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Evaluation of Various Forms of DSRC System- A Review

M. Abinaya [*], T. Suganya Thevi
Dept of ECE, PSNA College of Engineering and Technology, Dindigul, India.

Abstract

Wireless communication is the fastest growing segment of communication industry. It has captured the attention of media and the imagination of public. There are many new applications emerging in the wireless communication including automated highways and factories, smart homes and appliances, remote telemedicine. So the growth of wireless systems coupled with the proliferation of laptop and palmtop computers as stand-alone systems and as part of the larger networking infrastructure. Vehicle safety wireless communications are emerging due to the occurrence of many accidents when distant objects or roadway impediments are not detected quickly. To avoid these accidents, long range safety systems are needed with real-time detection capability and without requiring a line-of-sight view by the driver or the sensor. Early detection of intersections is required for obstacle location around blind corners and dynamic awareness of approaching vehicles on intersecting roadways. So this article discusses the vehicle safety by the communications-based active safety systems research called Dedicated Short Range Communications (DSRC) used in various forms available in wireless vehicle safety systems.

Keywords: DSRC, Vehicle Safety, Wireless Communication system, Detection Capability**.**

Introduction

Communications-based active safety applications use vehicle to vehicle (V2V) and Vehicle to infrastructure (V2I) short-range wireless communications to detect potential hazards in a vehicle's path, even the driver cannot see. The connected vehicle provides enhanced awareness at potentially reduced cost and offers functionality over autonomous sensor systems available on some vehicles today. Communication based sensor systems could potentially be a low-cost means of enabling hazard detection capability on all vehicles, but requires vehicles and infrastructure to be outfitted with interoperable communications capabilities. Dedicated Short Range Communication is the communications media of choice for communications-based active safety systems research.

DSRC operates in a licensed frequency band. It is primarily allocated for vehicle safety applications. It provides a secure wireless interface required by active safety applications. It supports high speed, low latency and short-range wireless communications. It works in high vehicle speed mobility conditions. Its performance is immune to extreme weather conditions (e.g. rain, fog, snow, etc.). It is designed to be tolerant to multi-path transmissions typical with roadway environments. It supports both vehicle-to-vehicle and vehicle-to-infrastructure communications. This article discusses about the recent development in DSRC applications available in processing the vehicular wireless communications.

Methods in DSRC

Reddy J.B et al., (2000) said that DSRC application needs flexible and robust air interface technology to support high and low data rate services in mobile environments. So they analyze various DSRC applications for their data requirement and present typical DSRC channel scenarios with their parameters. They proposed a hybrid OFDM architecture which is a combination of single carrier and multicarrier communication systems for DSRC services. These single carrier devices communicate with in an OFDMA scheme in the uplink for more spectral efficiency reasons. Hyun Mee Choi et al., (2001) presented the requirements and structure of advanced DSRC system for supporting Mobile IP service on car. Advanced DSRC system has the features of frequent movement, small communication coverage and no soft-handoff. In advanced DSRC system, Foreign Agent (FA) clustering and service forwarding are chosen for supporting mobile IP service on car, this is according to the advanced DSRC system features. The reasons behind this are FA clustering is good in frequent, high-speed movement and service forwarding is appropriate in single communication islands. Service forwarding can be provided within a cluster and between clusters. For service forwarding agent discovery and registration are not required within a cluster.

Shimezawa K et al., (2002), to realize a seamless high speed road vehicle communication system, they proposed the code division multiplexing

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(CDM) radio transmission scheme by using cyclic shifted and extended (CSE) codes as spread codes. The number of codes generated from a code is limited to the length of the shift interval and the tolerable period of delayed waves also depends on the length. So they used a method to minimize the length of the shift interval and a cancellation technique with a simple calculation in order to eliminate the interference from delayed waves caused by the reduction of the length of shift interval based on CSE codes. Shanmugam S.K and Leung H (2004) proposed a novel non-coherent M-ary chaotic spread spectrum communication scheme for DSRC in intelligent transportation systems (ITS). They encode the M-ary information symbols on to the bifurcation parameter of a chaotic system. So a new chaotic communication scheme exploits the ergodic properties of chaotic signals for demodulating the received signal. Their scheme is basically non-coherent which eliminates complex synchronization procedure. This scheme also utilizes a low complexity multipath mitigation technique to combat fading.

Sawaya T et al., (2005) developed a consecutive radio zone DSRC system with in-vehicle antenna using a new angle diversity technique to provide high speed wireless link. In the consecutive radio zones, the same radio signals with the same frequency are distributed by radio on fiber technology. To mitigate the interference of coherent waves in adjacent areas, they designed a new in-vehicle antenna based on the reactance diversity scheme. This reactance diversity antenna works as a diversity antenna in a stand-alone form, and is able to improve anti-fading performance without having to change the existing DSRC receiver design. Fan Yu et al., (2007) presented a novel Medium Access Control protocol for inter-vehicular wireless networking using the emerging Dedicated Short Range Communication standards. The main contribution is the design of a self-configuring TDMA protocol capable of inter-vehicle message delivery with short and deterministic delay bounds. So they proposed Vehicular Self-Organizing MAC (VeSOMAC) designed to be vehicle location and movement aware so that the MAC slots in a vehicle platoon can be time ordered for minimizing the multi-hop delivery delay based on the vehicles' relative locations. A novel feature of VeSOMAC is in-band control mechanism for exchanging TDMA slot information during distributed MAC scheduling.

Tsuboi et al., (2009) introduced their first concept for DSRC cell design combining of mobile communication cell design. They explain about cellular structure for urban area for Universal Mobile Telecommunications System (UMTS) in terms of cell design of wireless communication. So they brought UMTS cell design concept theory to DSRC cell design architecture in order to find how much vehicle in a cell and how long to connect in a cell for connecting network in a cell. This cell design is important for non-safety application such as map-update, infotainment and other internet service capability. They described the study and analysis for DSRC cell design, especially for V2I non-safety application. Later Tsuboi et al., (2010) said about practical wireless communication system guide line especially for automotive network applications among potential wireless communication systems including existing network technology such as 3G or UMTS including next broadband access WiMAX. They also provided more practical method for wireless communication architecture design.

Ying Qing Xia and Jia Lou (2010) focused on the surface wave on antennas that has great effects on its performance in Dedicated Short Range Communication system. A slot coupled right-hand circularly polarized (RHCP) patch antenna on which the coupling slots optimized to not only remarkably reduce the surface wave but also reduce the radiation on back. Jaber N et al., (2011) proposed a quantitative model to evaluate the quality of service (QoS) of DSRC systems using three leading repetition-based protocols under hidden terminals and highway scenarios. Thus the performance model is analyzed by means of probability of success and delay performances.

Chih Neng Liang and Bo Chiuan Chen (2012) built on three DSRC WAVE Boxes and one PC because of deployment in maintaining high performance under heavy channel load. Two devices located in roadside and one located in vehicle side. The communication protocol of the DSRC device is set to converter mode. They installed three WAVE Boxes and PCs in ARTC's test-bed and set a WAVE Boxes to be a jammer. The jammer can simulate many cars to interfere the communication. Kamal F et al., (2012) outlined the development of an 802.11p DSRC communication system with adjustable transmission power. The key components of the system were a Linux-powered embedded system and a 5.9 GHz mini-PCI RF transceiver. The software driver controlling RF transceiver had been developed to facilitate the communication in DSRC frequency ranges from 5.85 GHz to 5.92 GHz. A spectrum analyzer was used to validate the central operating frequency of 5.9 GHz and also an indoor test confirmed communication between two units at a distance of 15 m.

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Franciscatto B.R et al., (2012) proposed an integrated Micro strip-fed quasi-Yagi antenna array for a different DSRC system. Here they proposed based on the European DSRC standards so the identification is performed by a reader connected via buried coaxial cable to an antenna located under the lane structure. Juinn Horng Deng et al., (2013) proposed the joint detection and verification of frequency shift keying (FSK) modulation and demodulation (MODEM), Manchester coding and decoding (CODEC) schemes are for dedicated short range communication (DSRC) systems over high mobility fading channels. They said that joint coded-FSK detection scheme with low complexity benefit can outperform the conventional separated coded-FSK detection scheme due to the joint scheme with time diversity gain to enhance the detection performance.

Yu-Hsuan Lee and Cheng-Wei Pan(2014)., here they proposed that DSRC standards generally adopt FM0 and Manchester codes to reach dc-balance, enhancing the signal reliability, so the coding-diversity between the FM0 and Manchester codes seriously limits the potential to design a fully reused VLSI architecture for both. So they used the similarity-oriented logic simplification (SOLS) technique to overcome this limitation. Hung Wen Lin et al.,(2014) proposed a low-area digitalized band-pass filter (BPF) for the DSRC Receiver. The resonance of active inductor and MOS varactor are utilized to generate band-pass filtering characteristics. To apply for different pass band, both the inductance of the inductor and the capacitance of the varctor are designed to be adjusted via digital controls. Band selectivity is raised by cascading stages of BPF cell.

Wenfeng Li et al., (2014) derived application-level reliability metrics of various safety applications with worst-case settings and vehicular environments based on an accurate analytical model in one dimension vehicular communication networks. The reliability related QoS metrics in both the MAC-level and the Application-level including packet reception ratio, T-window reliability, and awareness probability are derived. Inspired by the correlation between road traffic and vehicle speed revealed by Green shields model, they observed that the current reliability related QoS requirements for safety applications are set without considering changes of road traffic. Based on their observation, a new reliability requirement setting is tuning tolerance time for various safety applications with different road traffic. Taking velocity, density and time into account, application-level reliability metrics are improved for high vehicle density. Paikari E et al., (2014) utilizes PARAMICS traffic micro-simulation software to study the impact of deploying Connected Vehicles (CV) in Deerfoot trail, Calgary, Alberta. They have implemented a V2V Assisted V2I system for PARAMICS. It uses Dedicated Short Range Communication protocol to acquire traffic data, calculate and compare important traffic safety and mobility parameters and their impacts on CV by testing five scenarios differentiated by the percentage of 0% to 40% market penetration of CVs. They demonstrated the effect of considering DSRC, re-routing guidance and advisory speed for upstream and downstream traffic and demonstrated that the CV technology can enhance traffic safety and mobility in freeways, if the percentage of CVs is significant and the CV technology is accompanied by advisory speed reflected on Variable Message Signs (VMS) on both upstream and downstream of the incident location using DSRC range.

Xuehai Xiang et al., (2014) proposed to address the high rates of false alarms and missing alarms in emergency warnings system by establishing a robust rear-end collision warning model without using expensive high-end devices. Their simulations have shown that high rates of missing alarms occur in the vehicle kinematics (VK) model, as well as false alarms in the VK model with maximum compensation (VK-MC). Pertaining to these rates, a novel model based on the neural network (NN) approach is implemented by them. Serageldin A and Krings (2014), addressed reliability issues of safety applications in Intelligent Transportation Systems (ITS) that use Dedicated Short Range Communication in Wireless Access in Vehicular Environments (WAVE) systems. Reliability of such applications is affected not only by the usual environmental effects of wireless communication, but also potentially by malicious act. The case of constant and random jamming and their impact on safety applications are investigated under consideration of the data rates used. So the most important message, the Basic Safety Message (BSM), which is transmitted on a dedicated safety channel that can be jammed, resulting in safety application failure. To mitigate against jamming a communication scheme based on redundant channel is used that utilizes channels with higher power ratings for communicating data with BSM-equivalent content, while not deviating from existing standards. The impact of channel and message redundancy for different data rates is investigated. They demonstrated that application reliability increases inverse to the data rates of the channels.

Analysis of reviewed DSRC system

Reddy J.B et al., (2000) concluded that single carrier devices communicate in an OFDMA scheme in the uplink for more spectral efficiency reasons and simulation results shows it is feasible to operate hybrid OFDM for a variety of DSRC applications. Hyun Mee Choi et al., (2001) reported that agent discovery and registration are required for service forwarding between clusters. So service forwarding between clusters will provide better Mobile Office, but increasse the implementation complexity. Shimezawa K et al., (2002) reported that the maximum transmission rate of CSE based CDM transmission per one-code using the newly transmission scheme is 3 times as large as that using the conventional CSE codes and DQPSK-CDM transmission scheme. Shanmugam S.K and Leung H (2004) concluded that their Performance analysis shows the superior communication performance of the chaotic spread spectrum scheme over conventional spread spectrum schemes in rapid multipath fading environments. So they developed the scheme is attractive in terms of communication performance, multipath mitigation, and system complexity. Sawaya T et al.,(2005) demonstrated that consecutive radio zones can successfully extend the service area while maintaining the quality of π/4 shift QPSK modulated communication defined by the Japanese DSRC standard. So they showed that the convenience of a DSRC system can be further enhanced in a reasonable manner enabling Internet ITS to become more realistic.

Fan Yu et al., (2007) said about the in-band control mechanism is also used for fast protocol convergence during initial network setup and topology changes due to vehicle movements. So a simulation model has been developed for comparing VeSOMAC's performance with that of DSRC-recommended 802.11 MAC protocol for highway traffic safety applications. Tsuboi et al.,(2009) decided that DRSC cell design concept with combining UMST cell design method such as Erlang formula for DSRC cell architecture. So it guides practical DSRC condition of a cell with some real measurement wireless communication range of DSRC field test. This is one of good guidance for V2I DSRC cell design condition in future. Tsuboi et al., (2010) expanded potential wireless communication technologies from DRSC to 3G and WiMAX and also provide practical vehicle wireless communication systems for next new DSRC applications. Ying Qing Xia and Jia Lou (2010) concluded the coupling slots optimized to not only remarkably reduce the surface wave and also reduce the radiation on back. The simulated and measured return losses showed that their antenna has the bandwidth of about 2GHz. Jaber N et al., (2011) showed the performance study that the repetition-based protocols do not meet the DSRC critical safety reliability requirements when tested under higher transmission loads with hidden terminals taken into account. Under lower transmission loads, these protocols only meet the reliability requirements at relatively low vehicle densities. So their quantitative model and performance results presented in their study also serve as a benchmark for improvement of DSRC systems performance.

Chih Neng Liang and Bo Chiuan Chen (2012) reported the need to consider for the design of the DSRC radio test under heavy channel load, providing the designers for reference in the future not only to solve problems but also help to setup a test-bed for testing DSRC radio under heavy channel load. Kamal F et al., (2012) concluded that in a vehicle-to-vehicle test, packet loss of less than 1% was demonstrated when two vehicles traveled together at 60 km/h at a distance of approximately 150 m. In the vehicle-to-infrastructure test, an average distance of 405 m was measured. Franciscatto B.R et al., (2012) concluded that the antenna had been simulated using CST Microwave Studio software. Then antenna was fabricated on Rogers RO4003 substrate. So this antenna profile provides at 5.8 GHz that is a measured return-loss of -16 dB and a high simulated gain of 16.75 Db. Juinn Horng Deng et al., (2013) here the joint algorithms with floating-point and fixed-point designs are verified in the software-defined-ratio (SDR) platform. Based on the measurement results via SDR equipment, they confirmed that the implementation of VHDL hardware circuit design of the joint detection scheme can provide robust performance over high mobility Rician multipath fading channel environment. Yu-Hsuan Lee and Cheng-Wei Pan (2014) concluded that the SOLS technique improves the hardware utilization rate from 57.14% to 100% for both FM0 and Manchester encodings for DSRC system. And they found that the maximum operation frequency is 2 GHz for Manchester and 900 MHz for FM0 encodings. They also found that the power consumption is 1.58 mW at 2 GHz for Manchester encoding and 1.14 mW at 900 MHz for FM0 encoding. This encoding capability can fully support the DSRC standards of America, Europe, and Japan.

Hung Wen Lin et al., (2014) concluded that the center frequency is ranged from 27MHz to 41MHz with an average frequency resolution of 0.11MHz and the adjacent channel suppression is -16dB@ 40±2.5MHz. The input third-order intercept point is 6dbm. Wenfeng Li et al., (2014) obtained results under worst case with different vehicle density and observe the feasibility of reliability requirement setting. Paikari E et al., (2014) equipping freeways with VMS, to use V2I communication, complements the CV technology, improves CV efficiency and leads to higher safety and mobility enhancement in freeways. Xuehai Xiang et al., (2014) by training and validation, the NN models are able to provide emergency warnings with an improved performance of false alarm probability under 20% and the missing alarm probability under 10% for all test cases. Serageldin A and Krings A (2014), their analysis showed that DSRC safety applications that use redundant communication can overcome jamming attacks if data rates of 3Mbps and 6Mbps are used, while 12Mbps communication is not advisable.

Conclusion

This article dealt with active Dedicated Short Range Communications (DSRC) application for Intelligent Transport Systems (ITS) and its economic evaluation focused on many wireless systems like vehicle communication, mobile Communication etc. Thus DSRC have the possibility to transform automotive safety, enabling widespread deployment of effective Active Safety features. The primary challenge is to develop scalable, robust, low-latency and high-throughput technologies for safety applications that will significantly reduce collisions and save lives and property loss. So DSRC was developed with a primary goal of enabling vehicular safety applications. DSRC is the only short-range wireless alternative today that provides Fast Network Acquisition, Low Latency, High Reliability when Required, Priority for Safety Applications, Interoperability, Security and Privacy which is one of the challenging task faced by all in the worldwide.

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	**M.Abinaya** PG Student, pursuing Master Degree in VLSI Design, PSNA College of Engineering and Technology, Dindigul, had obtained her Bachelor's degree with first class in Electronics and Communication Engineering from Anna University, Chennai in the year 2013. Her areas of interest include VLSI Design, Embedded Systems and Digital Design. Email_id: abinayame23@gmail.com
	**T. Suganya Thevi** Assistant Professor, Dept of Electronics and Communication Engineering, PSNA College of Engineering and Technology, Dindigul, India had obtained her Bachelor's degree with distinction in Electronics and Communication Engineering from Anna University, Chennai in the year 2006. She had completed her Master's degree in Applied Ecletronics from Anna University, Trichy in 2010. She has a teaching experience of about five years. She also has an industrial experience of 2 years. Her areas of interest include Image processing, Networking and VLSI.