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Wireless Connectivity in Connected Vehicles for Road traffic safety: Review and Ideas

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ABSTRACT: The presence of devices in an automobile that connect the device to other device within the car/vehicle and or devices networks and services outside the car including other car, home, office or infrastructure. The application includes everything from traffic safety and efficiency, infotainment, parking assistance, roadside assistance, remote diagnostics. Connected vehicles safety applications are designed to increase situation awareness and mitigate traffic accidents through vehicle to vehicle (V2V) and Vehicle to Infrastructure (V2I) communications. Typically vehicles that include inter active advance driver –assistance system (ADASs) and Co-operative intelligent Transport System (C-ITS) can be regarded as connected. The C-ITS where vehicle co-operate by exchanging messages wirelessly to avoid hazardous road traffic situations that are currently receiving a great deal of attention around the world.

C-ITS applications can be categorized into road traffic safety, road traffic efficiency and value added services. Road traffic safety applications have stringent requirements for both bounded delay and high reliability. Examples of road traffic safety applications are warning of lane changes, emergency vehicle approaching, stationary vehicles, road conditions and road work.

The existing C-ITS for collision warning is based on the sensors such as camera, radar or light detection and ranging (LIDAR) to detect vehicle or object in front and warn the driver of potential collision, However, the existing sensor based systems are able to detect only those vehicles that are within the employed sensor measurement ranges and blind spot may occur owing to obstacles.

This paper will discuss the various ideas of implemented for vehicle to vehicle communications.

Keywords: vehicle to Vehicle, Road traffic safety, Co-operative Intelligent Transport System, connected vehicles

I. INTRODUCTION

As an indispensable part of modern life, motor vehicles have continued to evolve since they were invented in the
Second Industrial Revolution. Nowadays, people expect more than vehicle quality and reliability. With the rapid development of information and communication technologies (ICT), equipping automobiles with wireless communication capabilities is expected to be the next frontier for automotive revolution.

A connected Car is the one that is equipped with Internet access. This allows the care to share internet access with other devices both inside as well as outside the vehicle. Types of functions that can be made include music/ audio playing, Smartphone apps, navigation, roadside assistance, voice commands, contextual help/offers, parking apps etc. Connected vehicles on the go are proactive, cooperative, well informed, and coordinated, and will pave the way for supporting various applications for road safety (e.g., collision detection, lane change warning, and cooperative merging). Connected vehicles refer to the wireless connectivity-enabled vehicles that can communicate with their internal and external environments, i.e., supporting the interactions of vehicle-to sensor on-board (V2S), vehicle-to-vehicle (V2V), vehicle-to road infrastructure (V2R), and vehicle-to-Internet (V2I), as shown in Fig. 1. These interactions, establishing a multiple levels of data pipeline to in-vehicle information systems, enhance the situational awareness of vehicles and provide motorist/passengers with an information-rich travel environment. Further, connected vehicles are considered as the building blocks of the emerging Internet of Vehicles (IoV), a dynamic mobile communication system that features gathering, sharing, processing, computing, and secure release of information and enables the evolution to next generation intelligent transportation systems (ITSs) [3].

In this Paper we focus on the various wireless connectivity and present various industrial and academic advances for establishing Vehicle to X (V2X) connectivity.

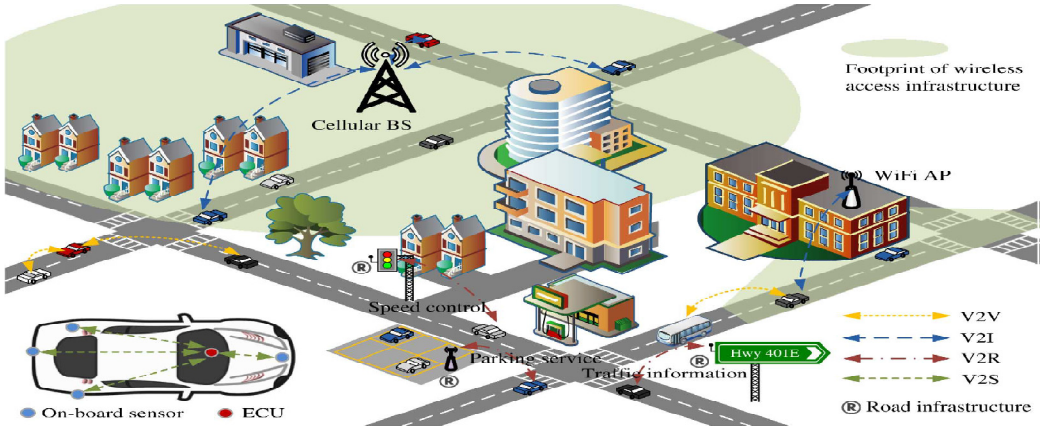

Fig. 1.

II. VEHICLE TO VEHICLE COMMUNICATION

The vehicles on road can have connectivity in two ways: Intra vehicle connectivity and Inter vehicle connectivity.

The Intra Vehicle communication is the connectivity within the vehicle wherein both type ie wired and wireless connectivity can be establish. On the other hand, the inter vehicle communication is the communication between the vehicle and environment. This communication can be only wireless.

A. Intra Vehicle Communication

With increasing intelligence, modern vehicles are equipped with more and more sensors, such as sensors for detecting road conditions and driver's fatigue, sensors for monitoring tyre pressure and water temperature in the cooling system, and advanced sensors for autonomous control. To do so, an intra-vehicle communication network is used. Wired solutions such as controller area network (CAN) protocol, FlexRay, and TTEthernet, require cable connections between ECU and sensors. Cables and other acessories nowadays can add significant weight (up to 50 kg) to the vehicle mass .

Recent advances in wireless sensor communication and networking technologies have paved the way for an intriguing alternative, where ECU and sensors are composed of an intra-vehicle wireless sensor network, leading to a significant reduction of deployment cost and complexity. There exist multiple candidate wireless technologies to build intra-vehicle wireless sensor networks, and the feasibility of different wireless options to in-vehicle environments has been a research focus.

B. Inter Vehicle Communication

It is widely believed that the advances of inter-vehicle communications will reshape the future of road transportation

systems, where inter-connected vehicles are no longer information isolated islands. By means of inter-vehicle communications or V2V communications, information generated by the vehicle borne computer, control system, on-board sensors, or passengers can be effectively disseminated among vehicles in proximity, or to vehicles multiple hops away in a vehicular ad hoc network (VANET). Without the assistance of any built infrastructure, a variety of active road safety applications (e.g., collision detection, lane changing warning, and cooperative merging) and infotainment applications (e.g., interactive gaming, and file and other valuable information sharing) are enabled by inter-vehicle wireless links.

The academia, industry, and government institutions have initiated numerous activities in the area of VANETs. Within the scope of this paper, we only review the options of wireless technology for enabling inter-vehicle communications.

DSRC/WAVE. Dedicated short-range communications (DSRC) is a key enabling wireless technology for both V2V and V2R communications. The U.S. Federal Communications Commission (FCC) has allocated 75 MHz bandwidth at 5.9 GHz spectrum band for DSRC. The dedicated bandwidth is further divided into seven channels to support safety and non safety services simultaneously. The specifications of DSRC are in the IEEE Standard for Wireless Access in Vehicular Environments (WAVE).

In spite of the DSRC spectrum, V2Vcommunications still face the problem of spectrum scarcity due to the following reasons:

1) the ever-increasing infotainment applications, such as high quality video streaming, require a large amount of spectrum resource, and thereby the QoS is difficult to satisfy merely by the dedicated bandwidth and

2) in urban environments, the spectrum scarcity is more severe due to high vehicle density, especially in some places where the vehicle density is much higher than normal . Due to recent advances in cognitive radio, dynamic spectrum access (DSA) is becoming a possible complementary technology for DSRC.

III. VEHICLE TO INFRASTRUCTURE COMMUNICATION

The Vehicle to Infrastructure interaction, similarly to V2V, is based on wireless communication technologies. The V2I communication is also an extensively researched topic in the United States. V2I is the wireless exchange of critical safety and operational data between vehicles and highway infrastructure, intended primarily to avoid or mitigate motor vehicle accidents but also to enable a wide range of other safety, mobility, and environmental benefits. V2I communications apply to all vehicle types and all roads, and transform infrastructure equipment into "smart infrastructure". They incorporate algorithms that use data exchanged between vehicles and infrastructure elements to perform calculations that recognize high-risk situations in advance, resulting in driver alerts and warnings through specific actions.

Internet connectivity is becoming a must-have feature of modern vehicles. The industry has responded promptly using off-the-shelf technologies, aiming to build a huge mass market of Internet-connected cars, whereas the academia focuses on the development of optimal solutions to enable connections between vehicles and the Internet. Wireless access technologies play a vital role in delivering the Internet services to vehicle users. Cellular and WiFi are two promising candidates. The cellular networks, such as 3G and 4G-LTE, can provide reliable and ubiquitous access services.

IV. VEHICLE TO ROAD COMMUNICATION

V2R connectivity is critical to avoid or mitigate the effects of road accidents, and to enable the efficient management of ITSs. DSRC/WAVE is considered a key technology to enable connections between vehicles and ITSs infrastructure, such as traffic lights, street signs, and roadside sensors. Moreover, roadside infrastructures can also be commercial content providers, such as the roadside unit (RSU) broadcasting flyers of superstores. RSU does not necessarily serve as Internet gateway as wireless infrastructures in V2I communications. Visible light communication (VLC), transmitting data by using light-emitting diodes (LEDs), has also been proposed for road-to-vehicle ITSs applications, such as traffic light control at intersections. As a key technology specified in the IEEE 802.15.7 standard, VLC can support a data rate up to 96 Mb/s through fast modulation of LED light sources.

V. CONCLUSION

In this paper, we have presented an overview of the wireless solutions to vehicle-to-sensor, vehicle-to vehicle, vehicle-to-Internet, and vehicle-to-road infrastructure connectivities. The biggest challenge for efficient and robust wireless connections is to combat the harsh communication environment inside and/or outside the vehicle. In addition, the significant research and development efforts are required to deal with the following issues.

1)To enable various wireless connectivity, multiple radio interfaces have to be implemented, such as DSRC/WAVE, WiFi, and 3G/4G-LTE interfaces, which may incur a high cost

2) In-vehicle systems have stringent requirement on latency and reliability for control/monitoring purposes. The full

adoption of V2S connectivity may not be feasible in the near future unless V2S connectivity can provide the same performance and reliability as the wired communication

3) Connected vehicle offers the driver a variety of information. However, there is an up limit on information provided to the driver. Excessive information increases the driver's workload and hence has a negative impact on safety. Therefore, the vehicle information system has to be appropriately designed for offering information to drivers.

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