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# Review Paper on Vehicle to Vehicle Communication for Crash Avoidance System

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**Abstract**

The objective of this paper is to provide a brief description on the proposed technologies to predict the collision between vehicles before the collision. The spectacular increase in traffic increases the demand for innovative technologies that can improve the safety and efficiency of transport systems. Road safety can be significantly improved by the use of wireless communication technologies for vehicle networks, which allows new services such as collision detection traffic management and other communication devices between moving vehicles. This paper presents an implementation of the complete vehicle-vehicle communication based on Li-Fi technology and DSRC technology based on Wi-Fi. The proposed system solves many of the problems faced by existing systems by using a GPS module instead of the conventional speedometer and also uses sensors that are reliable in areas where human intervention is involuntary or life-threatening in danger of extinction. The problems of congestion in the urban arteries increase day by day, and it is very difficult to deal with them in emergencies. Therefore, within the system, a communication unit is developed that interacts with other vehicles to free the lanes. This system aims to communicate with the vehicle in its environment using its location (i.e., using latitude and longitude) to indicate proximity. If these vehicles are in the immediate vicinity, drivers are notified by a message. In this way, drivers can communicate with each other and act according to the situation.

**Keywords:** Global positioning system; Li-Fi; Proximity sensors; Speedometer

## Introduction

In recent days, the number of vehicles on the road and the number of traffic accidents has increased significantly. The number of traffic accidents can only be reduced by introducing an intelligent and adaptable traffic management system together with the vehicle collision reporting and prediction system implemented in each road vehicle. This work aims to investigate the existing technologies used for the system to predict and prevent motor vehicle collisions. Airbags and air brakes are installed in most luxury cars to ensure the safety of passengers during the crash. All technologies are based on the integration of sensors and data processing modules, which is quite expensive and unaffordable in 90% of vehicles used in India. In light of this, researchers are focusing on implementing a cost-effective vehicle system.

The functionality of the collision prediction system module is to predict the possibility of an accident taking into account the relative speed of the vehicles. The speed and the relative positioning of the vehicles are the most important traffic parameters considered. The vision-based traffic alert system to assist the driver is also being considered in the early days, and the main intention was to warn the driver that he is predicting the possibility of a damaging traffic situation. In this system, the tracking and recognition of objects are the main milestones. The stages of stereo analysis and classification have been used in the past to implement the traffic recognition system based on views [1]. The later stages also propose an extended scheme for the recognition of objects through the combination of stereo analysis and motion analysis. When exploring the characteristics of the radar and laser sensor modules, the crash prediction system improved significantly in terms of reliability and functionality.

Communication and sensor technologies are widely considered research and development to make roads safer and smarter. Since today's vehicles are equipped with sensors that detect the environment, the additional step is to allow vehicles to communicate with each other. Intelligent Vehicle Communication is a network through which vehicles and road units can communicate with respect to safety alerts and traffic information. These connected vehicles provide a building block to improve safety and ride comfort. The growing wireless communication technologies promise to reduce the delay in the propagation of distress signals.

Active safety consists of perception and communication activities. Communication related to security involves two types of messages: periodic and event-driven messages. Periodic messages refer to the state of the vehicle such as position, speed, etc. They are used for security applications to detect dangerous situations. Event-controlled messages are used when an abnormal condition is detected [2]. The information provided after the deadline in the systems in real time is unusable and has a significant impact on the traffic safety system. The prerequisite for an ad hoc network is direct V2V communication. The wireless communication standard for ad hoc communication with V2V system in high-speed network environments must complete the data exchange within a time frame of 50 ms. Short-range dedicated communication (DSRC) supports direct V2V communication [3].

The Intelligent Transport System (ITS) has received more attention due to the new application that allows emerging wireless communications. Vehicle systems with new cooperative systems reduce the accident rate on the roads. These new traffic safety systems point to a greater need for wireless communication [4]. The challenge is to

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overcome the behavior of the unexpected radio channel and handle the rapid network changes in a timely and reliable manner. The communication of messages in real time does not require a transmission rate, but a predictable system to deliver the message before the deadline. Detecting system behavior in the worst case is usually an important feature in a real-time system [5]. We will discuss the different schemes associated with the crash prediction module in detail in this paper.

## Gps Based Technology

### Blind spot detection

The Vehicle to Vehicle Communication system processor uses GPS to improve road safety. The GPS provides information about steering angle, speed of the vehicle, location co-ordinates and path of the vehicle to the On Board Unit (OBU) of all the vehicles as shown in Figure 1. The OBU will process the data provided by GPS and the safety messages are generated in the embedded board based on the provided data and position of the vehicles. The safety messages will be transmitted and received by the RF module. The display unit displays the basic safety messages [6].

For Blind Spot Detection, two ultrasonic sensors are connected at both the mirrors of the vehicle. The ultrasonic sensor measures the distance between two vehicles and if any vehicle is in the blind zone, a buzzer will blow to warn the drivers. The ultrasonic sensor module works on the natural phenomenon of ECHO of sound. A pulse is sent for about 10µs to trigger the module. After which the module automatically sends 8 cycles of 40 KHz ultrasound signal and checks its echo. The signal after striking with an obstacle returns back and is captured by the receiver. Thus the from the sensor is calculated by the formula:

$$D = 0.5*C*(T1-T0)$$

where D- Distance of the object, C- Speed of sound (343m/s), T1- Time at which waves transmitted, T0- Time at which waves received [7].

### Real time wireless system

The wireless system consists of a main unit comprising of different functional sub units where a receiver and a transmitter are placed in the main unit which sends and collects data [8]. Major unit is the vehicle to vehicle communication for Lane clearance during the emergency situations. The unit will interact with the nearest vehicle and sends information regarding the emergency, then vehicle which gets the message will further communicates with its nearest vehicle and so on, during the slow moving traffic and will interact with the Traffic signals to clear the lane during jammed traffic [9]. The second subunit consists of sensors such as temperature and humidity sensors. These wireless sensors provide ambient temperature and humidity in real time at regular intervals. This temperature is compared to the set room temperature. If the measured temperature exceeds the threshold, the vehicle's cooling system is activated. The third subunit is the GPS unit that calculates the exact speed, the distance travelled and the location of the vehicle [10]. The GPS uses satellite technology to calculate the speed, distance and location of the vehicle. The last subunit in this system is the proximity sensors. The sensors are mounted on the rear end of the vehicle. These ultrasonic sensors detect the distance to obstacles during the reverse gear and transmit data wirelessly to the main unit located on the driver's side. The data in real time i.e., speed of the car, the distance travelled by the car; the temperature and humidity of the environment and the distance to the nearest car are shown on the LCD display [11].

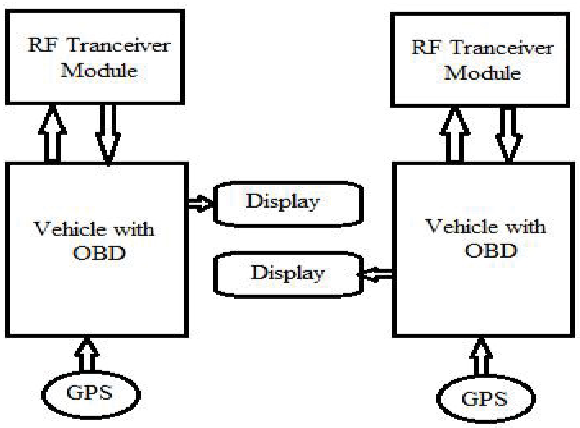


**Figure 1:** Block Diagram of Blind spot detection.

### Wireless system using microcontroller

The main concept of the system is the notification of adjacent vehicles in a vehicle collision. In the situation where a vehicle collides, its geographical position and state are transmitted to a sufficient distance. Upon receiving the information, the next vehicles can avoid possible collisions by knowing the location of the source of the alarm. At the heart of the system is a microcontroller responsible for integrating the information of all peripherals [12]. The system is accompanied by a GPS module, a GPRS/GSM module, an RF module and an accelerometer. The GPS module provides information on the geographical position of the module and therefore, on the position of the vehicle. In addition, the module can provide additional information, namely the speed and heading capability. The system can receive settings via SMS. In addition, the functionality of the system includes the ability to send SMS messages in the event of a car accident indicating the geographical location of vehicle. The accelerometer is used to provide the system with the ability to detect an accident by automatically triggering an alarm. The accelerometer provides information on the acceleration in two axes through analog signals, while the third axis would be redundant. In case of emergency, a wireless packet is transmitted through the RF module. The antenna used externally extends the range of the transmitted signal to a safe alarm announcement range [13].

The functionality of the proposed system supports two types of emergency operation, automatic and manual. The first one is activated when a collision of the vehicle is detected using the accelerometer data. When the system enters this mode, an SMS is sent according to the predefined settings, while the RF alarm transmission begins to inform nearby vehicles. The SMS and RF alarm packages contain information about the geographical location, the current time and the type of vehicle that triggered the alarm. The main difference between the first and the second is that in the manual mode, the functionality of SMS is omitted. The manual mode of operation can only be invoked by a driver's action that indicates the critical position of the vehicle on the road. Finally, in normal operation (not in emergency mode), the system detects and receives packages from other vehicles and provides information to the driver and other potential integrated systems [14].

## Can Protocol Based Technology

The design is based on the ARM Cortex-M0 controller for the implementation of the Collision Warning System (CWS) and the Collision Avoidance System (CAS) as shown in Figure 2. The alert

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warning system connected to the leading vehicle is responsible for warning the Collision Avoidance System of the next vehicle to warn its driver and relieve an accident resulting from an imminent collision in the rear [15]. The warning system calculates the deceleration generated by braking with an infrared accelerometer and evaluates the deceleration thresholds. The Collision Avoidance System receives the IR signal transmitted by the CWS and draws proper control actions based on the time calculated until the collision. The Collision Avoidance System communicates with the Electronic Control Unit (ECU) of the vehicle that controls the vehicle's brakes. The Nuvoton Nuc 140 development board is used with a built-in CAN 2.0B controller such as CAS and vehicle ECU to simulate an environment in which messages are generated to control the DC motor connected to the ECU.

The CAS interrupt architecture sends CAN messages as part of the interrupt subroutine for several duty cycles of the pulse width wave representing the braking stages. Received messages are stored in their corresponding message objects if they pass the acceptance filter protocol of the message handler. These messages are stored in the message RAM of the controller. The message controller controls the handling of the data in the TX / RX register of the CAN controller. The message is read and an appropriate reaction mechanism is adopted according to the control program (Figure 2).

The CAS only generates the message when the brake intensity is at the highest level. Upon receiving the message correctly, the ECU stops the DC motor, which is a control action generated in response to the Collision Avoidance System [16].

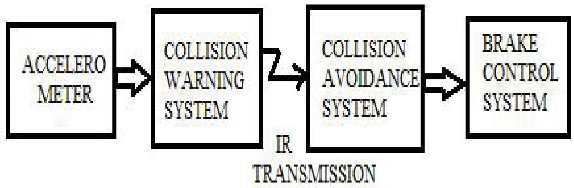


**Figure 2:** Block diagram of CAN protocol based design.

**Figure 3**: First scenario of Vehicle to Vehicle Communication using Li-Fi.

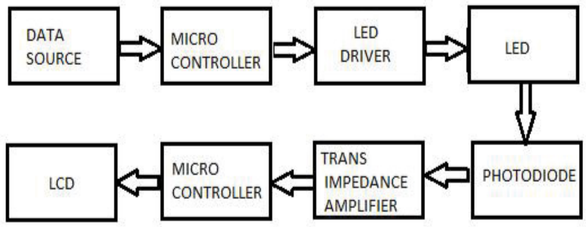


**Figure 4:** Building Block of the developed Li-Fi system.

## LI-FI Based Technology

Li-Fi technology proposes a vehicle-to-vehicle communication system that does not require a global positioning system or even a Wi-Fi or 3G wireless connection. It has been proposed to use sonar Programmable Interface Controller (PIC) that sends a short tone pulse of 40 kHz that cannot be perceived by the human ear. The echo of the signal is detected by the microcontroller. The distance is calculated from the time required to send and receive the echo signal [17].

The proposed system requires a transmitter and a receiver in each vehicle in both rear and front sides of the vehicle.

### First scenario

As shown in Figure 3 when vehicle 1 brakes, the speedometer in the vehicle detect that the current speed is lower than the previous speed. Therefore, the transmitter located in the taillights sends a message to vehicle 2. Vehicle 2 receives the message using the photodiode located in the front of vehicle 2. A notice of (Slow DOWN) will be displayed in vehicle 2 using an LCD.

### Second scenario

When vehicle 1 is in a T junction, the vehicle 1 transmits its speed information with the LED in the headlights to vehicle 2. The speed information is received by the photodiode in vehicle 2 and both the speeds are compared. When the vehicle 2 crosses the intersection while the vehicle 1 moves at high speed, the driver is warned to check the other vehicles that is nearby [18].

The block diagram of the Vehicle to Vehicle communication using Li-Fi technology is shown in Figure 4.

The data source, e.g. (Speed sensor) reads the speed of the vehicle. The sensor speed data are peak-to-peak AC voltages, so they are converted to DC voltage for the microcontroller to read. Then, the data is processed by a microcontroller (for example, to compare between current and previous speeds). The new processed data is transmitted to the LED controller. The LED driver keeps the current constant to protect the LED. Then the data is transmitted by the LED light as a carrier. In a wireless transmission of data by light, the photodiode detects the transmitted light in the form of current. The function of trans- impedance amplifier is to convert the received current into voltage. Finally, the voltage is processed through the microcontroller so that it can be read on the LCD screen.

## Applications

### Vehicle safety

In most of the industrialized countries, the highest priority is vehicle safety. The reason is the increasing number of traffic accidents due to the growing number of vehicles.

### Comfort for the driver and passengers

The comfort of the driver can be increased by turning on the cooling system when the interior car temperature exceeds the threshold value.

## Advantages

### Improves traffic management

The traffic light schedule may vary depending on the traffic congestion. Law enforcement officials can use this technology to provide drivers with real-time instructions.

### Assistance to the driver

Vehicular communications can help with parking by providing information about the other vehicles nearby.

### Avoid collisions

The driver is notified in time of a possible car accident.

## Limitation

Depending on the model of the vehicle and the complexity of the system, it is expected that the installation cost of the V2V communication system in the vehicle will be high.

## Scope for Future Work

The implemented system is just a warning system. It is not involved in the mechanics of the vehicle. Feedback can be provided to the vehicle so that the vehicle automatically brakes or changes lanes when vehicles are too close. The data of the test vehicle (e.g., an ambulance) can be transmitted at an intersection to the central location of the traffic signal. As a result, the traffic light changes from red to green and the ambulance can move quickly.

## Conclusion

Communication has opened many new opportunities for the automotive industry. This review paper has addressed all the technologies to improve traffic congestion and traffic safety. In addition, situations such as collision, delay and redundancy were analysed, which can be improved or overcome with a simple alert transmission. The GPS is used so that the V2V system processor can determine the speed, direction and position of the other vehicle. The CAN protocol system is known for its efficient control and response time. This system is quick in response compared to all other systems. It is independent of infrastructures and external networks to calculate all parameters, which in turn increases efficiency. With Li-Fi technology, the transmission of data from one vehicle to another with LED light is much easier. Compared to Wi-Fi technology, traffic problems are reduced to a very large number when using LI-Fi technology. This will lead to a cleaner, greener, safer and brighter future in this world without radio waves since radio waves have a detrimental effect on living beings. Thus, the methods discussed help us to avoid traffic accidents effectively.

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