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RESEARCH STUDY ON INTER-VEHICLE COMMUNICATION IMPLEMENTATION IN MALAYSIA

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RESEARCH STUDY ON INTER-VEHICLE COMMUNICATION IMPLEMENTATION IN MALAYSIA

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Report submitted in fulfilment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering with Automotive Engineering

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BORANG PENGESAHAN STATUS TESIS♦

JUDUL: **CHARACTERISTIC OF PALM OIL METHYL ESTER AS ALTERNATIVE FUEL**

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Saya **MOHD FAKHRUL ANWAR B ALIAS (881108035129)**

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ABSTRACT

Vehicle-to-Vehicle (V2V) communications systems have recently drawn great attention, because they have the potential to improve convenience and safety of car traffic. Road accidents take the life of many people in the world each year, and much more people have been injuring and maiming. Statistical studies show that accidents could be avoid by 60% if drivers were informed only half a second before the accident. The objective of this report is to make an analysis of the possibility of implementing this technology in Malaysia. This research study is as guidance to develop a concept of V2V system. Applications with early deadlines are expected to require direct V2V communications, and the only standard currently supporting this is the IEEE 802.11p, included in the wireless access in vehicular environment (WAVE). The combination of WAVE and GPS is a good idea to forming collision avoidance system. The GPS system determines the location of vehicles and the WAVE system forming an ad- hoc peer-to-peer networking among the vehicles.V2V communication enable vehicle to communicate with their neighbouring vehicles even in the absence of a central base station to provide a safer and more efficient roads and to increase passenger safety. This technology can be implements in Malaysia but in order to do it some changing had to be made first to ensure the effectiveness of the technology. V2V communication should have a Doppler sensor as a device sensor that can integrates with cruise control to form adaptive cruise control. Other than that, it also need WAVE to assure a reliable communication system between vehicles. The GPS system is needs to determine exact location of car that can be use in roadways environment such as overtaking situation.

ABSTRAK

Sistem komunikasi antara kenderaan (V2V) baru-baru ini telah menarik perhatian besar, kerana sistem ini mempunyai potensi untuk meningkatkan keselesaan dan keselamatan lalu lintas. Kemalangan jalan raya meragut banyak nyawa di seluruh dunia setiap tahun, dan ramai lagi yang telah cedera akibat kemalangan jalan raya. Statistik kajian menunjukkan bahawa sebanyak 60% kemalangan boleh dielakkan jika pemandu di beri amaran hanya setengah saat sebelum kemalangan berlaku. Tujuan laporan ini dibuat adalah untuk melakukan analisis tehadap kemungkinan mengimplimantasikan teknologi ini di Malaysia. Penelitian ini adalah sebagai bimbingan untuk membangunkan sistem V2V di malaysia. Aplikasi dengan waktu tamat awal memerlukan komunikasi langsung V2V, dan satu-satunya komunikasi pada saat ini menyokongnya adalah IEEE 802.11p,yang termasuk dalam akses tanpa wayar dalam persekitaran kenderaan (WAVE). Kombinasi WAVE dan GPS adalah idea yang baik untuk membentuk sistem mengelakkan pelanggaran. Sistem GPS menentukan lokasi kenderaan dan sistem WAVE membentuk sebuah rangkaian peer-to-peer ad-hoc antara kenderaan. Komunikasi V2V membolehkan kenderaan berkomunikasi dengan kenderaan jiran mereka tanpa perlu adanya stesen pangkalan pusat untuk memberikan kondisi jalan yang lebih selamat dan lebih efektif untuk meningkatkan keselamatan pemandu.Teknologi ini dapat aplikasikan di Malaysia tetapi untuk melakukannya beberapa pengubahan harus dibuat untuk memastikan keberkesanan teknologi. Komunikasi V2V mesti mempunyai sensor *Doppler* sebagai sensor peranti yang boleh berintegrasi dengan cruise control untuk membentuk *adaptive cruise control.* Selain itu WAVE juga diperlukan untuk memastikan sistem komunikasi yang selamat antara kenderaan. Sistem GPS adalah diperlukan untuk menentukan lokasi yang tepat daripada kereta

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LIST OF ABBREVIATIONS

ABS	Antilock Braking System
ACK	Acknowledgment
AIFS	Arbitration Interframe Space
BSS	Basic Service Set
BSSID	Basic Service Set Identification
CSMA/CA	Carrier Sense Multiple Access With Collision Avoidance
DCF	Distributed Coordination Function
DSP	Digital Signal Processing
DSRC	Dedicated Short Range Communication
EDCA	Enhanced Distributed Channel Access
FCC	Federal Communication Commission
FFT	Fast Fourier Transforms
FOKUS	Fraunhofer Institut für offene Kommunikationssysteme
GPS	Global Positioning System
In-V	Intra-Vehicle
IVC	Inter-Vehicle Communications
JARI	Japan Automobile Research Institute
MAC	Media Access Control
OBE	On-Board Equipment
OBU	On-Board Unit
OFDM	Orthogonal Frequency-Division Multiplexing
PHY	Physical Layer
STDMA	Self-Organizing Tdma
TELCO	Telecommunication Network for Cooperative Driving
UWB	Ultra-Wideband
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VII	Vehicle Infrastructure Integration
WAVE	Wireless Access for Vehicular Environments
WLAN	Wireless Local Area Network

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Inter-Vehicle Communications (IVC) systems have recently drawn great attention, because they have the potential to improve convenience and safety of car traffic. IVC represents communication between vehicle or vehicle and sensors placed in or on various locations, such as roadways, signs parking areas, and even the home garage. For example, sensor-equipped cars that communicate via wireless links and thus build up ad-hoc networks can be used to reduce traffic accidents and facilitate traffic flow. Emerging vehicular in the terms of Intra-Vehicle (In-V), Vehicle-to-Vehicle (V2V), and, Vehicle-to-Infrastructure (V2I) communications are fast becoming a reality and will enable a variety of services for safety, traffic efficiency, driver assistance, as well as infotainment to incorporate into modern automobile designs. IVC can be considered to be more technically challenging because vehicle communications need to be supported both when vehicle are stationary and when they are moving. This research will be focus on V2V communication.

Vehicle-to-Vehicle (V2V) communication can promote more safety. Exchange of information regarding vehicle dynamics and road condition among vehicles could play a crucial role in driver and passenger safety. A driver, provided with information about road conditions and velocities of the vehicles around it, is able to make better decisions concerning vehicle control and travel path. When vehicles communicate their real-time velocity values, a driver can avoid accidents by adjusting her velocity according to neighbouring vehicle velocities

1.2 PROBLEM STATEMENT

Road accidents take the life of many people in the world each year, and much more people have been injuring and maiming. Statistical studies show that accidents could be avoid by 60% if drivers were informed only half a second before the accident (C. D. Wang and J. P. Thompson, 1997). The main reason of these accidents is a limitation in view of roadway emergency events that can be due to the distances, darkness, and existence of an inhibiter in the road. In addition, a delay of the vehicle's driver to react against the events on the roadway could make irreparable results. Road and traffic safety can be improved is drivers have the ability to see further down the road and know if a collision has occurred. This can become possible if the drivers and vehicles communicate with each other. If traffic information was provided to drivers, police and other authorities, the road would be safer and travelling on them would become more efficient. It is possible to build a multi-hop network among several vehicles that have communication devices. These vehicles would form a mobile ad-hoc network and could pass along information about road conditions, accidents and congestion.

The graph below shows the number of crashes and number of fatal crashes than happen from 1979-2009.

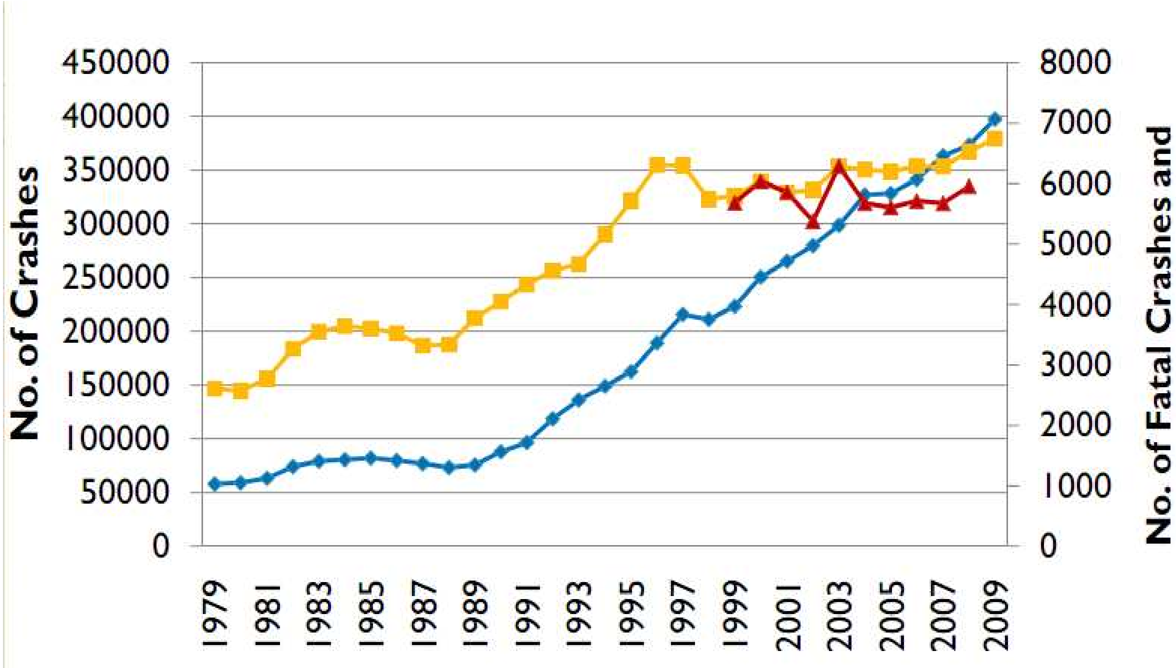


Figure 1.1: Graph for number of crashes and number of fatal crashes over the year.

Sources: (MOHAMED, 26 MARCH 2010)

The graph clearly shows that the no of crashes is increasing by a year. The numbers of fatal crashes also increase with the increasing number of crash. When the number of crashes is higher, the possibility for fatal crashes to occur will be higher. This problem will be continue to increase because the increasing the number of vehicle on the road.

The bar chart below show that the collision type that occur and the numbers of non-fatal and fatal crash resulting from the collision.

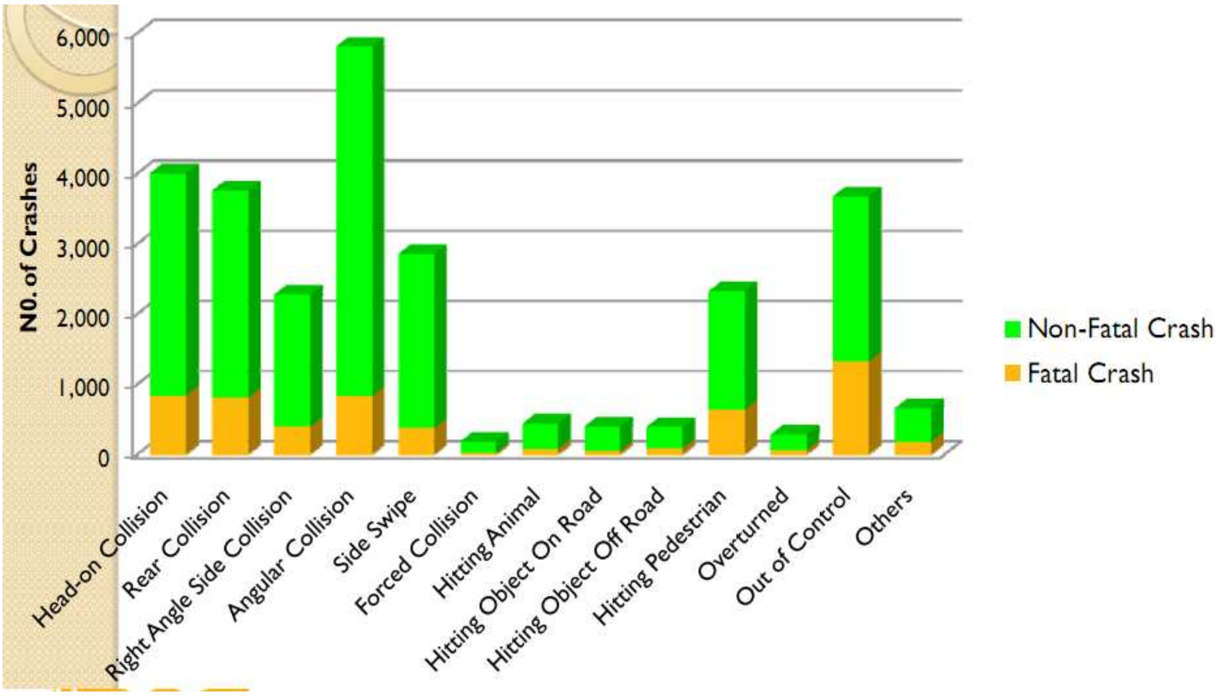


Figure 1.2: Bar chart for the number of crashes versus type of collision.

Sources: (MOHAMED, 26 MARCH 2010)

Refers to the bar chart, some of the crashes can be avoid or prevent by using IVC communications. With this technology, vehicle can communicate with each other and could send along information regarding vehicle velocity and road condition among vehicles. When vehicles communicate their real-time velocity values, a driver can avoid accidents by adjusting his velocity according to neighbouring vehicle velocities. These all problem regarding the accidents can be solved by using IVC.

1.3 PROJECT OBJECTIVES

The objective of this project is to research and propose a concept of inter vehicle communication (IVC) that suitable to be implemented in Malaysia.

1.4 PROJECT SCOPES

The scopes of this project are to investigate and propose recommendations on possibility IVC concepts in Malaysia. The research will focused on the possible communications system and protocol that can used between vehicles.

CHAPTER 2

VEHICLE-TO-VEHICLE COMMUNICATION SYSTEM

2.1 INTRODUCTION

This chapter explains in detail Vehicle-To-Vehicle (V2V**)** found in literature. The main purpose of this research study is as guidance to develop a concept system and to evolve current system. V2Vcommunications are going to create new services by transmitting packets from vehicle to vehicle without the use of any deployed infrastructures. These services will enable the vehicle to transmit necessary data such as the current location, the motion's direction, and the speed directly to other vehicle. It is possible to build a multihop network among several vehicles that have communication devices. These vehicles would form a mobile ad hoc network, and could pass along information about road conditions, accidents, and congestion. A driver could be made aware of the emergency braking of a preceding vehicle or the presence of an obstacle in the roadway. It can also help vehicles negotiate critical points like blind crossings at the intersections without traffic lights or entries to highways.

2.2 HISTORY OF V2V

Nowadays we are on the verge of witnessing a revolution in automotive technology. V2V has attracted research attention from both academia and industry in the US, EU, and Japan. V2V communications systems have the potential to improve convenience and safety of car traffic. For example, sensor equipped cars that communicate via wireless links and build up ad-hoc networks can be used to reduce traffic accidents. One of the earliest studies on V2V communication started by JSK (Association of Electronic Technology for Automobile Traffic and Driving) of Japan in early 1980s. In 1999, the U.S Federal Communication Commission (FCC) allocated 75 MHz of spectrum at 5.9GHz used exclusively for vehicle-to-vehicle and infrastructure-to-vehicle communication in the U.S called Dedicated Short Range Communication (DSRC). Later, California PATH and Chauffeur of EU have demonstrated research results. The newly initiated European Project CarTALK 2000 covers problems related to safe and comfortable driving based on IVC. CarTALK 2000 also co-operates with other projects like German FleetNet for the development of IVC. The Vehicle Infrastructure Integration (VII), a major initiative at the United States Department of Transportation envisions that a future vehicle will be equipped with an On-Board Equipment (OBE), which consists of an On-Board Unit (OBU), which is essentially a transceiver, a GPS receiver, and a computer. On December 17, 2003, the FCC adopted licensing and service rules for DSRC and lower layer standards developed by the ASTM 5.9 GHz standards working group. An international standard, IEEE 802.11p, also known as Wireless Access for Vehicular Environments (WAVE), was recently publishs. Shown below table 2.1 are some of the consortiums that associated with V2V communications development. (Issam Khalil, January 2006)

Table2.1: Consortiums associated with V2V communications development.

Consortium	Participants	Mission
Vehicle Safety Communication Consortium (VSC) (Founded 05/2002)	DAIMLERCHRYSLER Ford GM NISSAN TOYOTA	• Facilitate the advancement of vehicle safety through communication technologies. • Identify and evaluate the safety benefits of vehicle safety applications enabled or enhanced by communications. • Assess associated communication requirements including vehicle-vehicle and vehicle-infrastructure communications. • Contribute to 5.9GHz DSRC standards and ensure they effectively support safety.
EUCAR SGA (Founded in 05/2002)	Ford OPEL DAIMLERCHRYSLER	• Coordination of European pre-competitve activities in the field of telematics • Develop Inter-vehicle hazard warning based on 900Mhz Funkwarner technology in Europe • Define basic message set for safety messages
Car2Car Communication Consortium (C2CC) (pending)	Audi DAIMLERCHRYSLER	• Specification of an industrial standard for an open inter-vehicle communication platform and for basic safety applications. • To achieve allocation of an European frequency band dedicated for active safety applications. • To include other OEMs and suppliers into the consortium.

Source: (Holfelder, 2004)

A number of research projects around the world have been focusing on inter-vehicle communication systems. This section will present some of the larger projects.

In Europe, projects such as DRIVE investigated IVC systems for a safer and environmentally friendly transportation. The European Automotive Industry launched the Program for European Traffic with Highest Efficiency and Unprecedented Safety (PROMETHEUS) in 1986; its main objective was to make driving in Europe safer, more economical, more environmentally acceptable, more comfortable, and more efficient. (Issam Khalil, January 2006)

The PATH project is collaboration between the California Department of Transportation (Caltrans), the University of California, other public and private academic institutions, and industry. Its main mission is to apply advanced technology to increase highway capacity and safety, and reduce traffic congestion, air pollution, and energy consumption. PATH has generated a number of publications and prototypes in the area of IVC systems primarily focused on cooperative driving and vehicle platooning. As part of the project, they developed SHIFT, a realistic traffic simulator that also integrates communication components, thus being especially suitable for the evaluation of IVC systems. As part of the PATH project, a successful experiment with eight vehicles in a platoon formation was demonstrated (Benouar, 2002).

Fleetnet was a project that set up by a German consortium of six companies and three universities that is Daimler-Chrysler AG, Fraunhofer Institut für offene Kommunikationssysteme [FOKUS], NEC Europe Ltd., Robert Bosch GmbH, Siemens AG, TEMIC Speech Dialog Systems GmbH, Universities of Hannover and Mannheim, and Technische Universität Hamburg-Harburg and Braunschweig. The project was funded between 2000 and 2003. The main objective of the Fleetnet project was to develop a platform for IVC systems. The project focused on three classes of applications: cooperative driving, traffic information, and comfort applications. Since 2004 until 2008, most of the members of the Fleetnet consortium are working on a new project named Network on Wheels. The main objectives of this project are to solve questions on the communication protocols and data security for targeted vehicular communications.

CarTalk 2000 (2001–2004) was funded by the European Union within the 5th Framework program. The partners in the project were Daimler-Chrysler AG, Centro Recherché Fiat, Robert Bosch GmbH, and Siemens, Netherlands Organization for Applied Scientific Research, the University of Cologne, and the University of Stuttgart. The main objectives of the project were the development of cooperative driver assistance systems and a self-organizing ad-hoc radio network as the basis for communication with the aim of preparing a future standard (Issam Khalil, January 2006).

The Japan Automobile Research Institute (JARI), formerly the Association of Electronic Technology for Automobile Traffic and Driving (JSK), has a number of projects studied V2V systems since the early 1980s. In the 1990s, the project focused on cooperative driving; now it has shifted toward the standardization of IVC systems. One of the projects demonstrated a prototype for traffic coordination (DEMO 2000). In Italy, the Telecommunication Network for Cooperative Driving (TELCO) project has investigated the feasibility of an IVC system working at millimetre waves between 60 and 64 GHz. They have also investigated IVC systems based on GPRS and 3G networks (Issam Khalil, January 2006).

2.3 EXISTING COMMUNICATION TECHNOLOGY FOR V2V SYSTEM

2.3.1 Bluetooth

Bluetooth is a wireless technology optimized for short-range communication with low power. A Bluetooth ad-hoc network, called a piconet, accommodates up to seven users. Piconets that have common users can form a scatter net. However, the common user can be active in one piconet at a time. In a piconet, an arbitrary user plays the role of the “master" and the other users act as “slaves". Initially, different users have different clock times but in a piconet the slave clocks are synchronized with the master clock. A slave can be in the active communication or standby mode. The master controls the medium access. It polls the slaves for communication and schedules the transmission of the active users based on traffic demands to and from the different slaves. In addition, it supports regular transmissions to keep slaves synchronized to the channel. It is reliable up to a speed of 80 km/h and range of 80 m. However, it can take up to 3 seconds to establish the communication. In addition, since Bluetooth requires a master and slave setup, the master could potentially refuse a communication request. In addition, the master may already be communicating with another slave, which would lower the possible communication rate (Bicke, 2006).

2.3.2 Ultra-Wideband (UWB)

An alternative to Bluetooth is a new radio frequency technique called UWB. UWB technology loosely defined as any wireless transmission scheme that occupies a bandwidth of more than 25% of a centre frequency, or more than 1.5GHz. UWB uses very short pulses, so that the spectrum of the emitted signals spread over several GHz, because of the wideband nature of the signal, UWB has been used in radar applications. The Federal Communication Commission (FCC) refers to UWB technology as having high values of fractional bandwidth .The main advantages of UWB technology are its high data rate, low cost, and immunity to interference. On the other hand, it could possibly interfere with other existing radio services, for instance, the Global Positioning System (GPS). Because of a lower bit error rate, the coded Gaussian pulses waveform is thought to be superior to monocycle pulses. The system is not believed to be too sensitive to multipath or jitter effects. The fact that UWB could potentially interfere with communication sources is a technical problem that must be solved before it could be used in V2V systems. Also, there is a concern that UWB's radio coverage could extend to uninvolved vehicles, which could generate false or irrelevant information (Bicke, 2006).

2.3.3 Dedicated Short Range Wireless Communications (DSRC)

DSRC is a multi-channel wireless standard that based on the IEEE 802.11a PHY and the IEEE 802.11 MAC. It is targeted to operate over a 75 MHz licensed spectrum in the 5.9 GHz band allocated by the FCC in 1999 for the support of low-latency V2V communications. Clearly, communications-based V2V safety systems should not operate in an unlicensed band either at 2.4 GHz or 5 GHz. The creation of hand-held and hands-free devices that occupy these bands, along with the projected increase in

Wi-Fi hot spots and wireless mesh extensions, could cause intolerable and uncontrollable levels of interference that could disable the reliability and effectiveness of low-latency vehicular safety applications. This, in turn, makes a strong case for investigating DSRC as a potential candidate for supporting low latency vehicular safety applications to reduce collisions and save lives on the road. Even with a licensed band, cooperative spectrum management must ensure reliable and fair access to all applications, including priority scheduling of traffic between different application classes as well as within a given class. Unlike 802.11, multi-channel coordination is a fundamental capability of DSRC. Although IEEE 802.11 PHY supports multiple channels, MAC operation over the multiple channels is left optional to individual vendors and is not supported by the standard. As pointed out earlier, DSRC is similar to IEEE 802.11a, except for the major differences operating frequency band, application environment, MAC layer and physical layer. Operating Frequency Band for DSRC is targeted to operate in a 75 MHz licensed spectrum around 5.9 GHz, as opposed to IEEE 802.11a which is allowed to utilize only the unlicensed portions in the 5 GHz band. Application Environment, DSRC is meant for outdoor high-speed vehicle up to 200 km/h applications, as opposed to IEEE 802.11a originally designed for indoor WLAN applications. Thus, all PHY parameters are optimized for the indoor low-mobility propagation environment. This brings new challenges for wireless channel propagation with respect to multi-path delay spread and Doppler effects caused by high mobility. DSRC MAC Layer, the DSRC band plan consists of seven channels which include one control channel to support high priority safety messages and six service channels to support non-safety applications. Prioritizing safety over non-safety applications is an open problem that started to receive attention in the literature and is closely related to the problem of multi-channel coordination. Aside from these differences, the DSRC MAC follows the original IEEE 802.11 MAC and its extensions, for example IEEE 802.11e QoS. The bandwidth of each DSRC channel is 10 MHz, as opposed to the 20 MHz IEEE 802.11a channel bandwidth. Clearly, this has direct impact on the maximum data rate DSRC can support (27 Mbps), as well as timing parameters and frequency parameters. A side from these and some differences in the transmit power limit, the DSRC PHY follows exactly the same frame structure, 64 sub-carrier OFDM-based modulation scheme, and training sequences specified by IEEE 802.11a PHY. Thus, the impact of the drastically different vehicular environment on the DSRC PHY performance needs thorough investigation (Soheila V. Bana, 2001).

2.3.4 Wireless Access for Vehicular Environments (WAVE)

The IEEE 802.11p workgroup is currently working on standardizing the wireless access for vehicular environment (WAVE). WAVE is the next generation dedicated short-range communications (DSRC) technology, which provides high-speed V2V data transmission and has major applications in intelligent transportation systems (ITS), vehicle safety services and Internet access. Operating at 5.850-5.925GHz, WAVE systems adopt orthogonal frequency-division multiplexing (OFDM) and achieve data rates of 6-27Mbs/s. WAVE technology is a revolution solution for vehicle safety enhancement by providing drivers with early warning, perceive and assistance. It is an extension of humans natural sensing and realizes telesensing of vehicles. WAVE systems will build upon the IEEE 802.11p standard. The IEEE802.11p standard is meant to describe the functions and services required by WAVE-conformant stations to operate in a rapidly varying environment and exchange messages without having to join a Basic Service Set (BSS), as in the traditional IEEE 802.11 use case. The BSS is a term used to describe the collection of stations which may communicate together within an 802.11 WLAN (Wireless Local Area Network).Vehicular safety communications use cases demand instantaneous data exchange capabilities and cannot afford scanning channels. Therefore, it is essential for IEEE 802.11p radios to be, by default in the same channel and configured with the same Basic Service Set Identification (BSSID) to enable safety communication. A station in WAVE mode is allowed transmitting and receiving data frames with the wildcard BSSID value and without the need to belong to a BSS of any kind. This means, two vehicles can immediately communicate with each other upon encounter without any additional overhead as long as they operate in the same channel using the wildcard BSSID. So when the crashed car transmits the emergency messages, the other vehicle that near the car will get the message immediately. Upon receiving the message, the driver can make an action by stay in caution. Then send the message to other cars in the ad hoc network environment (Weidong Xiang, 2008).

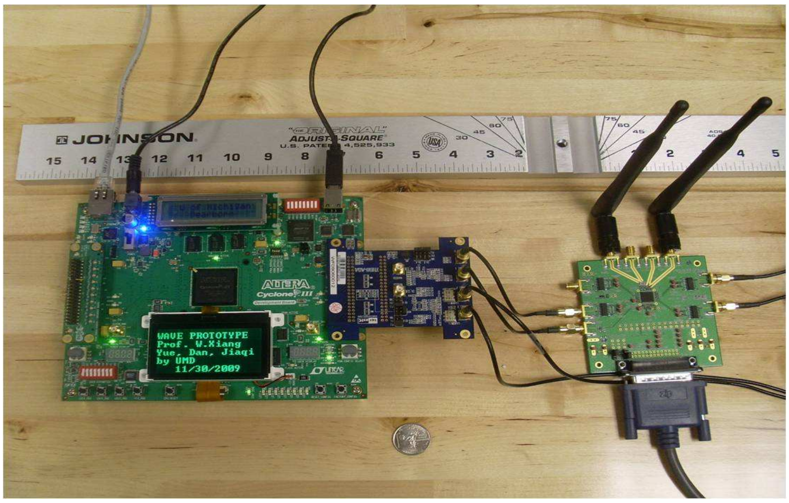


Figure 2.1: WAVE prototype

Sources: (WeidongXiang, december 2009)

Figure 2.2: Wi-Fi Aerial

Sources: (WeidongXiang, december 2009)

Using WAVE technology in exchanging data processes require real-time communication with high reliability, meaning that packets must be successfully delivered before a certain deadline. Examples of real-time deadlines within traffic safety applications are lane-change warnings, rear-end collision warnings, and conveying slippery road conditions, all of which include messages which must reach the intended recipients before the event takes place. A Voice over IP (VoIP) conversation over the Internet is an example of a real-time system that has data packets with deadlines since it is better to drop VoIP packets that are late than to introduce longer and longer delays. The antilock braking system (ABS) in a vehicle is another example of a real-time system; but contrary to the VoIP application, the requirement on error probability is significantly higher in this control application and also packets delivered shortly after the deadline could be used with diminishing returns. One of the most important parts real time communication systems is the MAC method. There are two MAC method, the 802.11p and STDMA MAC Methods (Katrin Bilstrup, 7 December 2008).

The Mac Method of 802.11p

WAVE contains an MAC and PHY layer derived from IEEE 802.11 , a new transport/network layer protocol (IEEE 1609.3), security issues specified in 1609.2, and an application protocol called 1609.1. The MAC method of the upcoming standard IEEE 802.11p is a CSMA/CA derived from the 802.11, and 802.11p will also use the quality-of-service (QoS) amendment 802.11e. The PHY layer of 802.11p is the 802.11a based on orthogonal frequency division multiplexing (OFDM), with some minor changes to fit the high-speed vehicular environment. The 802.11p together with the 1609.4 standard is designed for 10MHz wide channels instead of 20MHz as it is in the original 802.11a. Due to this, the transfer rates will be halved in 802.11p compared to 802.11a, implying transfer rates of 3, 4.5, 6, 9, 12, 18, 24, and 27 Mbps. The different transfer rates are obtained through changing modulation scheme and channel code rate. Another big difference in the 802.11p compared to the original 802.11 is that there is no difference between the nodes in the network, that is, all nodes are peers including the roadside units.

IEEE 802.11p will use enhanced distributed channel access (EDCA) from the QoS amendment IEEE 802.11e as MAC method, which is an enhanced version of the basic distributed coordination function (DCF) found in 802.11.The DCF is based on carrier sense multiple access with collision avoidance (CSMA/CA), meaning that the station starts by listening to the channel, and if it is free for a time period called an arbitration interframe space (AIFS), the sender can start transmitting directly. If the channel is busy or becomes occupied during the AIFS, the station must perform a backoff, that is, the node has to defer its access according to a randomized time period. In 802.11p, QoS is obtained by putting the data traffic within each node into four different priority queues. These queues have different AIFS and backoff parameters, that is, the higher priority, the shorter AIFS. The backoff procedure in 802.11 works as follows:

(i) Draw an integer from a uniform distribution [0,CW], where CW refers to the current contention window,
(ii) Multiply this integer with the slot time derived from the PHY layer in use, and set this as the backoff value,
(iii) Decrease the backoff value only when the channel is free,
(iv) Upon reaching a backoff value of 0, send immediately.

The MAC protocol of 802.11 is a stop-and-wait protocol and the sender will wait for an acknowledgment (ACK). If no ACK is received by the sender for some reason (that the transmitted packet never reached the recipient, the packet was incorrect at reception, or the ACK never reached the sender), a backoff procedure must also be invoked. For every attempt to send a specific packet, the size of the contention window, CW, will be doubled from its initial value (CWmin) until it reaches a maximum value (CWmax). This is done since during high utilization periods, it is convenient to distribute the nodes that want to send over a longer time period. After a successful transmission or when the packet had to be thrown away because the maximum number of channel access attempts was reached, the contention window will be set to its initial value again. Table 2.2 shows the default parameter settings for the different queues in 802.11p are founds together with the CW setting (Katrin Bilstrup, 7 December 2008).

Table 2.2: The default parameter settings for the different queues in 802.11p

	Queue no. 1	Queue no. 2	Queue no. 3	Queue no. 4
Priority	Highest	→		Lowest
AIFS	34 μs	34 μs	43 μs	79 μs
CW_{start}	3	7	15	15
CW_{end}	511	1023	1023	1023

Source: (Katrin Bilstrup, 7 December 2008)

In a broadcast situation, the receiving nodes will not send ACKs. Therefore, a sender never knows if anyone has received the transmitted packet correctly or not. Due to this, the sender will perform at most one backoff, which occurs when the initial channel access attempt senses a busy channel. Hence, broadcast packets will never experience multiple backoffs, and the contention window will always be CWmin. Figure 2.3 shows a flow diagram presents the CSMA procedure in the broadcast situation with periodic traffic.

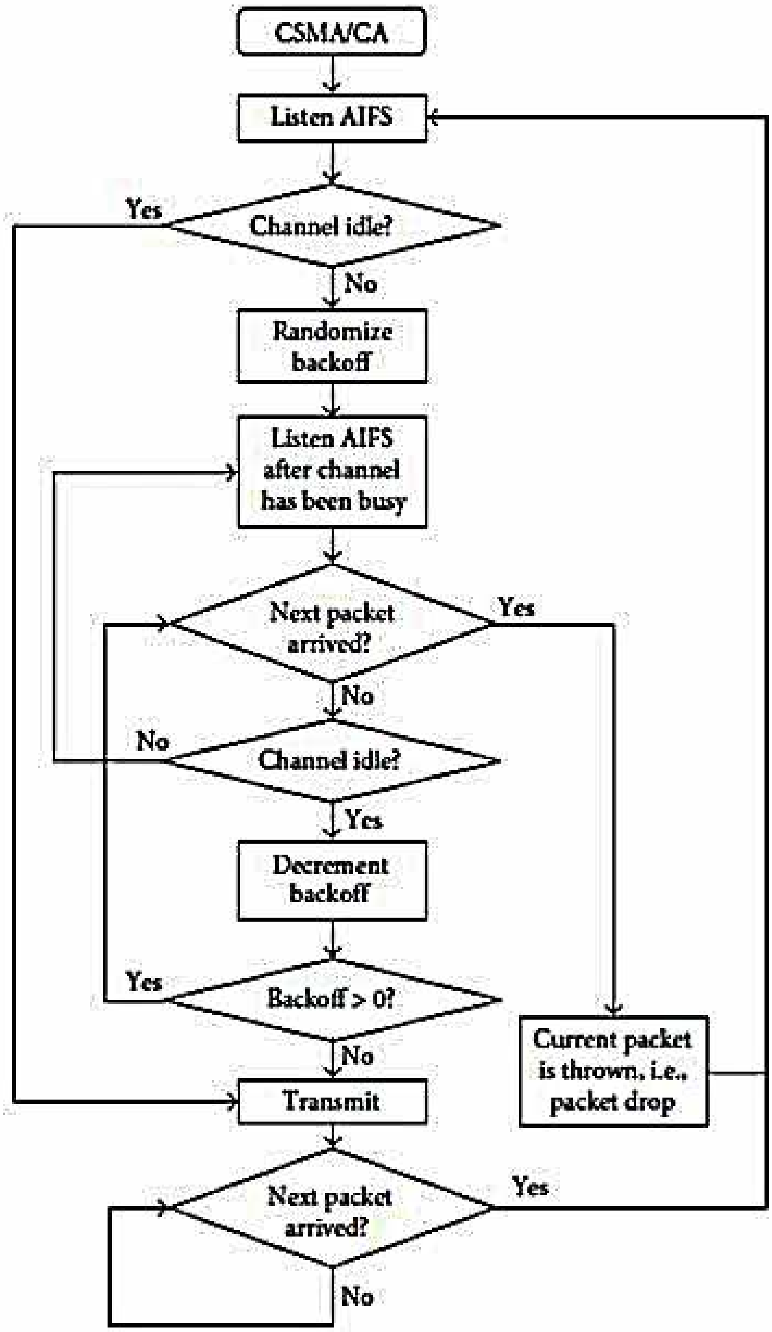


Figure 2.3: The CSMA procedure according to 802.11p

Source: (Katrin Bilstrup, 7 December 2008)

Self-Organizing Tdma (STDMA) Mac Method

The STDMA algorithm is found in a standard for the shipping industry, automatic identification system (AIS). There are international regulations saying that ships larger than 300 gross ton must use AIS, which is a transponder technique. Every ship will transmit messages containing information about its position, heading, and so on, at a predetermined heartbeat rate. The AIS system is used for identifying ships in the vicinity and it is of great help in, for example, bad weather situation since false radar images are a problem. With AIS, the ship will build its own surveillance picture about the neighbourhood using the messages received from other ships. Ships all over the world can meet and track each other through this system. AIS divides the time into one minute frames where each frame contains 2250 time slots and a transfer rate of 9.6 kbps is supported. Two different frequency channels, 161MHz and 162 MHz, are used for communication and the ships will divide its messages between these two channels (called channel A and channel B). A message is 256 bits long and it fits into one time slot.

STDMA is a decentralized scheme where the network members themselves are responsible for sharing the communication channel and due to the decentralized network topology, the synchronization among the nodes are done through a global navigation satellite system such as GPS. The algorithm is dependent on that all nodes are the network regularly sends messages containing information about their own position. The STDMA algorithm will use this position information when choosing slots in the frame. All network members start by determining a report rate, which is, deciding the number of position messages that will be sent during one frame and this translates into the number of slots required. After a node is turned on, four different phases will follow: initialization, network entry, first frame, and continuous operation. During the initialization phase, the node will listen for the channel activity during one frame to determine the slot assignments, that is, listen to the position messages sent in each slot. In the network entry phase, the station determines its own slots to use for transmission of position messages within each frame according to the following rules:

(i) Calculate a nominal increment, (NI), by dividing the number of time slots with the report rate,

(ii) Randomly select a nominal start slot (NSS) drawn from the current slot up to the NI,

(iii) Determine a selection interval (SI) of slots as 20% of the NI and put this around the NSS ,

(iv) Now the first actual transmission slot is determined by picking a slot randomly within SI that is not currently occupied by someone else and this will be the nominal transmission slot (NTS).

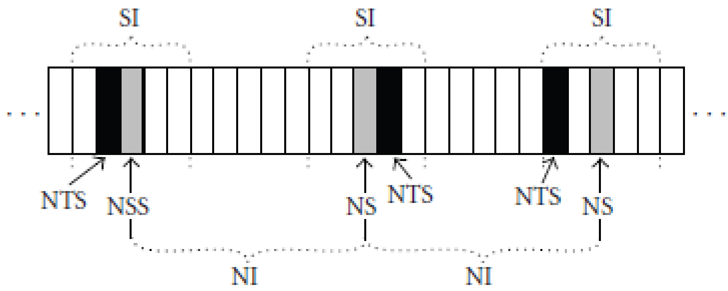


Figure 2.4: The frame structure for one node.

Source: (Katrin Bilstrup, 7 December 2008)

If all slots within the SI are occupied, the slot used by a station located furthest away from oneself will be chosen. Upon reaching the first chosen NTS, the station will enter the first frame phase where the rest of the report rate decided transmission slots (NTSs) are determined. An NI is added to the NSS and a new SI area is made available to choose a slot from. This is repeated until a frame has elapsed and all position messages are assigned a transmission slot. Every node has only one NSS and this is used to keep track of when the frame starts for this particular node, that is, all nodes keep track of its own frame and they look at it as a ring buffer with no start and no end. Modulo operations are used to avoid static numbering of slots. In computing, the modulo operation means finds the remainder of division of one number by another. The parameters NSS, NS, SI, and NI are kept constant as long as the node is up running. However, if the report rate changed during operation (increased or decreased number of position messages in the frame for some reason) then the parameters will changed since NI is dependent on the report rate.

When all slots within one frame duration are selected, the station will enter the continuous operation phase, using the NTSs decided during the first frame phase for transmission. During the first frame phase, the node will draw a random integer n for each NTS. After the NTS has been used for the n frames, a new NTS will be allocated in the same SI as the original NTS. This procedure of changing slots after a certain number of frames is done to cater for network changes, that is, two nodes that use the same NTS that were not in radio range of each other when the NTS was chosen could now have come closer and will then interfere if the NTS allocation was not changed (Katrin Bilstrup, 7 December 2008).

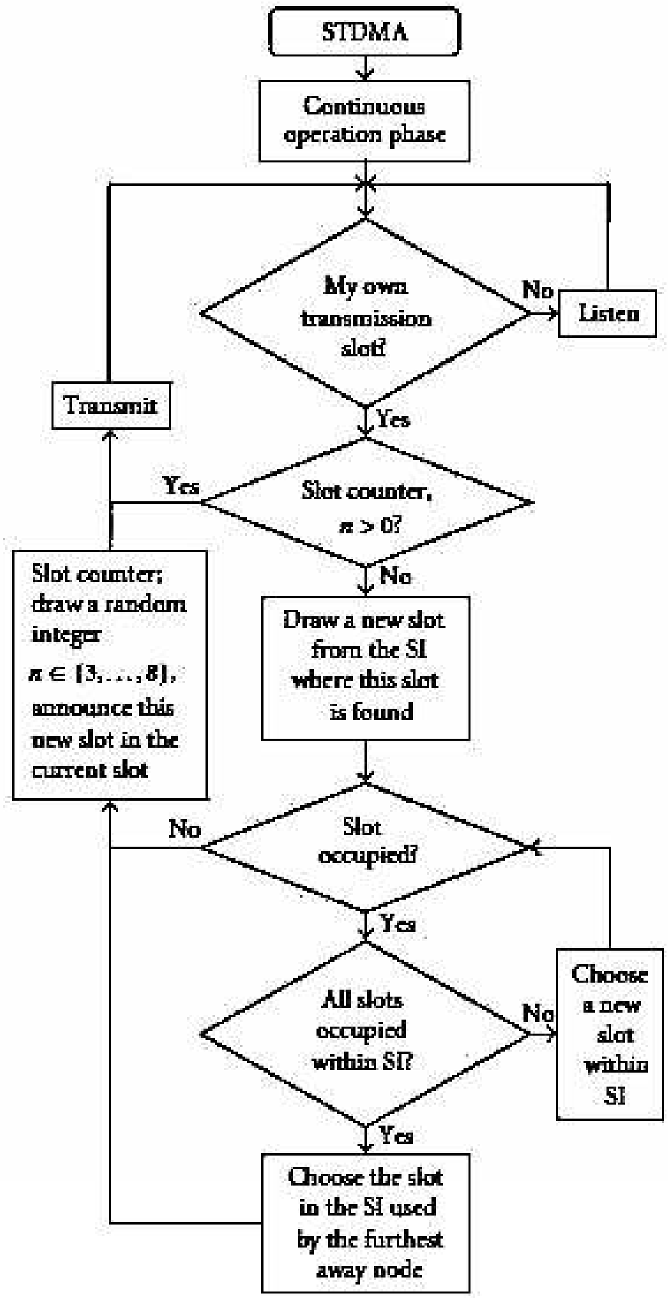


Figure 2.5: Continous operation phase of STDMA

Source: (Katrin Bilstrup, 7 December 2008)

Phy Layer

At PHY level, the philosophy of IEEE 802.11p design is to make the minimum necessary changes to IEEE 802.11 PHY so that WAVE devices can communicate effectively among fast moving vehicles in the roadway environment. This approach is feasible because IEEE 802.11a radios already operate at 5 GHz and it is not difficult to configure the radios to operate in the 5.9 GHz bands internationally. It is also desirable and sensible because of the technical challenges involved in radically amending a wireless PHY design. While MAC level amendments are fundamentally software updates that are relatively easy to make, PHY level amendment necessarily should be limited in order to avoid designing an entirely new wireless air-link technology. The changes made described as follows.

IEEE 802.11p is essentially based on the OFDM PHY defined for IEEE 802.11a, with a 10 MHz wide channel instead of the 20 MHz one usually used by 802.11a devices. IEEE 802.11 already defines 10 MHz wide channels, and it is straight forward in implementation since it mainly involves doubling of all OFDM timing parameters used in the regular 20 MHz 802.11a transmissions. The key reason for this scaling of 802.11a is to address the increased RMS delay spread in the vehicular environments. The root-mean-square (RMS) delay spread is probably the most important single measure for the delay time extent of a multipath radio channel. A recent study by CMU and General Motors shows that guard interval at 20 MHz is not long enough to offset the worst case RMS delay spread. If choice is simply between scaled versions of 802.11a, then 10 MHz is a reasonable choice.

There also need to improve receiver performance. Research shows there are potential for immediate neighbouring vehicles to interfere each other if they are operating in two adjacent channels. For example, a vehicle A transmitting in channel 176 could interfere and prevent a vehicle B in the next lane from receiving safety messages sent by vehicle C that is 200 m away in channel 178. Cross channel interference is a well known and natural physical property of wireless communications. The most effective and proper solution to such concerns is through channel management policies that is completely outside of the scope at IEEE 802.11. (Katrin Bilstrup, 7 December 2008)

2.4 SYSTEM AND SENSOR FOR V2V

2.4.1 Embedded Computational Units (ECU)

The ECUs are intended to be used as building blocks for larger functions. However, they can also be used as stand-alone functional blocks. The key to the design flexibility of the ECUs is the easily accessible control signals. These control signals are connects to the normal routing channels, which can also establish connectivity with the I/Os if the designer wants to drive the control signals externally. An ECU is an embedded system that controls one or more electrical subsystems in a vehicle. Output signals from an ECU contain information about the current state of the vehicle as the driver interacts continuously with the vehicle. For example, when the driver signals left by triggering the left signal handle, an ECU senses this change and immediately sends a signal to instruct the lightning system to light up the left signal light. A modern automotive can consists of up to 70 ECUs, sensing and taking tabs of the various parameters of the automotive. This rapid and complex exchange of signals ensures the proper functioning of the car. (held, 2007)

2.4.2 WAVE RF Front End

The RF front end is generally defined as everything between the antenna and the digital base band system. For a receiver, this “between” area includes all the filters, low-noise amplifiers (LNAs), and down-conversion mixer needed to process the modulated signals received at the antenna into signals suitable for input into the base band analogue- to-digital converter (ADC). For this reason, the RF front end is often called the analogue-to digital or RF-to-base band portion of a receiver. Radios work by receiving RF waves containing previously modulated information sent by a RF transmitter. The receiver is basically a low noise amplifier that down converts the incoming signal. Hence, sensitivity and selectivity are the primary concerns in receiver design. Conversely, a transmitter is an up converts an outgoing signal prior to passage through a high power amplifier. In this case, non-linearity of the amplifier is a primary concern. Yet, even with these differences, the design of the receiver front end and transmitter back end share many common elements like local oscillators. Thanks to advances in the design and manufacture of integrated circuits (ICs), some of the traditional analogue IF signal processing tasks can be handled digitally. These traditional analogue tasks, like filtering and up-down conversion, can now be handled by means of digital filters and digital signal processors (DSP) (WeidongXiang, december 2009).

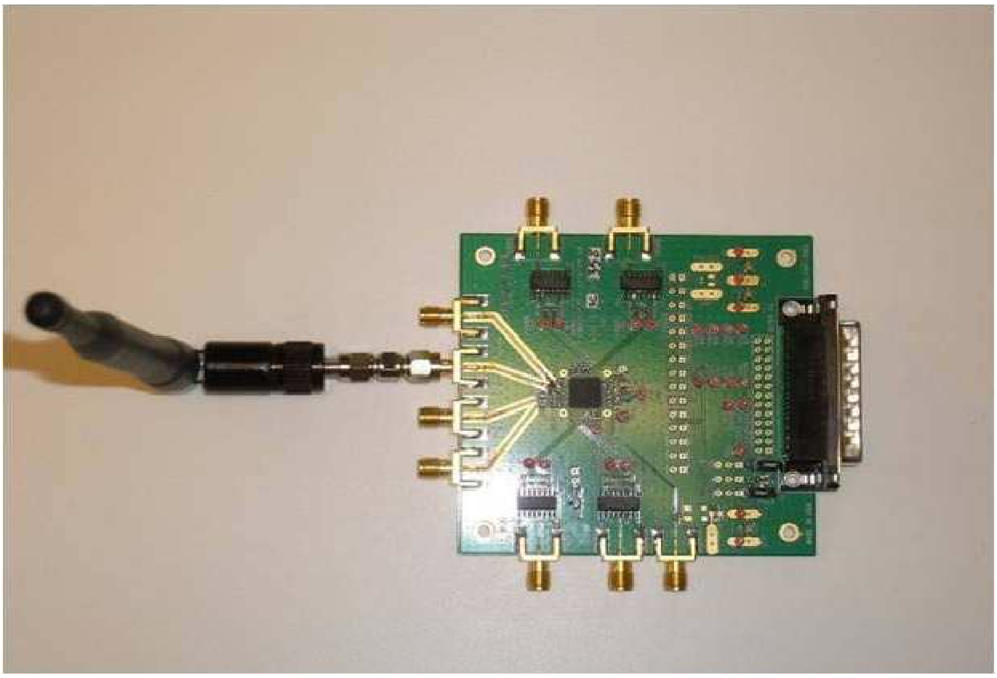


Figure 2.6: WAVE RF fronts ends

Source (WeidongXiang, december 2009)

2.4.3 Digital Signal Processing (DSP) Board

DSP applications utilizing multipliers in signal and data processing include filtering, image processing video compression and more. High computational power is needed to achieve real-time performance while processing the signal and data. Therefore, designers should keep their options open for hardware implementation of arithmetic intensive functions such as multipliers and adders since implementation of these functions in an ECU can yield much higher speed performance. Furthermore, the ECUs are easily accessible via a sea of high performance FPGA gates and dual-port embedded RAM blocks. Such a device can deliver performance, flexibility, parallel processing, and multi-channel processing capabilities.

Figure 2.7: DSP Board

Source: (WeidongXiang, december 2009)

In many of today's DSP applications, there is a need to be able to adapt to unknown conditions. The use of a fixed coefficient Finite Impulse Response (FIR) filters in many cases is not sufficient. DSP applications such as echo cancellation, estimation, and detection must use filters that behave differently depending on the conditions of the channel they are in. Therefore, an adaptive filter is the natural choice for these types of applications. An adaptive FIR filter is an FIR filter with coefficients that can be dynamically configured by an adaptive algorithm. There are many different adaptive algorithms available that are tailored to different applications. One of these algorithms is the Least Mean Square (LMS) algorithm**.**

2.4.4 Gps Sensor

The 28 satellites in the GPS are deployed in six orbital planes, each spaced 60˚ apart and inclined 55˚ relative to equatorial plane. The orbit of each satellite has an approximate radius of 20200km, resulting in an orbital period of slightly less than 12 hours. The system design ensures users worldwide should be able to observe a minimum of five satellites, and more likely to six to eight satellites, at any given time, provided they have an unobstructed view of the sky. This is important because users with no knowledge of their position or accurate time require a minimum of four satellites to determine what is commonly known as position, velocity and time solution, or PVT. The PVT data consist of latitude, longitude, altitude, velocity, and corrections to the GPS receiver clock.

The GPS satellites continuously broadcast information on two frequencies, referred to as L_1 and L_2, at 1575.42MHz and 1227.6MHz, respectively. The L_1 frequency is used to broadcast the navigation signal for non-military applications, called Standard Positioning Service (SPS). Because the original design called for the SPS signal to be lower resolution signal, it is modulated with a pseudorandom noise (PRN) code referred to as the Coarse Acquisition (C/A) code. The navigation message broadcast by every GPS satellites contains a variety of information used by each GPS receiver to calculate a PVT solution. The information in this message includes time of signal transmission, clock correction and ephemeris data for the specific space vehicle (SV), and an extensive amount of almanac and additional status and health information on all of the satellites in the GPS.

Each SV repeatedly broadcasts a navigation message that is 12.5 minutes in length, and consists of 25, 1500-bit data frames transmitted at 50 bits per second. A single data frame is composed of five 300-bit sub frames, each containing different status or data information for receiver, preceded by two 30-bit words with SV-specific telemetry and handover information. The first three sub frames, containing clock correction and ephemeris data relevant to the specific SV, are refreshed as necessary for each data frame transmitted during the navigation message broadcast. The almanac and other data transmitted in the final two sub frames are longer data segments, relevant to the entire GPS, requiring the full 25 data frames to be broadcast completely.

GPS receivers are composed of three primary components: the antenna, which receives the radio frequency (RF), broadcasts from satellites; down converter, which converts the RF signal into an intermediate frequency (IF) signal; and the baseband processor or correlator, which uses the IF signal to acquire, track, and receive the navigation message broadcast from each SV in view of the receiver. In most system, the output of the correlator is then processed by a microprocessor (MPU) or microcontroller (MCU), which converts the raw data output from the correlator into the positioning information which can be understood by user or another application. Several different techniques have been developed for using the GPS to pinpoint a user's position and to refine that positioning information though a combination of GPS derived data and additional signals from a variety of sources. Some of the popular techniques, such as autonomous positioning, differential positioning and server-assisted positioning, are briefly described below (lvlacic, 2001).

Figure 2.8: GPS sensor

Source: (WeidongXiang, december 2009)

Autonomous positioning, also known as single-point positioning, is the most popular positioning technique used today. Generally, autonomous positioning is the practice of using a single GPS receiver to acquire and track all visible GPS satellites, and calculate PVT solution. Depending upon the capabilities of the system being used and the number of satellites in view, a user's latitude, longitude, altitude and velocity may be determined.

The use of differential GPS (DGPS) has become popular among GPS users requiring accuracies not previously achievable with single-point positioning. Unlike autonomous positioning, DGPS uses two receivers to calculate PVT, one placed at a fixed point with known coordinates, known as the master site, and a second, a mobile unit, which can be located anywhere in the area surrounding of the master site where an accurate position desired. For example, the master site could be located on a hill or along the coastline, and the mobile unit could be a GPS receiver mounted in a moving vehicle. This would allow the master site to have a clear view of the maximum number of satellites possible; ensuring that pseudo range correction for satellites being tracked by the mobile unit in the vicinity would be available. The master site tracks as many visible satellites as possible, and processes that data to derive the difference between the positions calculated based on the SV broadcasts and the known position of the master site. This error between the known position and the calculated position is translated into errors in the pseudo range for each tracked satellite, from which corrections to measured distance to each satellite are derived. Corrections to measured pseudo ranges at the master site are considered equally applicable to both receivers with minimum error as longs, as the mobile unit is less than 100 km from the master site. This assumption is valid because the distance at which the GPS satellites are orbiting the earth is so much greater than the distance between the master site and the mobile unit that both receivers can effectively be considered to be at same location relative to their distance from each SV. Therefore, the errors in the pseudo range calculated for a particular satellite by the mobile unit are effectively the same errors in the same pseudo range at the master site. Of course, to calculate a position DGPS, a mobile unit must establish communication with a master site broadcasting DGPS correction information. Alternatively, a GPS receiver that has wireless communication capabilities, such as one that is integrated into an intelligent vehicle, may be able to access DGPS correction data on the Internet, or have it delivered on subscription basis from a private differential correction service provider. (lvlacic, 2001)

Inverse differential GPS (IDGPS) is a variant of DGPS in which a central location collects the standard GPS positioning information from one or more mobile units, and then refines that positioning data locally using DGPS techniques. With IDGPS, a central computing centre applies DGPS correction factors to the positions transmitted from each receiver, tracking to a high degree of accuracy the location of each mobile unit, even though each mobile unit only has access to positioning data from a standard GPS receiver. This technique can be more cost-effective in some ways than standard DGPS, since there is no requirement that each mobile unit be DGPS-enabled, and only the central site must have access to the DGPS correction data. However, there is an additional cost for each mobile device, since each unit must have a means of communicating position data back to central computer for refinement. For applications such as delivery fleet management or mass transit, IDGPS may be an ideal technique for maintaining highly accurate position data for each vehicle at a central dispatch family, since the communication channel is already available, and the relative cost of refining the positioning information for each mobile unit at the central location is minimal (lvlacic, 2001).

Server-assisted GPS is a positioning technique that can be used to achieve highly accurate positioning in obstructed environments. This technique requires a special infrastructure that includes a location server, a reference receiver in the mobile unit, and a two-way communication link between the two. This technique is best suited for applications where location information needs to be available on demand, or only on an infrequent basis. In a server-assisted GPS system, the location server transmits satellite information to the mobile unit, providing the reference receiver with a list of satellites that are currently in view. The mobile unit uses this satellites view information to collect a snapshot of transmitted data from the relevant satellites, and from this calculates the pseudo range information. This effectively eliminates the time and processing power required for satellite discovery and acquisition. Also, because the reference receiver is provided with the satellite view, the sensitivity of the mobile unit can be greatly improved, enabling operation inside buildings or in other places where an obstructed view will reduce the capabilities of an autonomous GPS receiver. Once the reference receiver has calculated the pseudo range for the list of satellites provided by the location server, the mobile unit transmits this information back to the location server, where the final PVT solution is calculated. The location server then transmits this final position information back to the mobile device as needed. Because the final position data is calculated at the location server, some of the key benefits of DGPS can also be leveraged to improve the accuracy of the position calculation (lvlacic, 2001).

The enhanced client-assisted GPS positioning technique is a hybrid between autonomous GPS and server-assisted GPS. This type of solution is similar to the server-assisted GPS, with the location server providing the mobile unit with a list of visible satellites on demand. However, in an enhanced client-assisted system, the mobile unit does the complete PVT calculation rather than sending pseudo range information back to location server. This technique essentially requires the same processing power and capabilities as an autonomous GPS solution, in addition to a communication link between the mobile unit and location server. However, the amount of time required to complete the PVT calculation is much less than with an autonomous GPS solution, because of the satellite view information provided by the location server and fewer exchanges with the location server are required than with a server-assisted solution. (lvlacic, 2001)

Collision warning system is the ones of the promising services which is aims for a safe and comfortable drive by tracking the movements of other vehicles. Vehicles transmit necessary data such as the current location, the motion’s direction, and the speed for tracking purpose and the CWS provides appropriate alerts or navigation to drivers, helping them become aware of the existence of other vehicles that are approaching the same intersection from other directions, even if these vehicles are out of sight. Vehicles equipped with the CWS come across many vehicles on their way and need to provide their own data promptly to other vehicles. The Carrier Multiple Access (CSMA) is suitable for Media Access Control (MAC) of the V2V because it allows distributed media access and all data packets is broadcasted. It is also important to maintain the freshness of data because the locations of moving vehicles continuously change with the time. This means reliable data deliveries are required for the CWS and data must be delivered timely, for example within 100ms.

2.4.5 Speed Sensors

The sensor components are head- way and the steering angle sensor. Information on steering angle is used to further support the data received from the headway sensor by permitting greater discrimination between hazards and spurious signals. Two types of the headway sensor considered are radar and laser radar. Velocity and range information is obtained by measuring the radar signal's Doppler frequency shift and reflection delay respectively. The reflection time of these determines the distance to the object in front. In the lidar system, a laser diode produces infra red light signals, the reflections of which are detected by a photo diode. Both these sensors have advantages and disadvantages. The radar system is not affected by rain and fog. The laser radar is more selective by recognizing the standard reflectors on the rear of the front vehicle. Radar produces strong reflections from bridges, trees, posts and other normal road side items. It can also suffer loss of signal return, due to multi-path reflections. Under ideal weather conditions the lidar system seems to be the best, but it becomes very unreliable when the weather changes.

The Doppler radar can measure a relative motion, the range of speeds that can be measures are 0.8 to 480 km/h. This type of sensor use a small DC power (10.5-16.5 VDC, 24W).

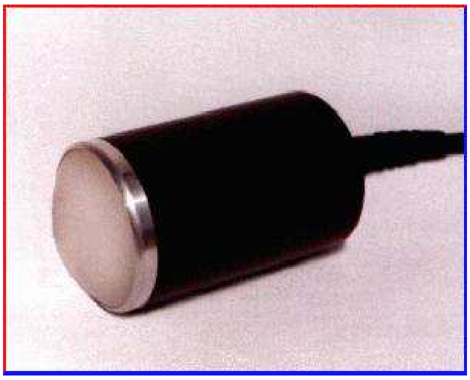


Figure 2.9: Doppler radar speed sensor

Sources: (CRANKSHAFT, 2009)

The output of this sensor is a pulse with frequency proportional to measured speed. The sensor can integrate with electronic control unit (ECU). A Doppler radar system is described that uses a monopulse antenna scheme to track multiple targets and generate range, range rate and azimuth angle output data for each target. The system requires less than 2 MHz of bandwidth and can be designed to operate at any microwave or millimetre-wave frequency. The transmitted power is less than 2 mill watts and the system can track targets to ranges in excess of 125 meters. The radar system uses frequency modulated continuous wave (FMCW) radar transmission with frequency shift keying (FSK) for range measurements to minimize bandwidth requirements. The Doppler radar system employs digital signal processing (DSP) and Fast Fourier Transforms (FFT) to identify, separate and track individual targets in the frequency domain. (CRANKSHAFT, 2009)

2.5 V2V CONCEPT FROM MANUFACTURES

2.5.1 General Motors

GM's V2V system consists of a roof-mounted transponder, antenna, and communications chip. This allows a vehicle to 'broadcast its location and monitor the positions of hundreds of other cars with the same capability 10 times every second. In one demonstration, a Cadillac CTS was driven at 35 mph directly into the path of a parked Cadillac CTS without touching the brakes. As the approaching CTS drew closer to the parked car, a green vehicle icon on a dash-mounted monitor used to indicate the CTS' speed and the distance between vehicles turns to yellow. At about 30 yards out, the icon turns red and the parked vehicles turn signals and brake lights flash in a rapid warning sequence. A second later, the brakes seize control of the moving CTS and pull it to a stop 15 ft. short of the parked car.

V2V systems could overcome blind spots such as when turn or passing. If a driver engages a turn signal, and there is a vehicle in his or her blind spot, the system sends a vibration through the driver's seat. The V2V system will determine whether or not to apply the brakes using algorithms that calculate the moving car's speed and it’s time to impact. The same algorithm can trigger the taillights to flash to prevent chain-reaction rear-end collisions. In addition, GM's V2V technology can warn the driver when vehicles ahead, regardless of lane, are stopped or travelling much slower or any vehicle ahead brakes hard, allowing the driver to brake or change lanes as needed. It also can use rear lights to warn the other driver when the approaching vehicle is moving very quickly and a rear-end collision is imminent. Using vehicle-to-vehicle (V2V) communication, a vehicle can detect the position and movement of other vehicles up to a quarter of a mile away. Vehicles will be equipped with a simple antenna, a computer chip, and GPS (Global Positioning System) technology; they will know where the other vehicles are by communicating directly with them, and other vehicles will know where they are in blind spots, stopped on the highway but hidden from view around a blind corner or blocked by other vehicles. The vehicles can anticipate and react to changing driving situations and then instantly warn the drivers with chimes, visual icons and seat vibrations. If the driver does not respond to the alerts, the car can bring itself to a safe stop, avoiding a collision.

The system would replace the long-range scanning sensor for adaptive cruise control, forward vision sensors for object detection, mid-range blind spot detection sensors, and long-range lane change assist sensors. GM has the ability to replace all of these sensors with one advisory sensor that will provide all-around, instantaneous traffic intelligence. This promises a better and significantly less costly way of sensing other vehicles around your car while driving.

During a demonstration attended by acarplace in March 2007, GM showed scenarios in which V2V technology can assist drivers. Using V2V communication, the vehicle alerts the driver to vehicles in blind spots with a steady amber light in the side mirror. If the turn signal is activated, a flashing amber light and gentle seat vibration on the side notifies the driver of a potentially dangerous situation. The vibration was enough to get our attention but not a sudden distraction - it was much more subtle than our pager.

Pile-ups on congested roads during rush hour due to a chain reaction rear-end collisions could be lessened. Using V2V, the vehicle monitors messages from other vehicles up to a quarter of a mile ahead. The trailing vehicle warns the driver first with visual icons and seat vibrations on the front and then automatically brakes if there is danger of a read-end collision with the vehicle ahead. (By Bill Siuru, 2008)

2.5.2 BMW Future Safety Systems

BMW innovations concerning accident prevention are based on detailed analysis of accident causes and chronology. It is against this background that it develops and tests specifically tailored solutions and systems. The aim is to help drivers handle their driving responsibilities, to inform and/or warn him, and thus avoid accidents through preventive technology or at least mitigate the consequences.

Technology was designed to provide people with functions that compensate for physiological limitations. However, the decision rests with the driver. Current developments by BMW Group Research and Technology are in the field of driver assistance systems. These systems improve driver anticipation, making use of both autonomous on-board systems and inter-vehicle communication. BMW Group Research and Technology also carries out research into a new Internet Protocol-based networking technology for on-board electronics systems. This “future on-board electronics” project is based on the vision that all vehicle applications should be able to communicate intelligently and on an equal basis with each other and with their environment. In this way, vehicles will become an integral part of the digital telecommunications infrastructure (By Bill Siuru, 2008).

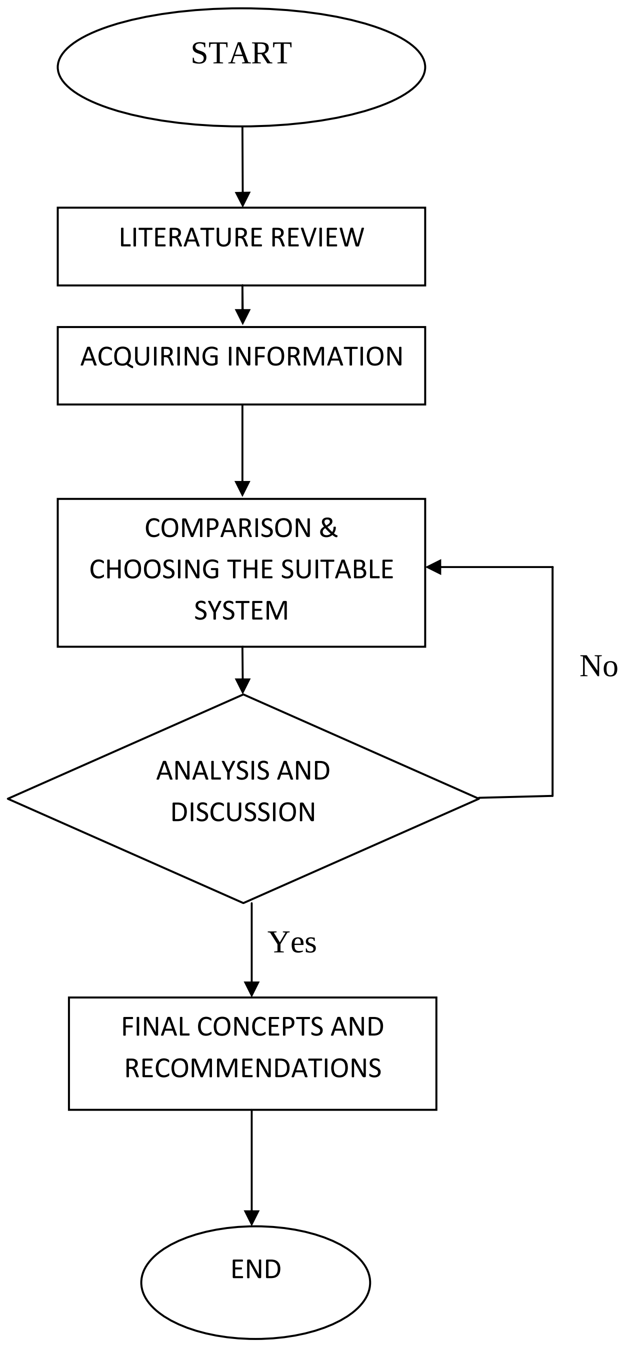
CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter explains and describes the methodology that used in this study. This chapter also will describe about the compatible technology for V2V communication system. Generally, the V2V systems should have a forward radar sensor, communication system and a GPS system. Generally, the function of forward radar sensor is to measure a distance or velocity between the vehicle and another vehicle up ahead of it, also to detect any obstruction in the roadway. This information can be use to automatically adjust the speed of the vehicle and informs the driver via a visual or audio signal or alarm of the potential occurrence of a frontal collision condition. It is a good idea to have a communication system, such as wireless local area network (WLAN), to communicate the location of other vehicle and to form an ad-hoc network among vehicle. The ad-hoc network can be use in broadcasting accident warning if there any occurrences of an accident, an intersection alert to reduce the danger at intersection, overtaking and lane change assistance. There are varieties of uses for GPS technology today, from basic positioning application that might provide a traveller with their current location, speed and direction to their destination, to highly complex applications where the user's position information is feeds into a system that provides location-specific features and services tailored for that user.

3.2 FLOW CHART



The acquired information is gathered and being present under chapter 2: literature review. The information about the network access, systems and sensor can be found through the book, but the information that can get from the internet much more large and spacious. There are various researches about the current technology on vehicle-to-vehicle (V2V) communication that can be found from the journal in the internet.

The first task is to identify the network access that would be implementing in communication on vehicle. The task is to find a suitable network access to use on V2V communication and the possibility to apply it in Malaysia. The focuses in this stage will be finding the essential wireless communication technique, such as, WAVE and DSRC. Identify the device needed to develop the system. Plan the step to implement the function in development progress.

The analysis phase required the knowledge on planning phase to be structured and discuss. Therefore, a detail research for all the problems is important to be understood. At this stage, some important things must be highlighted to continue the phases until it well structured. The research of the wireless communication technique is important to find the latest and suitable technique, this determination require a lot of research based on other researches that implement the technique on V2V.

The next phase is design phase. The primary objective of the design phase is to create a design that satisfies the agreed application requirements. The central idea of the V2V solution is to enable vehicles within each other's proximity to be aware of their own location and then estimate their position with respect to other vehicles. The location awareness problem constitutes of three sub-problems*:* Determining either the exact location using a GPS receiver (at discrete intervals), applying corrections to the measured location using continuous-time active sensors and sharing this information with other vehicles.

The above mentioned aspects are used by the V2V framework to enable a vehicle to estimate collision course with another vehicle. The process of collision course detection involves several periodic iterations of information transfer through the wireless network. The choice of iteration period is critical in determining the efficiency, reliability and scalability of the V2V system. The time interval should be small enough to reduce the possibility of an accident occurring while the protocol is in the process of finding a collision course; and large enough so that the location information sent by one vehicle to another is meaningful. The challenge is to develop a location aware mechanism that does not require complex signal processing or synchronization.

3.3 FORWARD RADAR SENSOR

One solution to avoiding accidents can be obtained by an adaptive cruise control (ACC) system that integrates radar sensor with the cruise control. The ACC system will be explains in detail on the next chapter. There are two types of radar that will be discussed, which is Laser radar and Doppler radar. These two radars are compared sto choose the most suitable radar sensor.

3.3.1 Laser Radar

Laser radar uses a laser to generate a light pulse or series of pulse in the upper infrared (IR) band and has extremely narrow beams in comparison to microwave-based radar. Although laser radar can measure speed and range, it requires an exact aim and cannot be use within patrol vehicle from behind glass. In addition, laser radar detection capability is considerably decreased by fog, rain, dust, smoke, and humidity. Due to these limitations laser radar is not reliable enough to be use with ACC system (Harris, 2006).

3.3.2 Doppler Radar

A Doppler radar is radar that makes use of the Doppler Effect to produce velocity data about objects at a distance. It does this by beaming a microwave signal towards a desired target and listening for its reflection, then analyzing how the frequency of the returned signal has been altered by the object's motion. This variation gives direct and highly accurate measurements of the radial component of a target's velocity relative to the radar. Doppler Effect well knows in the study of sound. Doppler’s effect can be described by the formula:

$$F_m = 2vF_e \cos\frac{\alpha}{c} \quad [3.1]$$

Where,

F_{m} = frequency of the received signal

V = speed of the vehicle

F_{e} = the frequency of the transmitted signal

α = the angle between the transmitted signal and the path along which the vehicles travels

C = propagation speed of the signal in the air.

From the formula above we can deduce the speed of the car.

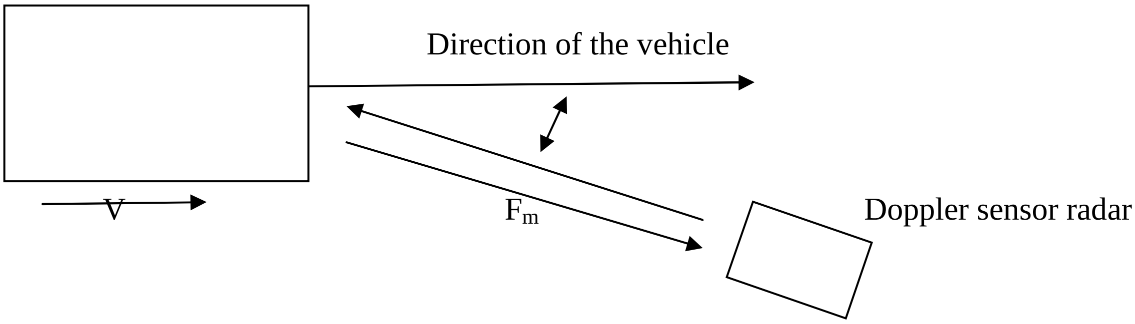


Figure 3.1: Doppler radar sensor

The sensitivity of the radar increases as the angle between the beams and the path of the vehicle (α) decrease. Doppler radar works perfectly well during a rain or mist. In general, when it rains it comes down vertically which is right angles to the Doppler radar beam, bringing about a Doppler effect of zero (Cos 90=0 so Fm=0). Heavy rain that comes down at the angles due to strong gust of wind cannot asset to the signal to noise ratio of the receiver and prevents its correct operation. In this case they processor will simply rejected the measurements. Since mist does not move, it will be practically invisible to the receiver and the measurements are completely unaffected. The distance from which this radar can measure the speed of a vehicle depends on two factors, the power of SHF oscillators and the sensitivity of the detector. Oscillator's powers are generally low and the use of a directional aerial increases the transmitted power. The biggest problem of the detector is a signal to noise ratio. In this section, the sensitivity can be improved using an aerial. Whilst the older Radars could only take measurements up to 20 meters, the newer models with the ultras sensitive detectors are capable of taking a measurement up to several hundred meters. Sometimes the Doppler radar equipment contains the DSP, which uses special algorithms with the very short time, making extremely fast readings possible. Because all of it characteristic, Doppler radar sensor is more reliable and more suitable to be use with cruise control.

3.4 COMMUNICATION SYSTEM

There are several technologies can be considered to be used as a communication system for V2V communication system. The most of them are Bluetooth, UWB, DSRC and WAVE.

3.4.1 Bluetooth

Bluetooth is a wireless technology for short-range communication with low power usage. It can built an ad-hoc network accommodates up to seven users. However, Bluetooth is only reliable up to a speed of 80 km/h and range of 80 m. It can take up to 3 seconds to establish the communication. In addition, since Bluetooth requires a master and slave setup, the master could potentially refuse a communication request. In addition, the master may already be communicating with another slave, which would lower the possible communication rate. This condition is not suitable for V2V communication that requires instantaneous data exchange between high-speed vehicles (Harris, 2006).

3.4.2 Ultra-Wideband

UWB technology is loosely defined as any wireless transmission scheme that occupies a bandwidth of more than 25% of a centre frequency, or more than 1.5GHz. The main advantages of UWB technology are its high data rate, low cost, and immunity to interference. However, UWB could possibly interfere with other existing radio services, for instance, the Global Positioning System (GPS). The fact that UWB could potentially interfere with existing radio services is a technical problem that must be solve before it could be use in V2V systems.

3.4.3 Dedicated Short Range Communication

DSRC is a multi-channel wireless standard that is based on the IEEE 802.11a PHY and the IEEE 802.11 MAC. DSRC is designed to operate within a frequency band (5.9 GHz) licensed solely for the purposes of vehicular communications, and is being optimized for operation within high-speed vehicular environments. The disadvantage of DSRC is, to exchanging a messages or information a vehicle need to join a Basic Service Set (BSS). The BSS is a term used to describe the collection of stations that may communicate together within an 802.11 WLAN. Thus, these make DSRC not reliable for real time communication. Real time communication means a message or packets must be successfully delivered before a certain deadline.

3.4.4 Wireless Access for Vehicular Environments

The last option left is WAVE technology. WAVE is the next generation dedicated short-range communications (DSRC) technology, which provides high-speed V2V data transmission. WAVE systems will build upon the IEEE 802.11p standard. The IEEE802.11p standard is meant to describe the functions and services required by WAVE-conformant stations to operate in a rapidly varying environment and exchange messages without having to join a Basic Service Set (BSS). Vehicular safety communications use cases demand instantaneous data exchange capabilities and cannot afford scanning channels. Therefore, it is essential for IEEE 802.11p radios to be, by default in the same channel and configured with the same Basic Service Set Identification (BSSID) to enable safety communication. A station in WAVE mode is allowed to transmit and receive data frames with the wildcard BSSID value and without the need to belong to a BSS of any kind.

3.5 GPS SYSTEM

A GPS system can be used in determine the vehicle location, by combining GPS system with communication system, the coordinates of the vehicle can be transmitting to other vehicle indicating the exact position of the vehicle. With the information obtained, an early precaution can be made by the driver to prevent unwanted clash.

3.6 CONCLUSION

For the conclusion, a V2V communication should have a Doppler sensor as a device sensor that can integrates with cruise control to form adaptive cruise control. Other than that, it also need WAVE as a reliable communication system between vehicles. The GPS system is needs to determine exact location of car that can be use in roadways environment such as overtaking situation.

CHAPTER 4

CONCEPT DESIGN AND ANALYSIS

4.1 INTRODUCTION

The central idea of the V2V solution is to enable vehicles within each other's proximity to be aware of their own location and then estimate their position with respect to other vehicles. The location awareness problem constitutes of three sub-problems: Determining the exact location using a GPS receiver at discrete intervals, applying corrections to the measured location using continuous-time active sensors and sharing this information with other vehicles.

The above mentioned aspects are used by the V2V framework to enable a vehicle to estimate collision course with another vehicle. The process of collision course detection involves several periodic iterations of information transfer through the wireless network. The choice of iteration period is critical in determining the efficiency, reliability and scalability of the V2V system. The time interval should be small enough to reduce the possibility of an accident occurring while the protocol is in the process of finding a collision course; and large enough so that the location information sent by one vehicle to another is meaningful. The challenge is to develop a location aware mechanism that does not require complex signal processing or synchronization. The V2V system also must include an adaptive cruise control system that will use a sensor to detect front vehicle speed and distance. With the value of speed gained the system should adjust the vehicle's velocity depending on the distance from the front vehicle.

4.2 PROPOSED SYSTEM CONCEPT OF V2V COMMUNICATION SYSTEM

The picture below shows the concept of the car that equip with V2V communication system.

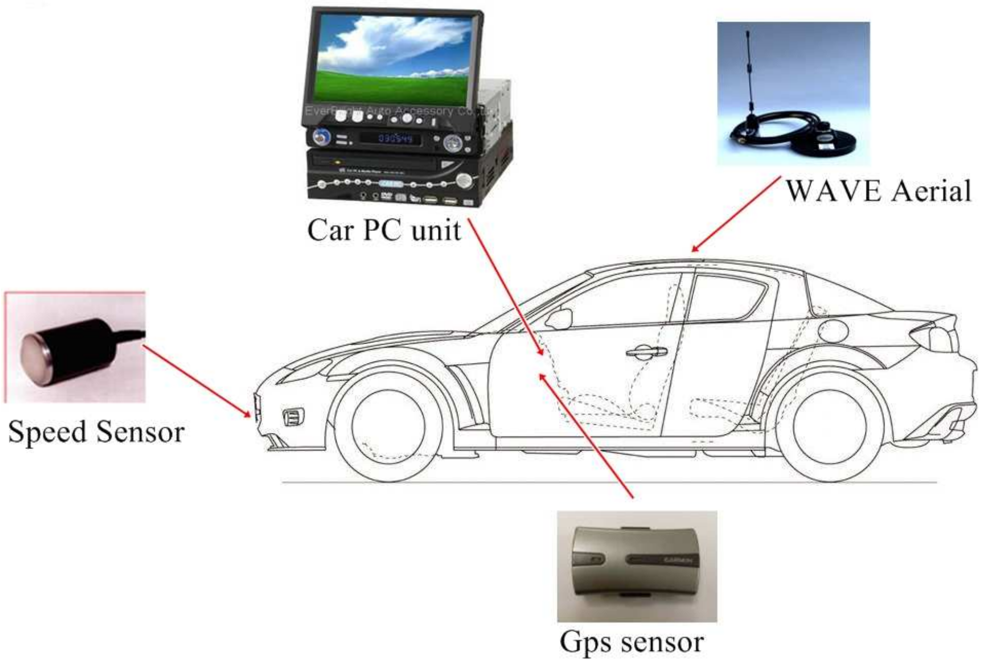


Figure 4.1: Concept car

The car should have a speed sensor, which is Doppler radar to scan for other vehicles and objects to assist the driver in preventing a collision. The car also consists a Car PC unit or On-board Unit (OBU) that will control WAVE system to communicate with other vehicles. The OBU will be integrating with GPS sensor/ receiver, using GPS the car will compute their personal user location. WAVE will enable transmission and reception of Information Packets. These packets contain such as geographic location of the vehicle, collision zone radius, velocity, displacement and direction.

4.3 RADAR SYSTEM AND ADAPTIVE CRUISE CONTROL (ACC)

An ACC System can be seen as an extension of today's Cruise Control System. The extended system will not only keep a fixed speed, but it will also adapt the speed of the vehicle to that of slower vehicles ahead. This permits the system to be used also in dense traffic. The sensor will do a measurement on vehicles in front of the host car; decide if vehicles ahead are in the same lane as the host car, determine their velocity and distance. Then deliver the information to ECU, ECU will process the information and control the throttle valve opening regarding the value of speed obtained. The sensor shall mount in the front of the car with a clear field of view over the area that should be scan.

4.3.1 Monopulse Radar System

The monopulse radar system techniques employed in the new vehicle radar system add a new dimension to the radar performance. The monopulse system uses the same Doppler FMCW (FSK) modulation methods, but includes two antennas and two receivers for signal comparison to determine the azimuth angle to the targets. This system measures range, closing rate and azimuth angle independently and instantly for any number of simultaneous targets

.

Knowledge of target azimuth angles allows the detection zone to be better shaped to highway geometries and can be combined with steering information to track targets around typical interstate highway turns. The monopulse radar system computes azimuth angle data for each target over a total azimuth range of 12 degrees. This azimuth capability permits the radar system to track targets around typical interstate radius curves, to minimize false alarms by skewing the detection zone when in turn, and to shape the detection zone as a function of range to better fit the traffic lane.

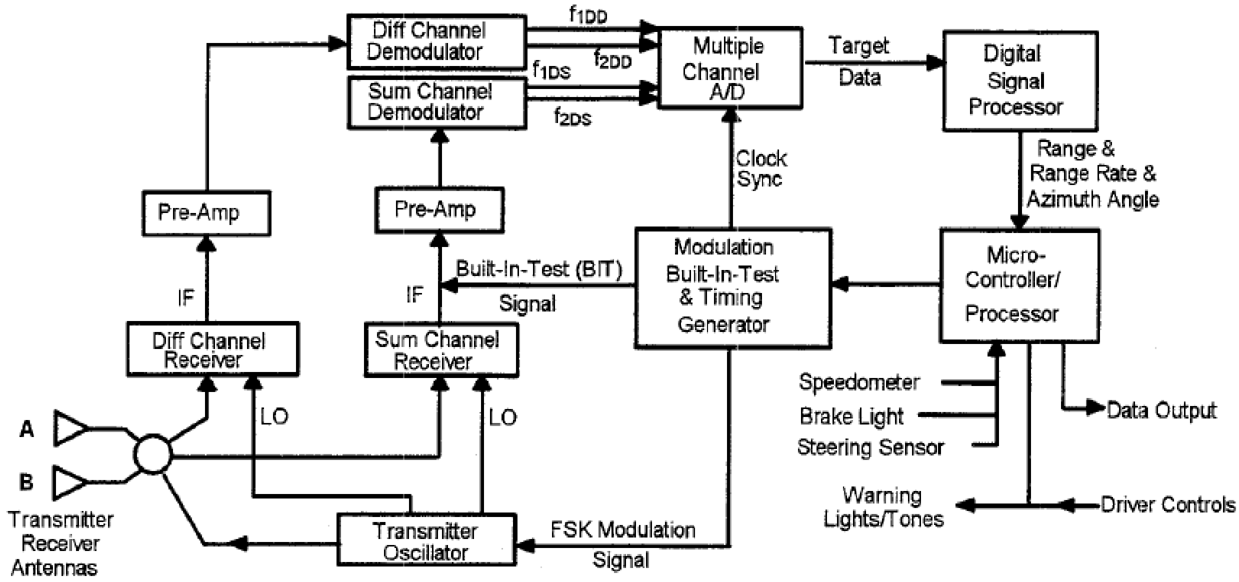


Figure 4.2: Monopulse radar system block diagram

Source: (Woll, 2002)

The monopulse system has two separate antennas labelled A and B in the block diagram and two separate receivers for the radar Doppler signals coming from the sum of the two antennas and from the difference of the two antennas. The azimuth angle to each target is computed from the ratio of the signal strength on the sum channel to the signal strength on the difference channel. Target data is linked together for each target by the unique Doppler frequency associated with that target.

The wider beam width of the mlonopulse antenna system results in lower antenna gain by about 5 dsi so more power must be delivered to the antenna to achieve the same field strength density as the narrow beam width, fixed beam radar system. The lower antenna gain of the antenna also reduces the signal strength of the received signal. Field and laboratory testing has demonstrated that sufficient signal to noise figures can be easily achieved for successful operation of monopulse systems in vehicle applications. It can be seen from the block diagram that there are now four Doppler frequency data channels to process for the monopulse system, namely f_{1DS} and f_{2DS} from the sum channel f_{1DD} and f_{2DD} from the difference channel. The DSP generates data on the frequency, phase and signal strength for each of the Doppler channel frequencies. Vehicle target measurements are calculated as follows:

Closing Rate: The closing rate is calculated from the frequency value of any one of the four Doppler channel frequencies (f_{1DS}, f_{2DS}, f_{1DD}, $f_{2DD)}$. The frequency divided by 45 Hz will give closing rate in km/h.

Range: The range is calculated by measuring the phase difference either between f_{1DS} and f_{2DS} or between f_{1DD} and f_{2DD}.

Azimuth Angle: The azimuth angle to the target is calculated by comparing the signal strength values either between f_{1DS} and f_{2DS} or between f_{1DD} and f_{2DD}.

The monopulse radar system measures azimuth angle data for each target with an accuracy of ± 0.1 degrees from 6 degrees left to 6 degrees right of straight ahead, a total azimuth range of 12 degrees. This azimuth capability permits the radar system to track targets around typical interstate radius curves, to minimize false alarms by skewing the detection zone when in turn, and to shape the detection zone as a function of range to better fit the traffic lane. The monopulse Doppler radar system offers several advantages over switched beam systems or mechanically scanned antenna systems. The monopulse system provides continuous azimuth angle data for multiple targets without the data processing interruptions normally encountered during antenna beam switching. Mechanically scanned systems provide target data only when the antenna is aim at a target and then must wait for the scanning to return to the target for data refreshing. The monopulse antenna, however, has lower gain, and therefore should have more power delivered to the antenna port. The FMCW (FSK) Doppler radar system provides great radar efficiency with respect to frequency bandwidth and output power. The simultaneous and independently calculated range and range rate of these systems offer excellent target tracking algorithm possibilities. (Woll, 2002)

4.3.2 Embedded Computational Units (ECU)

The cruise control ECU microprocessor takes input from sensors to find out the vehicle-operating vehicle. It then sends out the signal the throttle actuator to regulate the throttle valve position to maintain the required speed. The cruise control adjusts the throttle proportional to the error. The errors are the difference between the desired speed and the actual speed. The closer the car gets to the desired speed the slower it accelerates. Most cruise control system use a control scheme called proportional-integral-derivative control (PID). Mathematically known that the integral of speed is distance and the derivative of speed is acceleration. The PID control system uses these three factors proportional, integral and derivatives. Calculating each individually and adding them to get the throttle position. The integral factor is based on the time integral of the vehicle speed error. The derivatives factor, the derivatives of speed is acceleration. If the car slows down, the cruise control can see the acceleration is decreasing. Before the speed can actually change much, the system respond by adjusting the throttle opening.

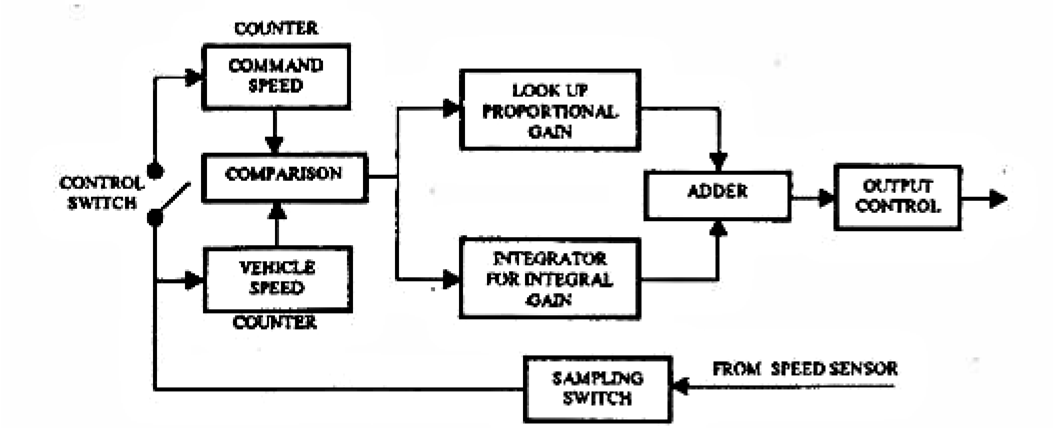


Figure 4.3: Block diagram of cruise control ECU

Source: (2009) (Nice, 2001)

4.3.3 Speed Control

Actuator connected to the throttle valve and control throttle butterfly position. Throttle valve controls the power and speed of the engine by limiting how much air the engines take in. Many cars use actuators powered by engine vacuum to open and close the throttle. These systems use a small, electronically-controlled valve to regulate the vacuum in a diaphragm. The ECU's speed control microprocessor operates the vacuum pump, which in turn moves the throttle valve actuator diaphragm until require speed is maintained without the use of the accelerator pedal so that the driver can remove his foot from the pedal. The microprocessor continuously monitors the vehicle speed signal and constantly changes the throttle position taking account of variations in road gradients, wind resistance and thereby maintains the speed the speed of the vehicle to that of slower than vehicles ahead. To increase speed, the pump operated for a short time to increase the vacuum, and to reduce speed the control valve is pulsed open to reduce the vacuum slightly. To overtake another vehicle, the accelerator pedal pressed in the normal way to increase speed. When the pedal released the cruise control automatically takes over, and the system returns to the adaptive cruise control. Once the brake pedal is pressed,-the microprocessor detects the closure of the stop lamp switch and immediately opens the pressure release valve to rapidly decrease the vacuum to disengage the system. As a safety measure, the brake pedal uses an additional pair of switch contacts, which open to disconnect the positive supply from the solenoid valves, allowing them to open. This action also carried out on manual transmission vehicles by using a switch on the clutch pedal. When the cruise system is deactivated by pressing the pedal or the clutch pedal the driver can control car speed to the desire speed. Because the brake forces being applied of course the car speed will be slower than the vehicle in front of that car. (Nice, 2001)

4.4 APPLICATIONS OF WAVE SYSTEM

Applications with early deadlines are expected to require direct V2V communications, and the only standard currently supporting this is the IEEE 802.11p, included in the wireless access in vehicular environment (WAVE). With the WAVE communication system, a new system that can assist driver in several driving environments can be constructed. Two nearby vehicles periodically exchange information about their own movement in terms of exact position and local clock time seem like a convenient way in preventing collusions. Using these inputs, vehicles determine whether or not they are on a collision course with each another. The combination of WAVE and GPS is a good idea to forming collision avoidance system. The GPS system determines the location of vehicles and the WAVE system forming an ad- hoc peer-to-peer networking among the vehicles.

4.4.1 Lane Changing Awareness

One important way of V2V to increase the driving safety focuses on the data exchange among vehicles. The exchange of appropriate data with desired vehicles is helpful to assist a driver realizing a situation or preventing possible accident. Consider the situation on the picture below sometimes accident can happen when cars try to change their lane.

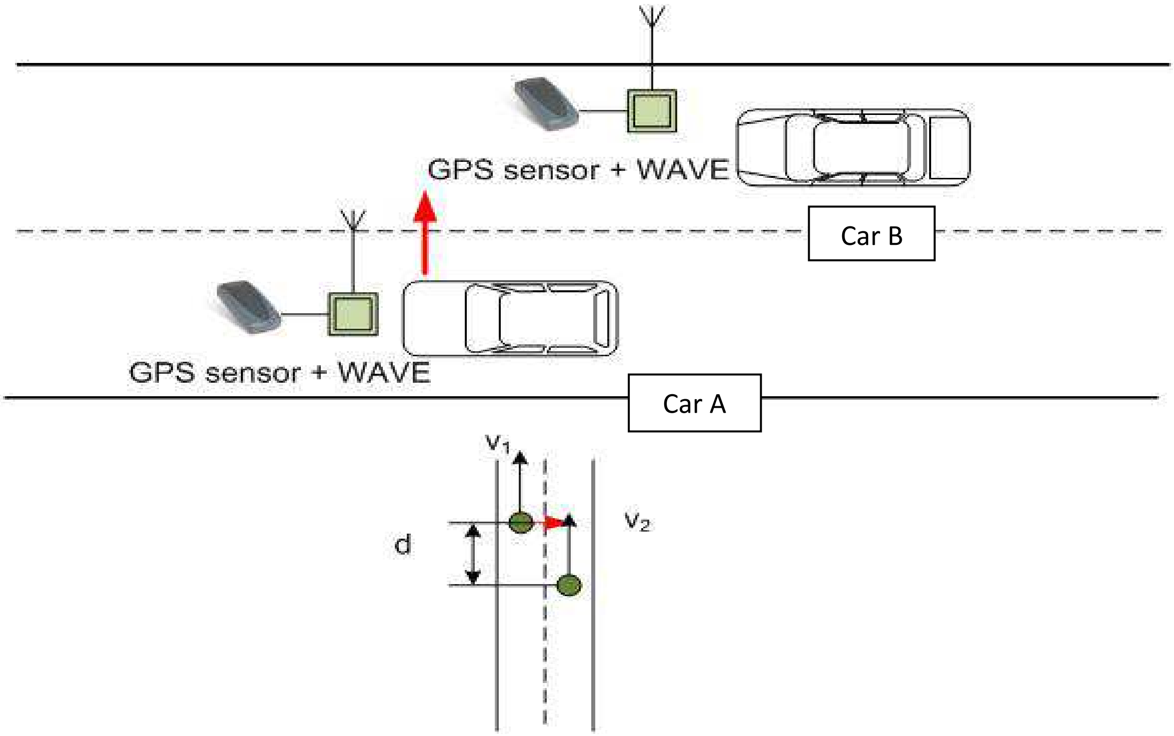


Figure 4.4: Lane Changing situation

Source: (WeidongXiang, december 2009)

The accident may happen if car B did not notice that car A is changing lane. If car A can send appropriate packets of data to the car B a fatal accident can be avoided. The data sent should give information to car B about car A, for example the position, the speed and the distance of car A. It also should send a data that saying car A is changing a lane. With enough data the OBU's system on car B can give a warning to the driver so the driver can takes an appropriate action to avoid an accident. To add more safety; the system should work in two way connection. Car B also can sent a message to car A, giving the information to car A about their location, speed and distance. By this way car A will know that car B is approaching from the back. A system will give warning to car A whether it is safe to change lane or not. The exchange of data is better than just a simple light signal, because sometime driver did not notice the light signal. If a system that give warning to the driver using voice message, warning display or alarm is used it will be more convenient to the driver.

4.4.2 Vehicles Overtaking Assistant

In an ideal world, overtaking accidents could be preventing by making a better road design. Safety of the roads can be improve by making the road spacious enough, if all roads in Malaysia designed like a highway with three lanes road, so there will no need driver to overtake other car. These seem like a good idea but to redesign all the roads in Malaysia it will be much expensive. Exchanging data in vehicular environment will be a good solution for this problem

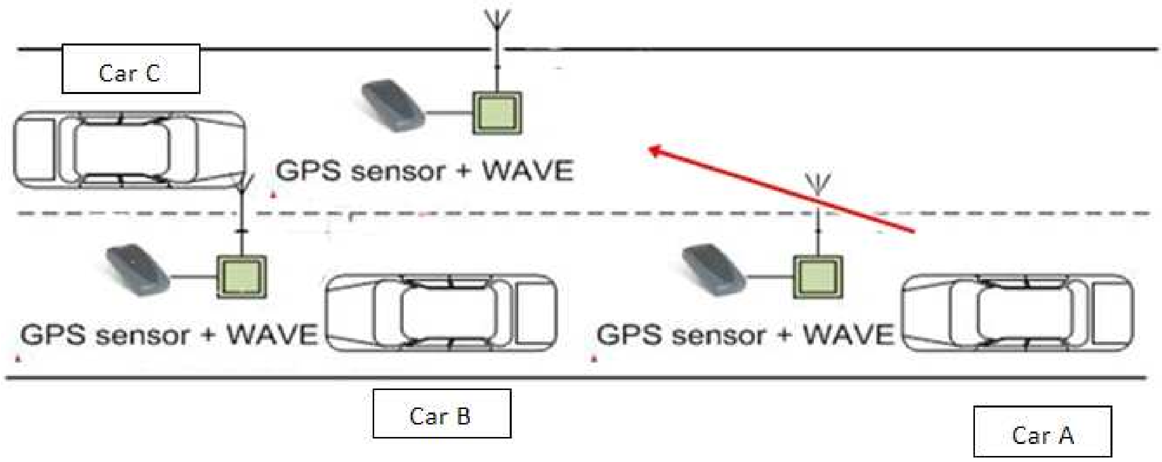


Figure 4.5: Overtaking situation

From the picture above, consider car A is trying to overtake car B but they did not notice car C. An accident would occur if there were no warnings to car A about car C. By using WAVE technology integrated with GPS sensor, we can create an ad hoc network that exchange data between the vehicles. When car A's driver want to overtake car B, the driver should send a signal to car B and then car B determine the location of car C by exchanging data between them. After that, car B sends the information to car

A. Car A use the information to determine whether it safe to overtake car B or not. If not an alert message will be display on the OBU's display unit and a warning alarm will be trigger to alert the driver. To send the signal, the driver of car A just need to activate the turn signal and then it will trigger Onboard Unit (OBU) to send a data signal to car B using WAVE system.

4.4.3 Accident Warning

Vehicles that are involved in an accident are the most reliable source of information about the very fact that there is an accident. If vehicles involved in an accident are equipped with short-range communication and a crash sensor, they can send out a warning message to the following traffic to avoid mass collisions.There are several types of sensor that been used nowadays. The sensor can be located in front of the vehicles. A several number of the sensor should be put in the crush zones effect so they will react almost instantly to the sudden deceleration that results from a frontal impact. The types of the crash sensor are:

Magnetic bias sensor

This sensor uses a sensing mass (a metal ball) held firmly at the rear of a small cylinder by a powerful bias magnet. During normal driving, the electrical contacts are open-circuit. When a collision takes place, the inertial force on the ball overcomes the magnetic bias force causing it to roll forward along the cylinder and to strike the electrical contacts thereby completing the detection circuit.

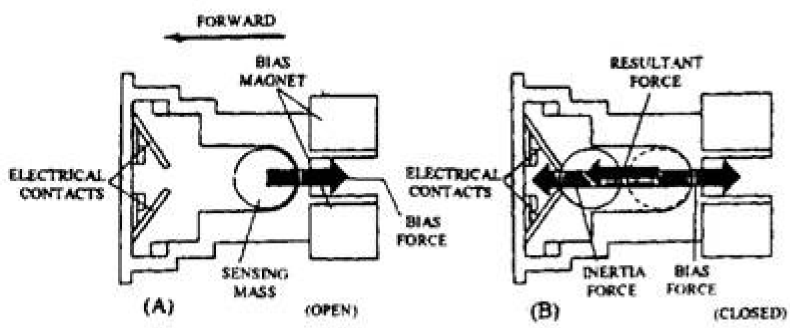


Figure 4.6: Picture (A) shows the sensor in the normal condition. Picture (B) shows the condition of the sensor when impact occurs.

Source (CRANKSHAFT, 2009)

Rolamite sensor

The Rolamite sensor uses a roll-spring, which is wrapped around a small roller and mounted to an electrical contact pad. The roll-spring is pre-tensioned so that during normal driving the roller is held firmly against a backstop and the detector contacts are open-circuit. When a collision occurs, the inertial force on the roller overcomes the pretensions on the roll-spring, due to which it travels forwards until the electrical contacts meet, completing he detection circuit. The total system is housed in airtight metal enclosures that are filled with inert gas to prevent corrosion and to ensure the mechanical and electrical functions of the crash sensors. Each sensor is wired as a normally open switch, but with a resistor connected in parallel with the contacts. The resistor permits the diagnostic module ECU to continually monitor the circuit's continuity for connector and wiring defects.

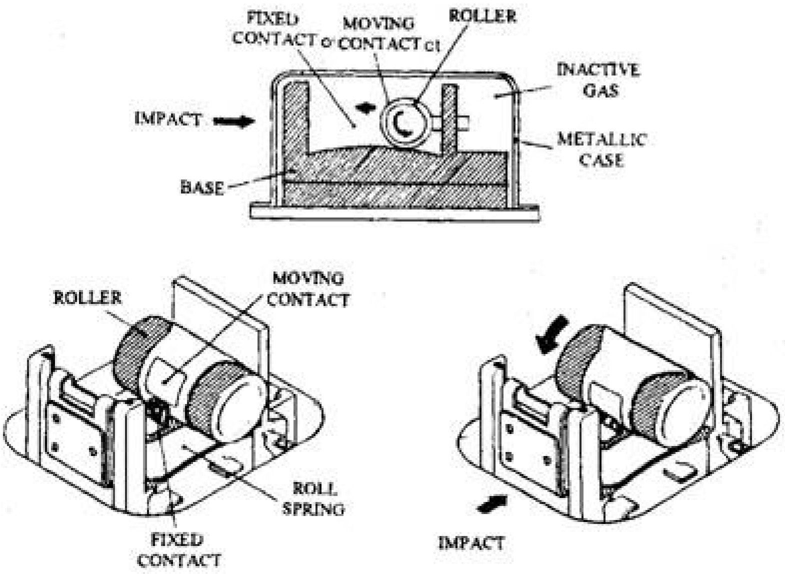


Figure 4.7: A rolamite sensor

Source: (CRANKSHAFT, 2009)

The crash sensor triggers a switch and sends a signal to on board unit (OBU). The OBU process the signal and send it to Wi-Fi transmitter. To protect the OBU from damage, the device will be placed on the dashboard. Normally when accidents occurs the area around the dashboard and driver seat were not affected too much, so there are a probability that the OBU will not suffered any damage. The OBU unit would send and emergency message to other car through WAVE when accident happened. To maintain the freshness of the data the messages should be send at least every five second. The OBU should have a microprocessor to process the signal. In order to extend the reach of the message, a repeat mechanism can carry the message further in the direction that is concerned.

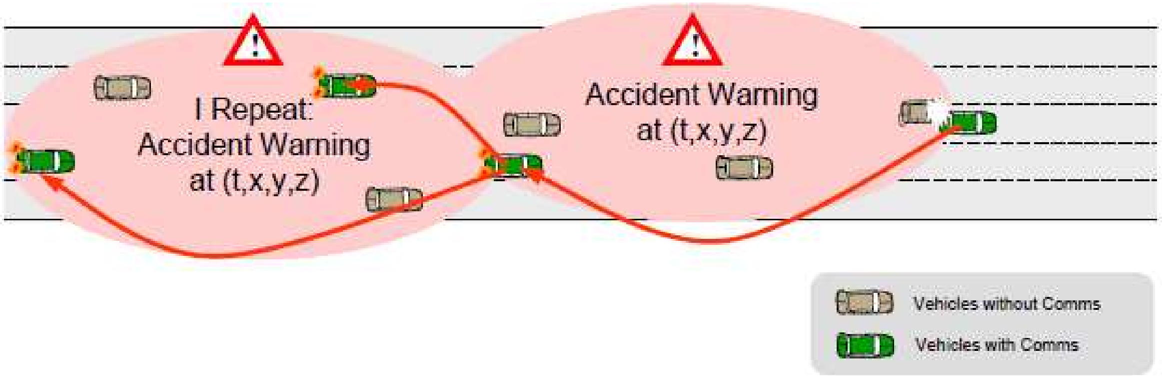


Figure 4.8: Messages Sharing

Source: (Holfelder, 2004)

4.4.4 Approaching Emergency Vehicle Warning

Approaching emergency vehicles send out a warning message to warn vehicles that are in its vicinity. Receiving vehicles can automatically mute the radio or the hands free-phone and give an audible or visual warning message to the driver. The driver can take an action by giving a way to the emergency vehicle.

4.5 ON BOARD UNIT

Every vehicle is equipped with an OBU or Car PC that acting as V2V system control panel. Its function is to determine packets of data that will be send and also extract information from the data received and then execute an appropriate action such as a warning signal. Every vehicle has a wireless transmitter/receiver pair for communication with vehicles in the communication cluster and the transmitter will be integrated with the OBU. A GPS receiver also will be connected to OBU; with right software a suitable framework can be developed. The OBU must contain a touch screen VGA monitor for the easy access. This monitor will act as a platform that will show a warning messages or direction guidance as well as having other infotainment possibilities.

4.6 GPS

GPS receiver is used to obtain the longitude, latitude and altitude values of a vehicle. The Global Positioning System (GPS) is actually a constellation of 27 Earth orbiting satellites. Each of these solar-powered satellites circles the globe at about 19,300 km, making two complete rotations every day (Harris, 2006). The orbits are arranged so that at anytime, anywhere on Earth, there are at least four satellites "visible" in the sky. A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to deduce its own location. A standard GPS receiver will not only place a vehicle on a map at any particular location, but will also trace the vehicle path across a map as it move. If the receiver is leave on, it can stay in constant communication with GPS satellites to see how the location is changing. Since the GPS receiver takes a measurement of location only at discrete intervals, and continuous vehicle information is required, onboard sensors for computing the position of the vehicle between two successive GPS readings is needed. Sensors that aid this measurement are referred to as Dead-Reckoning sensors. They include an accelerometer with tilt sensors to measure forces resulting from turning, acceleration or breaking and a rate gyroscope to measure instantaneous change in vehicle direction. These sensors can accurately measure changes in vehicle's position such as displacement and direction. Hence dead-reckoning sensors enable continuity of location. By integrating this system with WAVE, the information can be share among vehicle through wireless network.

4.7 IMPLEMENTATION POSSIBILITIES OF V2V COMMUNICATION SYSTEM IN MALAYSIA

Through this research the implementation of V2V communication system, seem to be possible because most of the system alterations are applied on vehicles without taking geological aspects and road conditions into account. The general nature of the system is universal. However, specifications of the system are still needed in order to suit its usage in Malaysia. The ACC system can be implemented in Malaysia without any problem because there are plenty of these systems available globally. Cars manufacture such as Mitsubishi, Chrysler, Toyota and Mercedes has already developed these systems in a way to improve their car safety. Some of the vehicles equip with the system may already available in Malaysian road. The usages of Doppler signal in this system also a good choice because it is suitable with the weather condition in Malaysia. Doppler signal works perfectly well during a rain or mist, which is the common condition in Malaysia. For the WAVE system, the IEEE 802.11p amendment is still new. This new wireless standard maybe not available in Malaysia yet. A research about the compatibility of this new wireless standard had to be done before it can be implements in Malaysia because this wireless signal might cause interruption with the radio wave that already exists here. Despite all the facts, the possibilities of implementation WAVE system are still higher. Research from other country shows that IEEE 802.11p can perform well without disturbs any others radio wave. Other than that, a GPS system is already in use in most of the modern car in this country. Therefore, there is no problem to use GPS in determining longitude, latitude and altitude values of a vehicle in this country region. However, the GPS positioning technique that being used here is just an autonomous GPS positioning technique which not really accurate compare to the other techniques. Inaccurate information about the position may lead to fatal error that may cause accidents to happen. This problem can be solve by using differential GPS positioning but this technique require an infrastructures known as master site.

4.8 LIMITATIONS OF V2V COMMUNICATION SYSTEM

Despite the possibilities stated above, there are still limitations that need to be considers. One of them is the cost, a larger cost are require in developing this system. To overcome this problem, only a new manufactured car should be equips with the system. The cost of installation of the system can be reduces with a massive production of the new car that integrated with this system. The older vehicle also can install this system but that would be costly. Thousands of workshops will need to install WAVE devices to existing billions of vehicles. Standardization is also necessary so that vehicles from different car manufacturers can communicate with each other. Moreover, the accuracy of GPS is not very convincing. The use of GPS system with the aided of Dead Reckoning sensors also have disadvantages. A disadvantage of Dead Reckoning is that since new positions are calculates solely from previous positions, the errors of the process are cumulative, and so the error in the position fix grows with time. Server-assisted GPS is a positioning technique that can be use to achieve highly accurate positioning but this technique requires a special infrastructure that includes a location server, a reference receiver in the mobile unit and a two-way communication link between the two.

4.9 SUMMARY

The number of vehicles has increased significantly in recent years, which causes high density in traffic and further problems like accidents and road congestions. A solution regarding to this problem is V2V communication, which vehicles are able to communicate with their neighbouring vehicles even in the absence of a central base station to provide a safer and more efficient roads and to increase passenger safety. This technology can be implemented in Malaysia but in order to do it some changing had to be made first to ensure the effectiveness of the technology. The system described in this chapter is suitable with Malaysian's road condition.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

The conclusions of this project are V2V communication technologies can greatly enhance the infotainment, safety, comfort, communication and convenience value of new vehicles. The design of communication protocols in V2V is extremely challenging because it needs a high-speed V2V data transmission to working with fast moving vehicle. The V2V communication has offered many new opportunities for the automotive industry. Several possible communications technologies can be use in V2V communication, the technologies are Bluetooth, UWB, DSRC and WAVE. Wireless LAN technology specifically IEEE802.11p or also knows as WAVE is currently the clear winner in the communication technology. There are many organizations competing in the course of WAVE study. From this research, WAVE system is reliable systems that support a real time communication. Using WAVE, two vehicles can immediately communicate with each other upon encounter without any additional overhead as long as they operate in the same channel using the wildcard BSSID. Different from other communications technologies that has high latency in establish a connection. However, despite the using of WAVE system, the proposed V2V concept in this report still have the limitations as told in Chapter 4. This V2V technology can be implements in Malaysia but in order to do it some changing had to be made first to ensure the effectiveness of the technology.

5.2 RECOMMENDATIONS

For the further research, a simulation of V2V system has to be made to get more information about how the system works. With the help of the simulation, the compatibility of V2V system on the roadmap in Malaysia can be clarified. Since this report is just about theoretical, an experiment should be conducts to determine the accurate information about the system. On-road experiment is a good choice in investigating the real performance of V2V system in Malaysia. Generally, the nature of this system is suitable for every place or every country but there still a chance that this system can be interfere by any existing radio wave. Moreover IEEE802.11p is still a new Wi-Fi standard so there are much more things that should be learn about this standard. Research about the communication of vehicle to infrastructure also a good idea in improving the effectiveness of vehicles communication. An infrastructure can act as beacon sharing information to vehicle or wider the communication range between vehicle. Also, provide maps that can be use with GPS to vehicle for a certain location. The infrastructures also can act as server that permits the vehicles with V2V communication system to access the internet.

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APPENDIX

GANTT CHART FOR PSM 1

Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Received Title	■														
Project Objective		■													
Project Scope		■													
Problem Statement		■													
Literature Review			■	■	■	■	■	■							
Methodology Research							■	■	■	■	■	■	■		
Report Writing (chapte 1,2,3)			■	■	■	■	■	■	■	■	■	■	■		
Report Submission														■	■
PSM Presentation															■

GANTT CHART FOR PSM 2

Activities/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Literature study															
Understanding															
Data collection															
Result & Analysis															
Conclusion															
Final Presentation															
Report Preparation															