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Connected Vehicle System for Crash Avoidance and Emergency Vehicle

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Abstract: ***These days the circumstance of Traffic is getting exceptional day by day and everyday numerous lives are lost because of accidents on streets. Particularly for crisis vehicles, the traffic is a main consideration which adds to the delay in reaching the destination. This delay can be a matter of life and death in case of rescue vehicles like Ambulance and so on. So there must be a vehicle assistance framework in each vehicle and motorbikes which not only recognize another vehicle but also gives the information about the type and location of other vehicles. This project describes the design and hardware implementation of a connected vehicle system. This system utilizes an in-vehicle gadget for gathering information about the type and location of other vehicles. This device utilizes sensor and GPS system to record data about the position and the location of a moving vehicle. Ultrasonic sensors are used to detect front and rear vehicles. It detects the front and rear end vehicle and then gives information to On-board vehicle unit. The location of the vehicle is tracked by utilizing GPS. This location data is sent to the application. The device utilizes the developing Zigbee standard as a low-cost low-power wireless ad-hoc network, to empower the device to be an individual from a Zigbee network and permit the information to be communicated to different vehicles. The sensor and GPS data used to give essential help signs to the driver.***

Keywords: Connected vehicle system, Global positioning system, Zigbee, Ultrasonic Sensors, UART communication, Arduino UNO.

I. INTRODUCTION

We have faith in the motto that sparing lives is better than everything else. Road well-being is one of the prime objectives of implementing assistance framework utilizing connected vehicle environment. Everybody needs to have an assurance of more secure vehicle. The vast majority of the mishaps are brought about by human mistake. Rate of the mishap can be decreased by planning the precise assistance framework. Likewise by considering the current substantial traffic conditions in India, in crisis circumstances, rescue vehicle administration gets exceptionally influenced. Individuals die due to not getting appropriate and opportune treatment which is a difficult issue. One approach to achieve a sans traffic development of the emergency vehicle is to stop the traffic stream in every single other way aside from the one conveying the rescue vehicle. Vehicle-to-Vehicle Communication can assist with diminishing the above issues. A CV system technology is one that offers security to the vehicular framework similarly regarding the driver and it lessens harm. Also helps to provide a traffic-free movement facility for emergency vehicles. Connected car is a development, which relies upon communication of information between close by vehicles to conceivably alert drivers regarding hazardous conditions. Also it help alert a driver that leading vehicle have to back off or told a user that it's undependable to continue through a crossing point in light of the fact that another vehicle is quickly approaching. The advanced driver-assistance systems (ADAS) applications are still in their early days and it is required to address several issues by assessing the relationship between human behaviour and applications. should take into account this low visibility driving environment.

Section II, is the survey of the previous works that has been carried out in this field that makes us to understand the requirements and the loops to be recovered. Section III gives the methodology used to achieve the results. In Section IV, the implementation of the project is discussed. Section V is about the results achieved.

A. Problem Statement

This project mainly consists of three scenarios for the vehicle safety system.

1) *Accident / Vehicle Crash with leading / rear end vehicles:* Most of the vehicle accidents occur due to bad weather conditions while driving. The drivers may not realize that a leading vehicle is slowing down, and they need to back off.
2) *Intersection Crash at the road junctions:* One of the deadliest types of car accidents is the intersection crash. There are different factors that contribute to the severity of such intersection crashes, including the impact angle and speed at which intersection accidents typically take place.

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3) *Emergency car stuck in a traffic jam:* During a traffic jam, the emergency vehicle will be stuck at the traffic signal intersection. This is because the road customers furthermore holding for the traffic signal move to green. This is a fundamental problem since it can create an emergency situation to become complicated.

B. Objectives

1) This project aims at designing a driving assistance system using connected vehicle technology to avoid accidents with leading vehicles and to provide a traffic-free facility to emergency vehicles.
2) It's another goal is to improve time response in the system and it can provide safety to human.
3) This project utilizes positioning and communication technology for their operations to provide information on the location of vehicles in relation to other vehicles.
4) Another objective of this system is that assist the driver during poor visibility.
5) It assists with maintaining a strategic distance from the rescue vehicle and other emergency vehicles holding up in heavy traffic by automatically clearing the track of the vehicle from traffic situations.

II. LITERATURE SURVEY

These connected vehicle systems refers to the empowering technologies to interface vehicles inside and outside their operational environments. It helps to improve safe vehicle driving, power savings, and so on [1]. Vaibhav V Ukarande, Gaurav R Bhalekar developed driver assistance framework using Zigbee communication to keep away from mishaps at T-Junction. Using this Zigbee framework safety messages appear at the intersections [3]. Mihai Negru, Sergiu Nedevschi presents a vehicular system that fit for distinguishing fog from a single picture. Then, inform the vehicle user about the mist thickness and the visibility distance. This technique depends on a solitary in-vehicle camera and is advancement over present mist recognition arrangements, regarding velocity and precision [4]. Shanmughasundaram R, Prasanna Vadanan S, Vivek Dharmarajan proposes a V2V correspondence framework for crisis vehicles, for example, Ambulances, Firefighting vehicles, Police vehicles and so on. Utilizing system emergency vehicle can travel quicker through traffic-thick streets utilizing Li-Fi technology [5]. Usman Khalil proposes a novel methodology dependent on the ultrasonic sensor to maintain a strategic distance from crashes. Accident recognition utilizing ultrasonic sensor will give the option to detect an accident [7].

III. METHODOLOGY

This section provides the methodology used for connected vehicle system. Also explains the block diagram and flowchart of the connected vehicle system. Connected vehicle technologies are utilized to connect a vehicle to other vehicle. An connected vehicle incorporates various communication devices. These various communication devices are introduced in the vehicle. CV systems empower in-vehicle network with different devices present in the vehicle. Likewise, it engages the relationship of the vehicle to external gadgets and applications. CV applications incorporate traffic protection, driver assistance, positioning using global positioning systems (GPS) and telematics to connected cars.

This project proposes connected vehicle technologies to reduce the problems discussed in the earlier section. This system planned for empowering information exchanges between vehicles and its surroundings. CV safety applications are intended to improve situation awareness and minimize car crashes. This proposed solution mainly consists of three stages. They are

1) Detection of Vehicles / Infrastructure(Traffic controller)
2) Establishment of the connection between vehicles / Infrastructure
3) Communication between vehicle to exchange vehicle information

In the first stage, the system detects the nearby vehicles or infrastructure in its limited range to establish the connection. It uses the Global Positioning System (GPS) or sensor system to detect vehicle location. GPS will give data about vehicle speed, co-ordinates of the location to the On-Board Unit (OBU) of the considerable number of vehicles. The On-Board Unit (OBU) will process the information given by GPS. Once other vehicles detected in the limited range, the second stage will establish the connection between vehicles / Infrastructure using connected vehicle technology.
Then communication is started between connected vehicles to exchange the information. Connected vehicles could significantly diminish the quantity of fatalities and wounds brought about by accidents on our streets and highways. The overview of connected vehicle technology is shown in the underneath figure.

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Figure 1: An overview of connected vehicle technology system

Connected vehicles systems are relied upon to be an essential part of automated driving as they will permit the exchange of sensor information among vehicles and cooperative localization between automated vehicles. It utilizes the IEEE 802.11p (WLAN) protocols to set up communication to trade messages holding vehicle data. The system utilizes data from different vehicles and afterward discovers that if a alert to the vehicle's user is required. If it is an emergency vehicle, it sends the message to the traffic controller unit to provide a traffic-free lane.

The block diagram of proposed connected vehicle communication is as shown in figure 4.2. Vehicle data will be shared between V2V and V2I, for example, traffic units. System mainly consists of On-Board Unit, location detector and communication module.

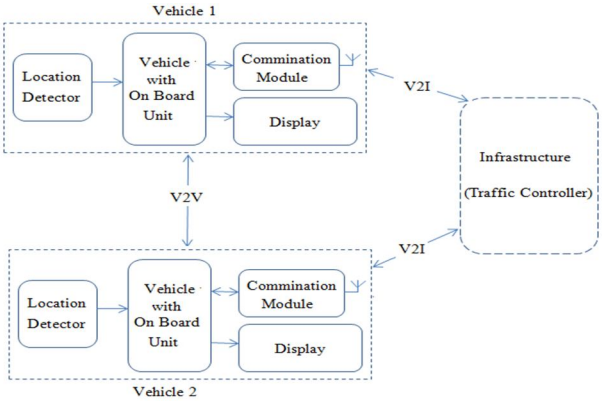


Figure 2: Block diagram of CV system

Location detector finds the close by vehicle or infrastructure by utilizing GPS and given to the OBU of the vehicle. For the front and rear vehicle detection sensors are used as a location detector. At that point, it will produce the security messages relying upon the located area and kind of cars. The security messages will be sent and gotten by the communication equipment. Essential security messages will be shown on the LCD to give attention to the driver. The overview of hardware implementation and working of the connected vehicle system is explained in the below flowchart.

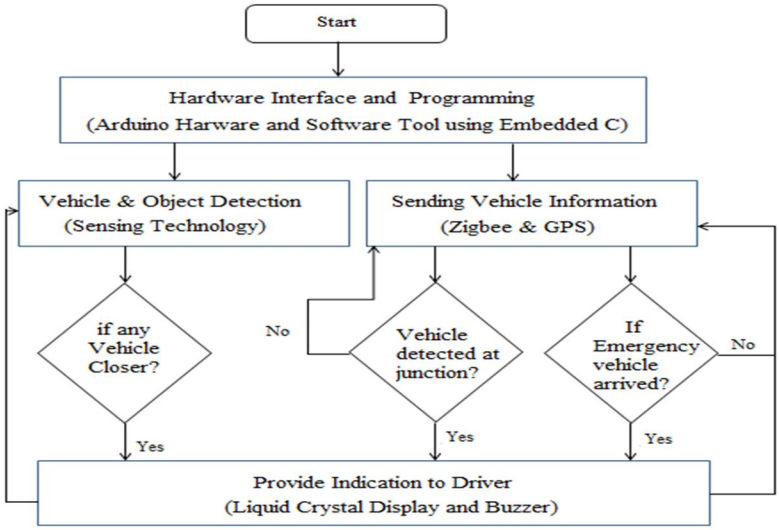


Figure 3: CV communication system flowchart

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a) Connected vehicle communication hardware model is implemented using the Arduino controller. Hardware interface will be done using Arduino software tool with embedded C programming.
b) The system continuously detects closer vehicles using sensor technology. If any vehicle detected, it will generate a safety message to the driver using the LCD display and Buzzer.
c) The system continuously sends vehicles information using GPS and Zigbee module. If an emergency vehicle detected, it will generate a safety message to the driver using LCD display and Buzzer along with the location and type of the vehicle.

IV. IMPLEMENTATION

This project requires a sensor system and a GPS module to detect other vehicles and their locations. Also requires a communication module to establish the communication between vehicles and the traffic controller. An LCD display and buzzer are used to provide safety messages and display the type and location of the vehicles. Arduino is used as the simulation software. Detailed block diagram of On-Board vehicle unit as shown below.

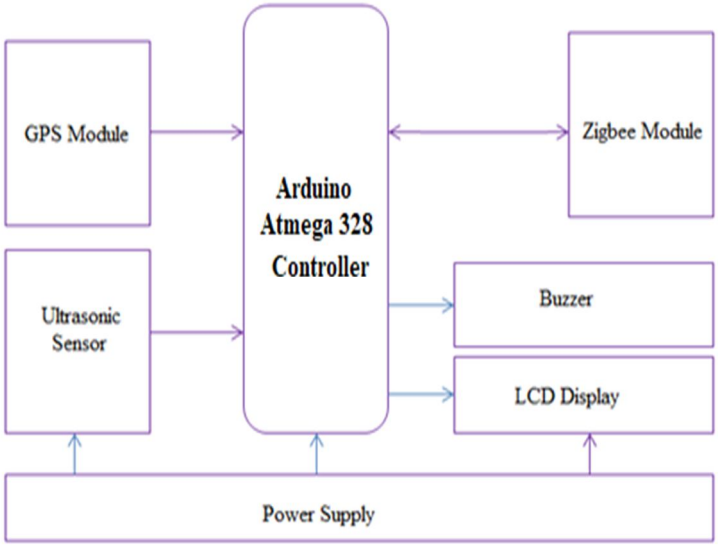


Figure 4: Block diagram On-board vehicle unit

Implementation of On-Board vehicle unit mainly consists of the following sections
1) Implementation of distance calculator using Ultrasonic sensors
2) Establish communication between two vehicles
3) Implementation of the Location detector
4) Implementation of LCD display interface and power supply

A. Object Detection Using Ultrasonic Sensors

Ultrasonic Distance sensors (HC SR-04) are used to determine the distance between vehicles. It has got two transducers, one for sending ultrasound and the second one for accepting the echo signal. Based on the time it takes for an echo to arrive we can measure the distance; since we definitely know the speed of sound in air which is around 343 m/s.

B. Steps for Interfacing

1) To start distance estimation a short pulse of 10us is send to trigger pin.
2) After this, the HC-SR04 Module will transmit a burst of 8 ultrasonic pulses.
3) Then it will yield a HIGH signal for the amount to the period taken for the sound waves to reflect back.
4) The pulse HIGH time is estimated and afterward utilized to find the distance.

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C. Distance Calculations

The speed of sound in air is,

$$Vs = 343 \text{ m/s} = 0.0343 \text{ cm/us}$$

We likewise know the time it took to sound waves to transmit and repeat back, let's call it T. Presently, by utilizing basic distance formula; we can determine the distance as:

$$\text{Traveled Distance} = \text{Time taken} \times \text{Speed}$$

$$DT = T \text{ seconds} \times 343 \text{ m/s}$$

Presently, since ECHO ON-Time in microseconds and furthermore to get the distance in centimetres.

$$DT \text{ in cm} = T \times 0.0343 \text{ cm}$$

After this, we separate the processed an incentive by 2 since the waves have traveled twofold distance.

$$D=\frac{0.0343 \times T}{2} \text{ cm}$$

Flowchart of distance calculation using the ultrasonic sensor is shown below.

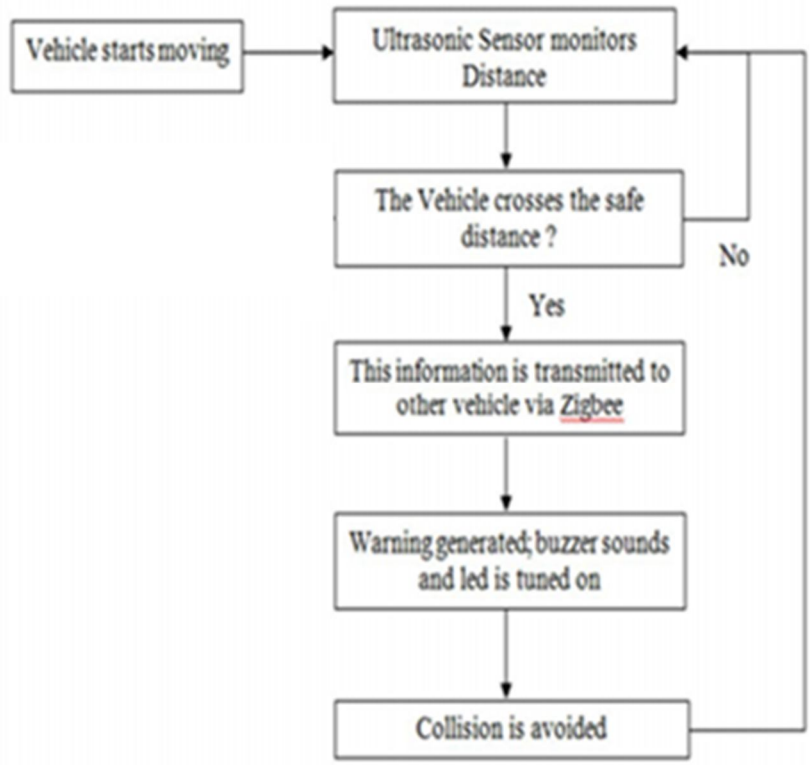


Figure 5: Object Detection flowchart

1) *Location Detection Using GPS:* The GPS module is utilized to give area (location) details of vehicles. The GPS module is constantly communicates sequential information as sentences as indicated by NMEA norms. To convey utilizing UART, it simply needs three fundamental signs which are to be specific, RXD (get), TXD (communicate), GND (shared opinion) signals. So to interface UART with Arduino Uno Atmega328 microcontroller, simply need the fundamental signals.
2) *Establish Communication Using Zigbee:* Zigbee module is used to establish communication between two vehicles. It is placed in the On-Board Vehicle unit. Below figure shows interfacing the Zigbee module with Arduino Uno Atmega328 microcontroller. The Zigbee modules operate at the 2.4 GHz frequency.
3) *Indication using LCD Display:* Display and buzzer is used to provide awareness to the driver about location and type of other vehicles. LCDs (Liquid Crystal Displays) are used for displaying warning messages to assist vehicle driver. The control pins used to design the LCD in information (data) mode or command mode. The control pins utilized to configure read mode or compose (write) mode.

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A prototype of vehicle 1 and vehicle 2 is shown in the below figure.

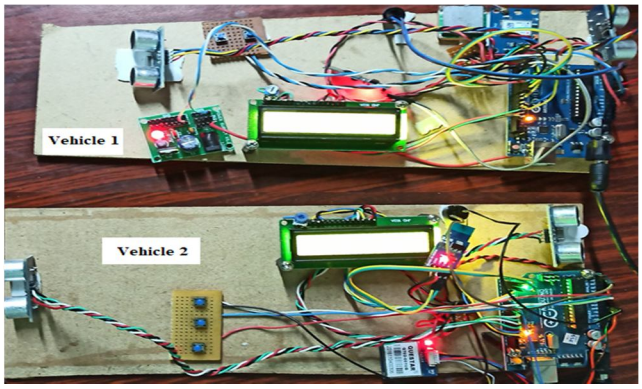


Figure 6: Project Prototype

V. RESULTS AND DISCUSSION

Hardware prototype of vehicle On-board units is implemented and tested. Hardware prototype uses two ultrasonic sensors and a GPS module to detect type and location and type of another vehicle. The connected vehicle system is designed to provide solutions to the following three different cases. They are

1) *Accident / Vehicle Crash with leading / rear end vehicles:* Designed connected vehicle system helps to reduce accident/vehicle crash with leading and rear end vehicles. It uses ultrasonic sensors to detect front and rear vehicles. It continuously detects front and rear end vehicles, and calculate the distance between vehicles then it warns a driver when other vehicles arrive closer using LCD display and buzzer. Indication of front and rear-end vehicle detection shown in the below figure.

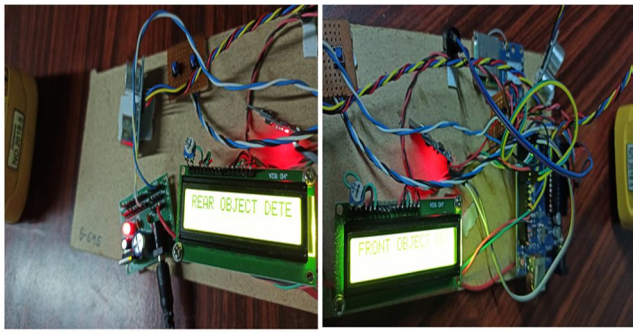


Figure 7: Detection of leading / rear end vehicles

2) *Intersection Crash at the road junctions:* Designed connected vehicle system helps to reduce accident/vehicle crash at the intersections. It uses Zigbee communication to detect other vehicles which are coming towards the intersection from another road. In this, one specified code is assigned to each vehicle. Vehicle On-board unit continuously sends vehicle code (vehicle number) information using the Zigbee module. If any vehicle come to within the communication range it receives the vehicle code (vehicle number) information, then it compares with its own vehicle code. If it is different then it warns a driver using LCD display and buzzer along with the GPS location of that vehicle.

Indication of the vehicle at the intersection shown in the below figure.



Figure 8: Detection of vehicles at the road junctions

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3) *Emergency car stuck in a traffic jam:* Designed connected vehicle system helps to provide a traffic-free moment for emergency vehicles such as ambulance, fire brigade vehicle, etc. It uses Zigbee communication to detect whether nearby vehicle emergency vehicle or not. In this, one specified code is assigned to emergency vehicles. Vehicle On-board unit continuously sends vehicle code information using the Zigbee module. If an emergency vehicle comes to within the communication range it receives the vehicle code information, then it compares with its own vehicle code. If it is an emergency vehicle then it warns a driver/traffic controller to provide free traffic moment for an emergency vehicle using LCD display and buzzer along with the GPS location of that emergency vehicle. Indication of emergency vehicle arrival shown in the below figure.

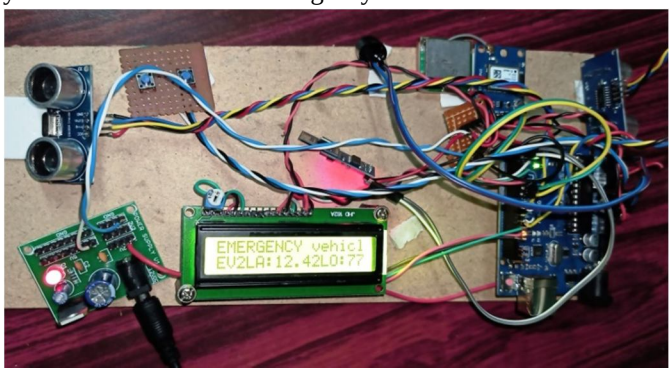


Figure 9: Detection of emergency vehicle

VI. CONCLUSION

The proposed connected vehicle system efficiently provides the location and type of other vehicles. A connected vehicle system is proposed to reduce accidents with front and rear vehicle and possible cash at junctions. Also, provide free traffic facility to emergency vehicles. There are so many numbers of automatic accident avoidance methods are available. These methods typically are not designed for motorbikes and cycles.

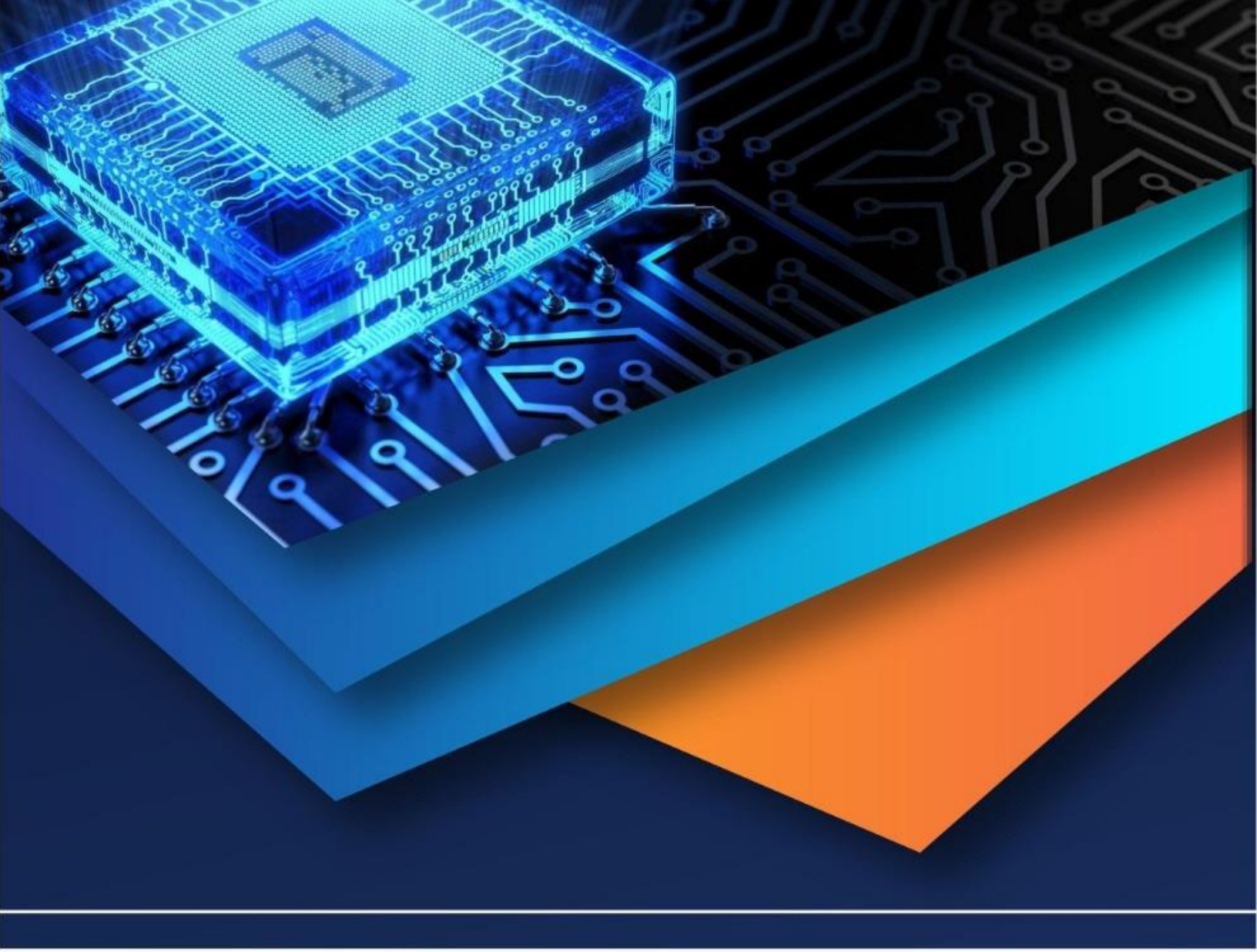
This system is consistently good as it utilizes ultrasonic sensor modules to detect the vehicles. In this, the ease ultrasonic sensor is utilized to recognize another vehicle and a GPS module is utilized to discover the area of vehicles. Communication between vehicles to detect and share type and location is achieved using Zigbee.

Using this connected vehicle system, we can reduce the accidents with front and rear vehicles and possible crash at intersections. Also, it helps to provide a traffic-free facility for emergency vehicles. This simple system can be installed in motorbikes and cycles. There are some weaknesses in this proposed connected vehicle system. The GPS signals could be abstracted by tall buildings. Advantage is that GPS is not as expensive. Limited ZigBee coverage range is another limitation.

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