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A proposed System for Vehicle-to-Vehicle Communication: Low Cost and Network Free Approach

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Abstract

Objectives: to propose a system which provides an alert and safe driving scenario to improve the crash prevention performance. **Methods/Statistical Analysis:** In this method, an LCD type display is installed at the back of a car for displaying the warning signs a driver has seen to the vehicle which is coming behind. A touch-enabled and a voice recognition devises are mounted on the dashboard for receiving the inputs from the driver of the vehicle which is connected a wireless transceiver, a microcontroller device as well as a display device on the back side of the vehicle so that the driver can alert the vehicle which is following. **Findings**: The proposed method costs less to implement and it is completely networking free since it does not require any establishment of the connection between vehicles. It can be easily implemented in all type of vehicles. **Application/Improvements:** This vehicle to vehicle communication system is more compact and accurate since the driver is directly conveying the alert to vehicle which is following it.

Keywords: Micro Controller, Network Free, Transceiver, Vehicle to Vehicle Communication

1. Introduction

Car to car communication is a network-based technology proposed for vehicles which provides comfort in driving and safety to the vehicles connected with it[1]. In this paper, an application of Vehicle to Vehicle (V2V) communication which does not require any infrastructure is proposed. This methodology is more robust since this vehicle to vehicle communication method does not require any network-based architecture or protocols. Vehicle-to-vehicle communication can be used to distribute various messages of multiple actions which are generated by the vehicle by using various sensors present in the vehicle. services such as warning about an accident, traffic jams information or messages about a rescue vehicle which is approaching. Moreover, information about the appearance of road or conditions about the weather can be also transmitted. Detailed vehicle to vehicle services such as warning on direct collision or intersection between two vehicles and its assistance with the complete information about the traffic is mentioned more detailed manner. Car to Car communication proposes the vehicle with the advanced technologies which can make it as a smart methodlogy[2]. Based on the report of World Health Organization (WHO), Saudi Arabia is at the second rank among all Arab countries and 23rd among all the countries in the world terms of deaths which are caused by road accidents[3]. In general, thousands of accidents are

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happened due to the adverse conditions of road quality[4]. In spite of that, various other factors namely mechanical problem in the vehicle, conditions about the bad weather and inability of the driver to ride etc also gives an ambient contribution for these road crashes. Hence, if the vehicle's driver is given a warning about the danger which is upcoming before a second of the impact, then 60% of these collisions could be stopped[5]. Even though, designing a fully automated and modified vehicle to vehicle communication scheme is still a challenge. At present, this system is in the stage of active research and development by various motor corporations such as General Motors, BMW, Honda, Audi, and Volvo etc.

A prototype for an inter-vehicular based communication system with consists of four vehicles using infrared rays was developed[6]. A very high frequency based technology was implemented by Ohio State University for the process of communication between inter-vehicle in[7,8] proposed and developed an inter-vehicular based communication system which better suits for all kinds vehicular based experiments throughout the industries. It is also based on scientific and medical band technology for communication. For the purpose of achieving an enhanced vehicular based communication system, the network-based communication technology was considered later on[9] developed and applied a communication-based technology to the system based on inter-vehicle communication for evaluating the validity of their system. Moreover, wireless local area network based off-the-shelf technology such as microwave technology, infrared technology, and millimeter wave-based technology is also adopted and used in this vehicle to vehicular communication systems in[8,10,11,12]. Due to the advanced development of these wireless based systems such as 3rd generation and 4th generation based technologies, Recently, the vehicular-based networking is more improved by its application. This provides a very high bandwidth and frequency for transmitting data in between the vehicles as well as to the networks. Then, the attention of these vehicular based communication-based systems turned to IEEE 802.11 based methodology. In[13] implied an IEEE 802.11a to conduct a V2V communication platform and analyzed the performance of the channel. In[14-16] used IEEE 802.11b as the radio based protocol for communication which is used to design a V2V communication prototype system. In[17] used IEEE 802.11n based devices for analysis of vehicular communication systems. In[18] proposed a new methodology of 802.11p-based ad hoc vehicle-to-vehicle communications for application for urban realistic urban mobility. In[19] proposed a novel real-world car traffic dataset which can be used in the performance evaluation of vehicular ad hoc networks. Inter-vehicle Communication Systems (IVCs)[20] depends mainly on direct to direct type of communication between various vehicles in order to maintain the needs of a communication in various large class of applications such as avoidance of collision, assistance of vehicle passing etc. This IVC system can be augmented or replaced in some situations by the infrastructure present at the roadside. This technology allows the access of internet and several other applications to the vehicle. A detailed discussion about the broad classification of V2V communication systems is presented in section 2. The term vehicular ad-hoc network was introduced recently for the application of multi-hop networks present in major vehicles. These types of vehicles mainly do not rely on infrastructure present on the roadside. In this vehicular ad hoc network, single-hop networks are also included in some advanced V2V communication systems. The IVC systems mainly focus on various Medium Access Control (MAC) protocol and other and routing issues which in particular points on the various misconceptions existing between the need for IVC based applications for effective communications. These services were offered some existing routing protocols. Various applications enabled by vehicular based communication systems are classified into the following categories. The most commonly used application is related to the safety of the public and the coordination between them with the traffic. Applications such as traffic management, information support for travelers, etc are provided by this kind

of vehicle to vehicle communication technology. For each type of application, addressing is considered based on its real-time requirements and the type of communication of vehicles which is necessary for its effective implementation. This paper mainly focused on a vehicle to vehicle communication system which is designed without any other assistance such as roadside infrastructure wise.

This paper is arranged as follows. Section 1 describes the introduction of the car to car communication. Section 2 shows the various types of vehicular communication systems. Section 3 describes the proposed methodology with its materials and methods. Section 4 depicts working principle of the proposed methodology. Section 5 explains the safety measures obtained from this methodology. Finally, Section 6 presents the conclusions and future enhancements in this work.

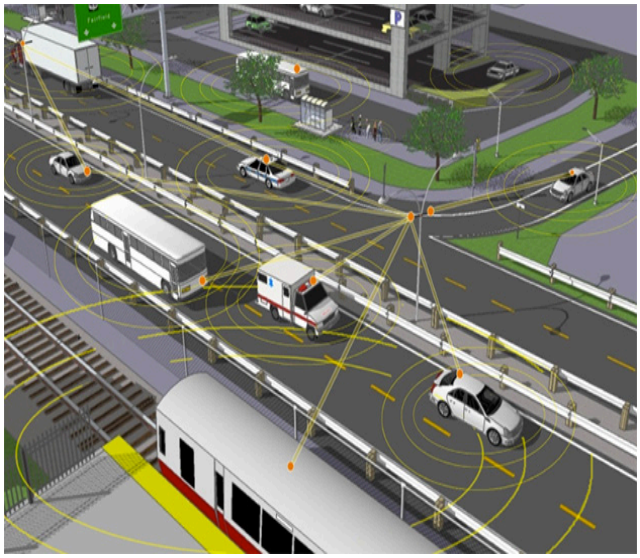
2. Types of Vehicular Communication System

Various services and solutions which are existing for vehicular communication based on networks that involves multiple V2V activities, vehicle-to-infrastructure and vehicle-to-pedestrian technologies are proposed by the previous researchers[1,3,6,20]. Following are the various types of vehicle to vehicle communication schemes available at present for avoiding the collision between the cars and to enhance the driving safety.

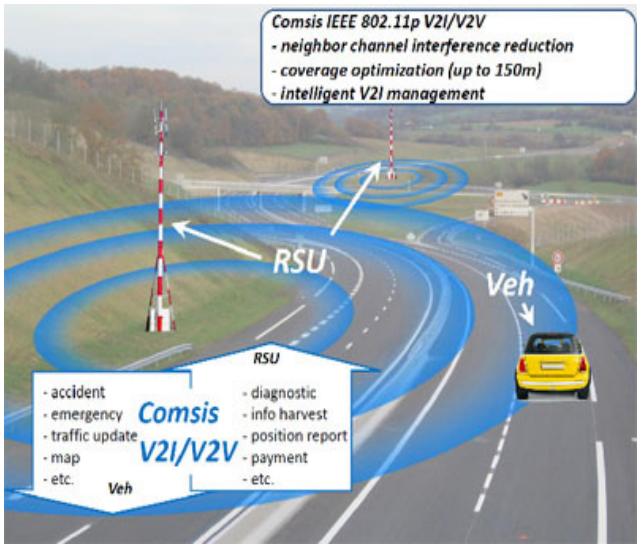
2.1 Vehicle to Vehicle Communication

Vehicle-to-vehicle communications[21] shown in Figure 1(a) consists of an inbuilt wireless network infrastructure in which the automobiles can send messages to each and every vehicle about the information at which what is happening in real-time. These data may include speed of the vehicle, the location of the vehicle, travel direction of the vehicle, breaking destination of the vehicle and capacity of the vehicle and stability loss of the vehicle. A short-range based communication scheme was used in this V2V technology.

2.2 Vehicle to Infrastructure



(a)



(b)

Figure 1. (a) Vehicle-to-vehicle communication, (b) Vehicle-to-infrastructure communication.

Communication

Vehicle-to-infrastructure communication[21] shown in Figure 1(b) is a model for a vehicular based communication system. It allows the vehicles to communicate by sharing the information with various components that are used for supporting the system of highway in a country. These components include RFID based readers which

are connected with cameras, traffic lights, each and every lane markers, various streetlights, and all the meters that are used for parking. This vehicle to an infrastructure based communication system which contains a wireless and bi-directional data system. In this system, all the data from components of various infrastructure can be sent to the vehicle through an ad hoc based network. A similar process is done for sending the data from the vehicle to infrastructure. Same as that of the vehicle-to-vehicle communication, this vehicle to infrastructure based communication uses predefined shortest path communication frequencies for transferring the data. Since these architectures require more network and infrastructure, it is necessary to propose a simple vehicular communication which rectifies the drawbacks present in these types of vehicular communication system.

3. Proposed System

In this proposed work, the application and services for V2V communication are only based on simple cost reduced and network free architecture which do not require any infrastructure. The architecture of the proposed system is shown in Figure 2. The proposed model consists of two input devices which are connected to a receiver. The input devices are mounted on the dashboard of the vehicle. An 8051 series microcontroller is connected to the receiver, a transmitter and along with an output device. An AT89v651 microcontroller is equipped with a power supply along with all the devices. A distance sensor is mounted on the back side of the vehicle. The user can access the control of input device which is present in his vehicle. whenever the user encounters any abnormal or irregular driving circumstances, he can convey the situation through the output device for the forthcoming vehicle by clicking the input touch device or the voice recognition device.

3.1 Input Device

In this work, two types of input devices were used. First one is the touch device and the second one is a voice recognition sensor. Both the input devices are mounted on the dashboard of the vehicle. The touch device has an

Table 1. Types of Warning Signs and its Detailed Description

Sl. No	Type of Warning	Description
1	HAZARD!	Any possible source of danger on the road or near the road which leads to a crash.
2	WRONG ENTRY	Any possible entry of vehicles which is in wrong side
3	ROAD UNDER CONSTRUCTION	Appearance of a construction in the road
4	FOG / MIST	Appearance or sudden arrival of FOG/ Mist.
5	SANDSTROM	Appearance or sudden arrival of Sand Strom
6	ACCIDENT	Appearance or sight of an accident
7	DAMAGED ROAD	Appearance of a damaged road
9	CROWDED	Appearance of a busy road
9	CROSSING AHEAD	Appearance of a crossing in the middle of the road
10	KEEP DISTANCE	Encountered a forth coming vehicle as too closer

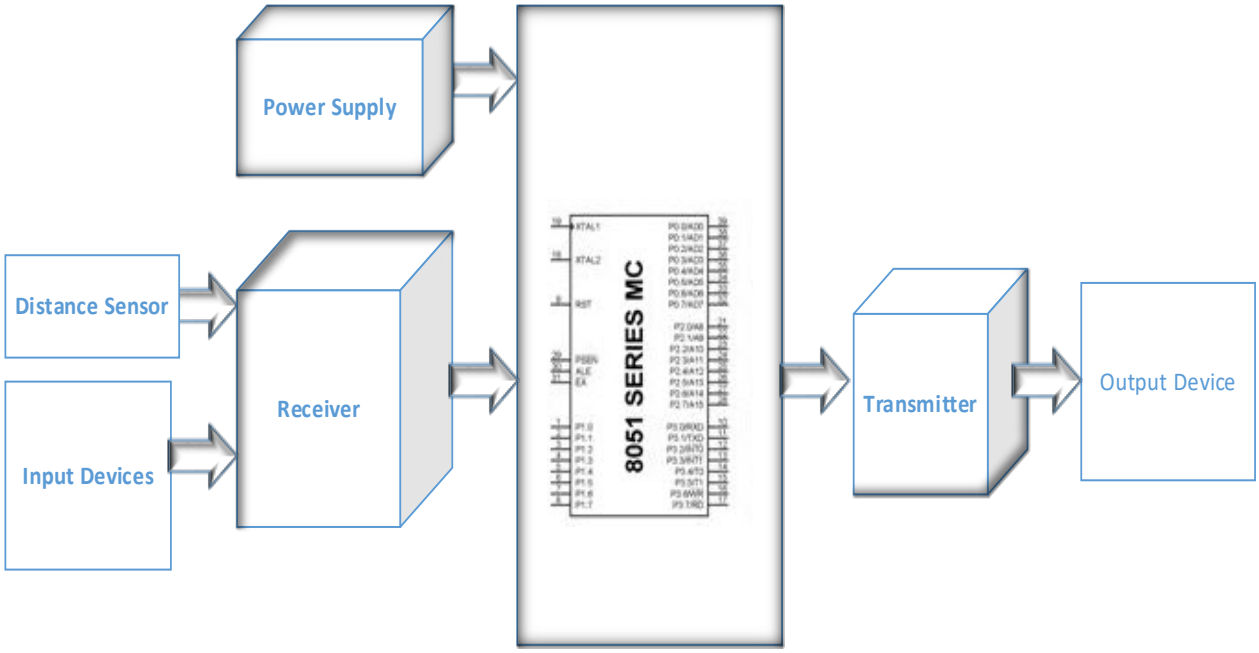


Figure 2. Proposed Architecture.

application as shown in Figure 3 which enabled the user to give the input towards the microcontroller. The device enabled the communication between the user as well as the microcontroller. When the user is encountering or approaching any type of inconveniences in the road, the driver can touch the appropriate button present in the touch device so that the exact contents present in the button is displayed in the output device which is mounted on the back side of the vehicle. The list of hazards or inconveniences a driver can face while driving is already inbuilt in the microcontroller. It is mentioned in Table 1 with its detailed description. The second category of the input device is a voice recognition sensor which senses the voice of the driver and automatically detects the type of inconvenience the user is faced or spelled from the list of word or voices present already. At present, the input devices are supposed to be designed for both English and Arabic languages as shown in Figure 2(d). When the user clicks the screen in any of the two languages, both the languages are displayed in the output LCD screen for the forthcoming vehicles driver's convenience.

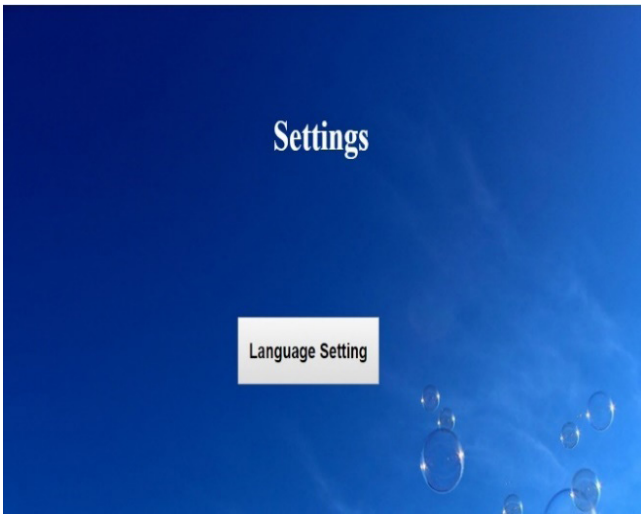
3.1.1 Input Interface

The prototype of input interface present in the proposed system is shown in Figure 3. Figure 3: (a) is the interface for the welcome screen which is visible to the driver. Figure 3 (b) is the settings screen at which the driver can set the interface as well as the language settings. Figure 3 (c) and (d) are the language settings screen at which the user can change the language accordingly. Figure 3 (e) is the window proposed for selecting the warning message.

3.2 Micro Controller

The microcontroller can be defined as a microchip which consists of programmable input and output peripherals which is connected to a processor and a memory. These embedded chips are used due to its various advantages in this proposed work. The microcontroller is designed to process various tasks based on the requirement of the system. An AT89v651 microcontroller is used to perform the complete tasks present in this methodology. The microcontroller is interfaced between all the components present in this system. Whenever it receives the input sig-

(a)



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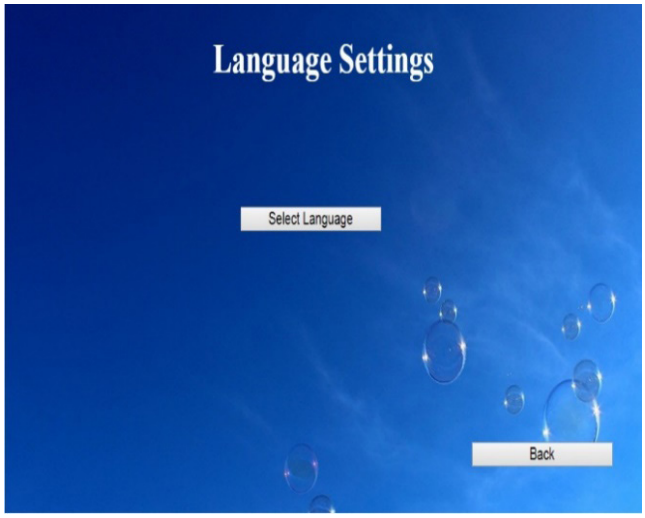

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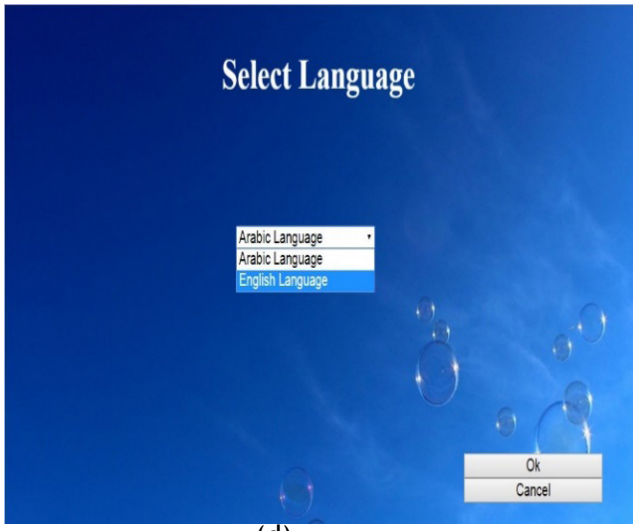

(d)

(e)

Figure 3. (a) Interface welcome screen, (b) Settings Screen, (c) Language Settings Screen, (d) Selecting Language, (e) Window for Selecting the Warning.

nals from the input devices, it checks whether the input is a touch event or a voice command. Depends upon the type of inputs, it sends the commands to the activators. The activators initiate the corresponding devices to act according to the microcontrollers commands.

3.3 Transmitter / Receiver

A transmitter is a device which is used in telecommunications systems which produce radio signals for the purpose of transmitting or receive data with the help of an antenna based architecture. A radio frequency alternating current generated by the transmitter which is then forwarded towards the antenna. The antenna further converts or transmits it as radio waves. In general, there are many types of transmitters are available which depends on the standard. In recent devices, transmitters based on Wi-Fi, Bluetooth, NFC, and cellular are being implemented and used. A receiver is a device which is used in telecommunications systems which receive the radio signals sent from the transmitter with the help of an antenna based structure. The receiver receives the signals from input devices and sends it towards the microcontroller. Based on the input, the microcontroller processes the signal and gives the command to the transmitter. Here in the proposed architecture, a Wi-Fi-based transmitter and receivers are supposed to be designed.

3.4 Distance Sensor

A distance sensor otherwise called as a proximity sensor is used to emit signals in the form of an electromagnetic field which is infrared in nature. It receives back the signals and also searches for changes in the return signal. It is shown in Figure 4. The maximum distance that this sensor can detect can be called as a nominal range. In this proposed model, two sensors are supposed to be designed each on the left and right side of the vehicle at which the proposed model is to be implemented. The distance sensor is set to emit an electromagnetic field at a set distance of 10 meters which is the defined normal range. Whenever a vehicle is reaching behind within the normal range, automatically the sensor detects the presence of a vehicle and sends the signal towards the microcontroller. The microcontroller sends the respective warning message to the output LCD display.

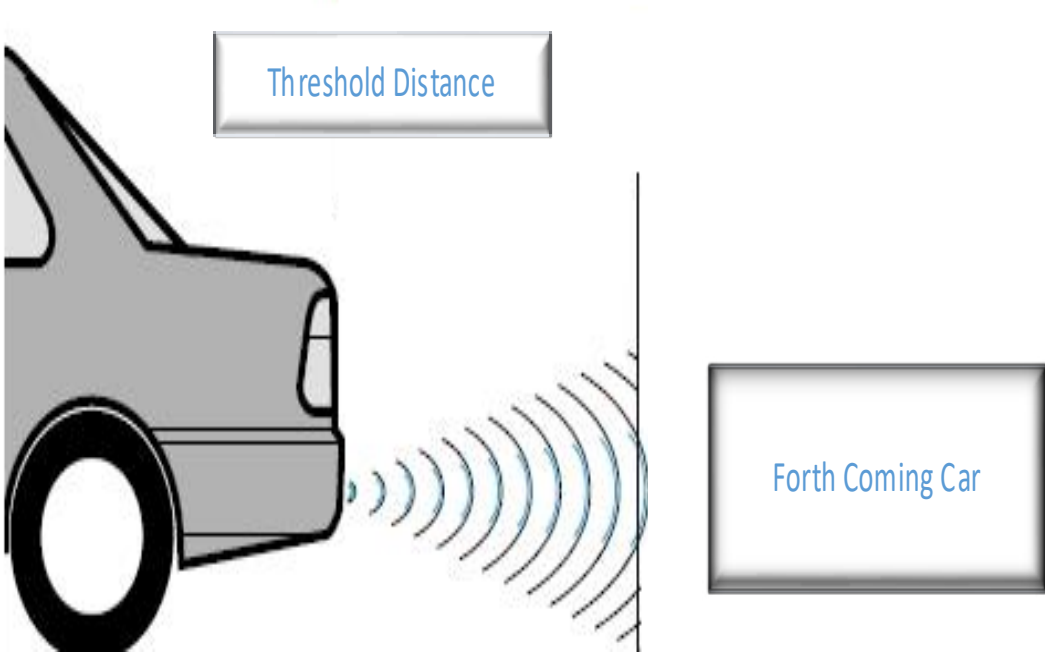

Figure 4. Working of Distance Censor.

3.5 Output Device

In this research, the output device is an LCD display which is fixed at the back of the vehicle. at which the proposed system is implemented. The Output device is connected to the microcontroller. When the microcontroller decides the type of warning message to be displayed, it sends the signal to the transmitter, the transmitter transmits the respective earning message it received from the microcontroller towards the LCD display. Sample Outputs of LCD Displays are shown in Figure 5 where four types of warning messages along in two languages are displayed.

4. Working Principle

The proposed system contains two types of input devices mentioned in section 3.1 which is interfaced to a receiver along with the microcontroller. The receiver receives the signal and sends it to the microcontroller. Microcontroller process the input. There are three types of inputs that can be given towards the microcontroller. One is from the dashboard-mounted touch type and the other one is from voice recognition device. Second is from the distance sensor mounted on back side of the vehicle. A threshold for a distance between two vehicles is already programmed. The threshold is fixed at ten meters. When the forthcoming vehicle comes within the set threshold distance, automatically the sensor senses the distance and displays a warning message to the forthcoming vehicle via the output display as shown in Figure 6. Here, the transmitter transmits the signals received from the microcontroller with respect to the signals received from the input device.

5. Discussion

Safety is considered an important concern while driving vehicles. Most of the vehicle to vehicle communications

Figure 5. Sample Outputs of LCD Display.

Figure 6. Sample Output of LCD Display fixed at rear.

are designed to maintain the safety and security of the passengers traveling in the vehicles. In[7] developed a technology-based very high frequency was implemented for the process of communication between inter-vehicle at the Ohio State University. In this proposed work it does not require more high-frequency infrastructures. In[20] implemented a low-cost approach which can be applied to the real-time vehicular communication system. Our approach is more reduced in cost since it does not require any infrastructure for establishing the communication between vehicle to vehicle. It is considered as more simple and robust since it requires minimum components. In[19] developed a model using real-time traffic dataset. However, in our proposed method, real-time datasets are not necessary. It is easy for any user to use the system more effectively without any inconvenience since it incorporates both the touch and voice type input devices. When the user clicks the screen in any of the two languages, both the languages are displayed in the Output LCD screen for the forthcoming vehicles driver's convenience as shown in Figure 6.

6. Conclusion

This work presented a novel method of communication between vehicles running in the roadway. This method can communicate more effectively with the successive vehicles present on the road. It is more compact and cost-effective since there is no need for any infrastructure or networks for establishing a connection between the vehicles compared to existing schemes. In this method, two types of input devices are connected to the microcontroller through the receiver. The processed information is further displayed in an output device which is connected to a microcontroller through the transmitter. Using the proposed system, whenever the driver encounters any abnormal or irregular driving circumstances, the user can display the situation for the forthcoming vehicle by clicking the input touch device. The proposed system is designed in a way such that it can ensure the safety of forthcoming vehicles and reduces chances of upcoming driving inconvenience faced by the driver. The main contribution of this paper is to give future directions to the vehicle to vehicle communication development as well as to the research. Future enhancements in this research can be a system of the device which is built with a global positioning system device and increasing the input language.

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