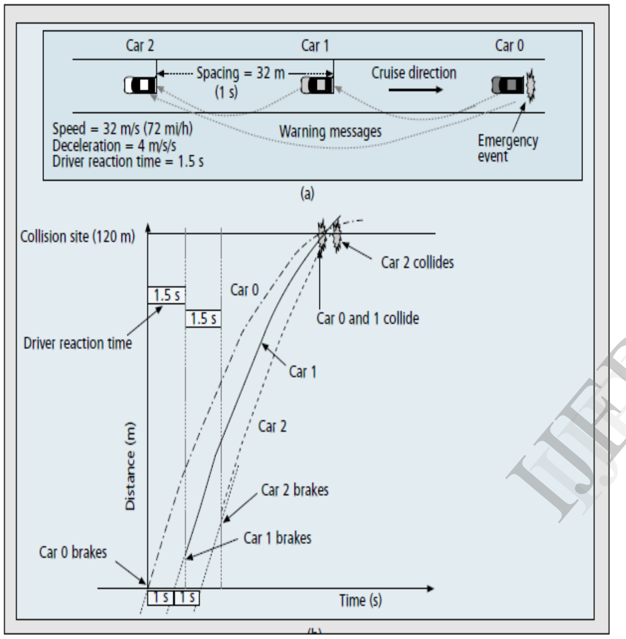


Figure 2. *Model for chain car collisions: a) a three-car highway platoon; b) chain car collisions when drivers react only on the tail light of the car ahead.*

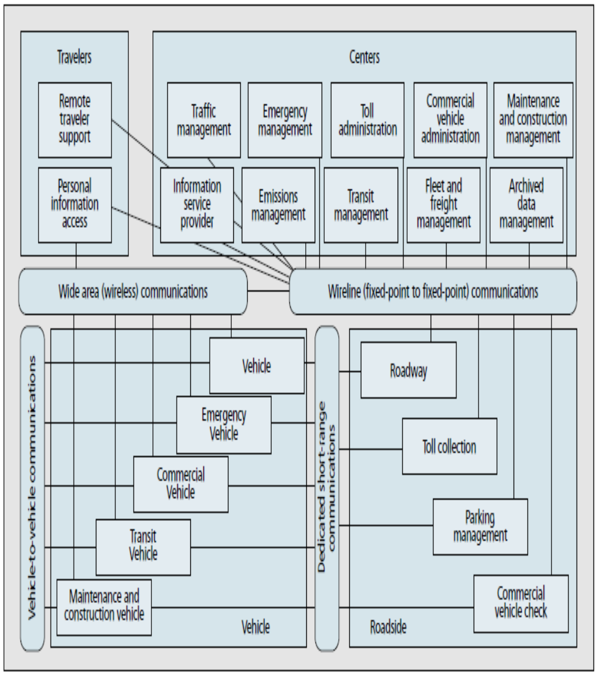


Figure 1. *Proposed national ITS architecture (U.S. DOT, 2003).*

Architecture

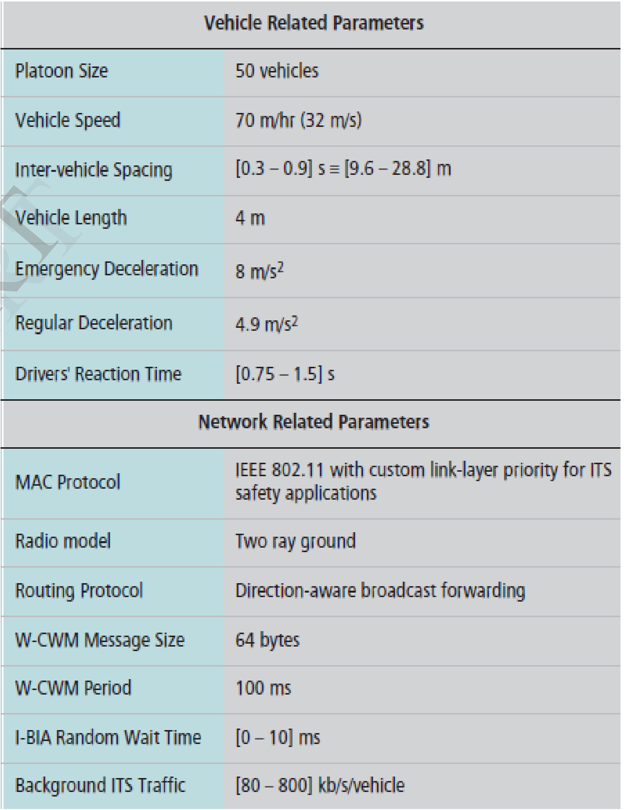
The mechanism of CCA is explained using a three-car highway platoon example, as shown in Fig. 2a. In the example, all cars are assumed to cruise initially at a steady speed of 72 mph (32m/s), and with an intercar spacing (or headway) of 1 s (32 m). Figure 2b illustrates the platoondynamics after the front car (car 0) initiates an emergency deceleration (at 4 m/s2) as a result ofan emergency event. As shown in the figure, the driver in car 1 starts to decelerate when he seesthe tail brake light of car 0, and the driver in car 2 does so when he sees the brake light of car 1. With an assumed driver's reaction time of 1.5 s, car 0 gets hit by car 1 at a distance of 120 m**,** and subsequently, car 1 is hit by car 2. The conclusion from this example is that if drivers react

State of the current research

Protocol research for vehicle-to-vehicle communication can be broadly categorized in the areasof Medium Access Control (MAC) and data forwarding across moving vehicles. IEEE 802.11a isconsidered to be the de facto MAC protocol for DSRC-based communication. Although 802.11aprovides a means for rapid application development, in dynamic vehicular environments theprotocol suffers from a number of performance limitations as reported in .The first limitationis a hop-unfairness problem due to which the effective data throughput of a multihop flowover 802.11 MAC can be severely limited due to 802.11’s self-competition between adjacentnodes in the same flow. The second limitation is a lack of MAC protocol stability, and its subsequent performance inefficiency in highly mobile vehicular environments. Although a number of improvements, including better fairness, quality of service, and the support for differentiated services have been proposed in the literature , the basic nondeterministic nature of 802.11 is still an issue for its applicability to dynamicDSRC applications. A set of Time Division Multiple Access (TDMA)-based slotted MAC protocols have been proposed for avoiding the inherent randomness and delay unpredictability of 802.11 . A slot reservation MAC protocol (R-ALOHA) for intervehicle communication was proposed in. Several other slot reservation MAC protocols were proposed for the Fleetnet project

4 Network Layer: The Role of Location Awareness

Almost all unicast routing protocols proposed for IVC are position-based. Basically, anyexisting position-based routing protocol for ad hoc networks can be applied to IVC,but the protocols can be optimized by taking into account the special features of vehicles.For example, GPS, Geographic Information System (GIS), and digital map can help a node to be aware of its location and the surrounding, like road topology. Since the road topologysomewhat implies the network topology in IVC, this knowledge does help to make the routing protocol more efficient . Furthermore, one of the most recent results on position-basedrouting proposes a forwarding scheme avoiding the need of beacons for improved efficiency.One of the real implementations, demonstrated by FleetNet, has not exploitedthese special features of vehicles yet. Their protocol behaves like a reactive routing protocolby requesting the location of a destination when sending a packet. Then greedy geographicalforwarding is used to forward packets. We also notice that most people try to solve theproblem of unicast routing just because “it is challenging in ad hoc networks”. Actually, bylooking at those applications mentioned in Section 1 (which involve almost group-orientedrather than pairwise communications), we are really wondering if unicast routing still has thesame significance as in “general” ad hoc networks.The application of broadcast is usually to disseminate traffic information. Most literaturessuggest scoped-flooding for broadcasting. Thanks to the peculiarity of this application, certainoptimizations can be applied. For example, Wischhof et al. adaptively change the intertransmissioninterval according to the significance of the event conveyed by the message intransmission, while Briesemeister et al. use a randomized interval. If the locations of vehicles are again taken into consideration, a multiresolution data structure can be used to express information in the message. The intuition here is that the further a vehicle is from the event, the less detail it needs. Summary Considering the application requirements for IVC, broadcast routing that disseminates information to a set of nodes that could be far from each other seems to be a necessary supporting mechanism; it could be optimized according the requirement of an application. On the contrary, unicast routing might be superfluous in most cases.

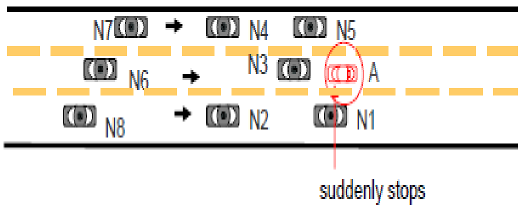


Vehicle Related Parameters	
Platoon Size	50 vehicles
Vehicle Speed	70 m/hr (32 m/s)
Inter-vehicle Spacing	[0.3 – 0.9] s ≡ [9.6 – 28.8] m
Vehicle Length	4 m
Emergency Deceleration	8 m/s^2
Regular Deceleration	4.9 m/s^2
Drivers' Reaction Time	[0.75 – 1.5] s
Network Related Parameters	
MAC Protocol	IEEE 802.11 with custom link-layer priority for ITS safety applications
Radio model	Two ray ground
Routing Protocol	Direction-aware broadcast forwarding
W-CWM Message Size	64 bytes
W-CWM Period	100 ms
I-BIA Random Wait Time	[0 – 10] ms
Background ITS Traffic	[80 – 800] kb/s/vehicle

Application challenges

Fundamentally, there are two different ways to achievecooperative collision warning: a *passive* approach and an*active* approach.

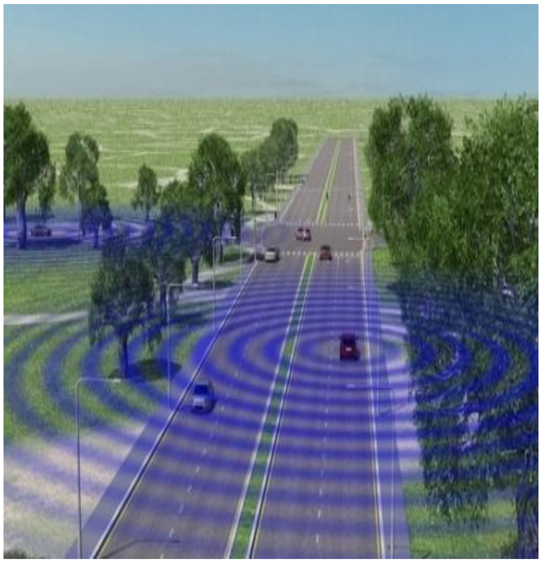
- Passive Approach: In the passive approach, all vehiclesfrequently broadcast their motion information (e.g.location, speed, and acceleration). It is the receivingvehicles' responsibility to determine the potential dangerfor itself. For example, in Figure 2, by receivingmessages from vehicle □, vehicle _ _ may find that theinter-vehicle distance is below a certain threshold. __ then warns its driver of potential collision. This requireshigh-precision vehicle motion information, together withhigh refresh rate (i.e., the rate at which the messages aresent), to avoid false warning or missed warning.
- Active Approach: In the active approach, when avehicle on the road acts abnormally, e.g., decelerationexceeding a certain threshold, dramatic change of movingdirection, major mechanical failure, etc., it becomesan abnormal vehicle (AV). Only when an abnormalevent occurs, the correspondingly AV actively generatesEmergency Warning Messages (EWMs), which includethe geographical location, speed, acceleration andmoving direction of the AV, to warn other surrounding vehicles. A receiver of the warning messages can thendetermine the relevancy to the emergency based onthe relative motion between the AV and itself. For theexample in Figure 2, it is vehicle A□'s responsibility towarn other vehicles when an abnormal event occurs at □.



An example scenario

Working Design

- Two cars are communicating to each other through RF i.e. Radio Frequency.
- Each car would be receiving its location through GPS & will send the Driver vehicle information to nearby cars.
- Driver vehicle information consists of car's location, car speed &where it is going i.e. its Line of sight.
- On the basis of received data from other car through RF, it will manipulate with its own location.
- According to the result of manipulation it will warn the driver and apply automatic brakes.



.

Conclusion

This paper proposes a Vehicular Collision Warning Communication (VCWC) protocol to improve road safety. In particular, it defines congestion control policies for emergency
Warning messages so that a low emergency warning message delivery delay can be achieved and a large number of coexisting abnormal vehicles can be supported. It introduces aMethod to eliminate redundant emergency warning messages, exploiting the natural chain effect of emergency events. It also enables the cooperative collision warning application

to share a common channel with other applications using service differentiation mechanisms.

In this article we have presented an overview of vehicle cooperative collision avoidance (CCA) Application using the emerging Dedicated Short-Range Communication (DSRC) infrastructureForintervehicle wireless networking. The concept of CCA has been introduced with an overview,and its implementation issues have been analyzed in light of specific requirements from theMAC and routing-layer protocols of the underlying wireless networks. Specific constraints andfuture research directions have then been identified for packet-routing protocols to support aneffective CCA system within the DSRC environment. To explain the interactions between CCAand its underlying networking protocols, we have presented example safety performance of CCAfrom simulated intraplatoon vehicle crash experiments.The results from these experiments were also used to demonstrate the need for networkdata prioritization for safety-critical applications such as CCA. Finally, the performance sensitivity of CCA to unreliable wireless channels has been discussed using these experimental results.

References

[1] "Dedicated Short Range Communications (DSRC) Home," http://www.leearmstrong.com/DSRC/DSRCHomeset.htm.

[2] C. David Wang and James P. Thompson, "Apparatus and method for motion detection and tracking of objects in a region for collision avoidance utilizing a real-time adaptive probabilistic neural network," 1997, US.Patent No. 5,613,039.

[3] Marc Green, ""How Long Does It Take to Stop?" Methodological Analysis of Driver Perception-Brake Times," *Transportation HumanFactors*, vol. 2, no. 3, pp. 195–216, 2000.

[4] Jatinder Pal Singh, Nicholas Bambos, BhaskarSrinivasan, and DetlefClawin, "Wireless LAN Performance Under Varied Stress Conditions in Vehicular Traffic Scenarios," in *IEEE VTC 2002 Fall*, 2002, vol. 2, pp. 743–747.

[5] Duke Lee, Roberto Attias, AnujPuri, Raja Sengupta, Stavros Tripakis, and PravinVaraiya, "A Wireless Token Ring Protocol For Ad-Hoc Networks," in *IEEE Aerospace Conference Proceedings*, March 2002.

[6] R. Verdone, "Multi-hop R-Aloha for inter-vehicle communication at millimeter waves," *IEEE Transaction on Vehicular Technology*, vol. 46, no. 4, pp. 992–1005, November 1997.

[7] H. Hartenstein, B. Bochow, A. Ebner, Matthias Lott, Markus Radimirsch, and Dieter Vollmer, "Position-Aware Ad Hoc Wireless Networks for Inter-Vehicle Communications: the Fleetnet Project," in *Proc. ACM Mobihoc'01*, 2001.

[8] M. Lott, R. Halfmann, E. Schulz, and M. Radimirsch, "Medium access and radio resource management for ad hoc networks based on UTRA TDD," in *Proc. ACM MobiHOC'01*, 2001.

[9] M. Lott, R. Halfmann, and M. Meincke, "A Frequency Agile Air- Interface for Inter-Vehicle Communication," in *Proc. ICT 2003*, 2003.

[10] M. Meincke, M. Lott, and K. Jobmann, "Reservation Conflicts in a
Novel Air Interface for Ad Hoc Networks based on UTRA TDD," in
IEEE VTC 2003 Fall, 2003.