Car Anti-Collision and Intercommunication System using Communication Protocol

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Abstract*: The wireless communication technologies enabled vehicles on a highway to communicate, in order to share state information and information to avoid potential collision. This paper discusses a protocol which avoids vehicle accidents. The vehicle state information is being obtained using ultrasonic sensors, to predict potential accident and accordingly reduces the vehicle speed. This protocol provides warning message when the safety distance is reduces than the safety limit. Here, the car will be equipped with an ultrasonic sensor which will continuously track for any obstacles from the front side. If the obstacle is detected then the microcontroller will continuously compare the distance given by the ultrasonic sensor. If distance goes on reducing indicating that the front car is coming closer to the current car then the microcontroller will start applying brakes until the distance is within safe limit. This paper discusses the various sensors and its types.*

Keywords*:* Anti-Collision System, Braking System, Sensor, Communication Protocol.

1. Introduction

The periodical improvement in the technique gives human race a new height. After independence, the number of vehicles subsequently increased but in last two decades it spreads drastically in every level of the society hence safety becomes main concern.

However, due to human avoidance, circumstantial error and negligible accidents occur. Many people lost their life every year in vehicle collision due to driver's inability to keenly observe the vehicles vicinity while driving [2].

A large number of vehicle accidents happen each year. Safety is a necessary part of man's life. According to the statistics provided by National Highway Traffic Safety Administration (NHTSA), there were 5,811,000 vehicle crashes reported in 2008 by police across US and 37,261 people killed and 2,346,000 people injured [1].

Road safety has been considered important in world over past few years. In case, if vehicle drivers were provided with early warnings, a large number of crashes could have been avoided. It may not be sufficient only the drivers observation and reaction to avoid accidents. Thus, if a device is designed and incorporated into the cars it will reduce the incidence of accidents on our roads and various premises. A lot of research has been conducted to develop collision warning systems to aid driving. Therefore several initiatives such as Cooperative Intersection Collision Avoidance systems and integrated vehicle based safety systems have been proposed in USDOT's intelligent transportation system program.

As collision avoidance system, an automatic braking system that operates under critical conditions would be ideal. Practically it is impossible to develop such a braking system which operates only in extreme emergencies [2].

In 1970's, number of systems uses microwave radar to avoid collisions. But such radar systems are not practical due to large antenna size, high cost and difficulties in getting approval in regard to Radio Law in Japan. Apart from microwave radar, laser Radar sensor is also used for sensing the distance. But here ultrasonic sensors have been used.

Figure 1: Communication between two cars

In figure 1, communication between two cars is represented. Ultrasonic sensor used for distance measurement between the cars. Communicating systems use well-defined formats for exchanging messages. Each message has an exact meaning intended to provoke a defined response of the receiver. A protocol therefore describes the syntax, semantics and synchronization of communication. A programming language describes the same for computations, so there is a close analogy between protocols and programming languages: protocols are to communications while programming languages are to computations [3]

The AHS (advanced cruise-Assist Highway System) to avoid traffic accidents and traffic congestion by controlling traffic states while communicating between vehicles via facilities installed on roads, has been recently proposed. However, the proposed system has the problem that many communication facilities have to be installed such as the vehicle information and communication system (VICS) which requires various beacons along the roads.

It is recommended that an intersection collision warning system be implemented as part of vehicle safety system, thus reduces the accidents. Such a system should have capability of supporting real time system that can warn drivers. Thus ultrasonic sensors are used with transmitter

and receiver. ZigBee is used for communication purpose and transmit message to LCD output on driver side.

2. Historical Background

The earliest research into inter-vehicular communications was conducted by JSK (Association of Electronic Technology for Automobile Traffic and Driving) of Japan in the early 1980s (Tsugawa, 2005). This work treated inter-vehicular communications primarily as traffic and driver information systems incorporated in ATMS (Asynchronous Transfer Mode).

From the 1990s through 2000, American PATH (Hedrick et al., 1994) and European "Chaffeur" (Gehring et al., 1997) projects investigated and deployed automated platooning systems through the transmission of data among vehicles.
Recently, the promises of wireless communications to support vehicular safety applications have led to several national/international projects around the world. Since 2000, many European projects (CarTALK2000, FleetNet, etc.), supported by automobile manufacturers, private companies and research institutes, have been proposed with the common goal to create a communication platform for inter-vehicle communication [4]

The IST European Project CarTALK2000 was focusing on new driver assistance systems which are based upon inter-vehicle communication. The main objectives were the development of co-operative driver assistance systems and the development of a self-organizing ad-hoc radio network as a communication basis with the aim of preparing a future standard.

The FleetNet project in Germany (FleetNet project-Internet on the road, supported by six manufacturers and three universities from the 2000 though 2003, produced important results on several research areas, including the experimental characterization of VANETs, the proposal of novel network protocols (MAC, routing) and the exploration of different wireless technologies [3]

3. System Outline

The system consists of a ultrasonic sensor that detects the distance to the target vehicle. For this system, two car models are represented. The sensor fulfills the tasks of headway control and obstacle detection. One car will be equipped with an ultrasonic sensor which will continuously compare the distance given by the ultrasonic sensor. If the next car is a safe distance then car will keep going at the same speed.

3.1 Anti-collision System

Here designing a system to avoid a direct collision between two cars. For this we are making two Car models representing the two CARS. Here the car will be equipped with an ultrasonic sensor which will continuously track for any obstacles from the front side. If the obstacle / CAR is detected then the microcontroller will continuously compare the distance given by the ultrasonic sensor. If the next car is at a safe distance then the CAR will keep going at the same speed. If the distance keeps reducing, indicating that the front car is coming closer to the current CAR then the microcontroller will start applying brakes until the distance is within safe parameters. This process will continue in a loop until the CAR comes to a Stop.

In this way we can ensure that a safe distance is always maintained between the two cars and thus Accident can be avoided. The three IR sensors are interfaced which are connected to the three sides of the car to detect any proximity to the car. The IR sensor will give a pulse to the microcontroller. The microcontroller will turn on the buzzer which will alert the driver in Time to avoid the accident.

3.2 Breaking System

Here a DC motor based BUGGY is used. The µC will increase and reduce DC speed control via Pulse width modulation. The µC will increase or decrease the ON time and OFF time of the entire pulse time. If we decrease the ON time then the voltage applied to the DC motor will reduce and the speed of the DC motor will be reduced.

3.3 Intercommunication System

Here we are designing a system in which the cars that are close by can communicate with each other on a RF link. The CARS can communicate about the current speed. The speed of the CAR in front of the car is constantly monitoring the speed. If the speed decreases suddenly the car behind comes to know about it instantly and the breaks are applied avoiding a possible accident. The cars can also communicate about the traffic condition, Weather condition etc.

Ultrasonic sensor: Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) work on a principle similar to radar or sonar which evaluates attributes of target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensor generates high frequency sound waves and evaluates the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology is used for measuring the distance. Fig no.2 shows the construction of ultrasonic sensor.

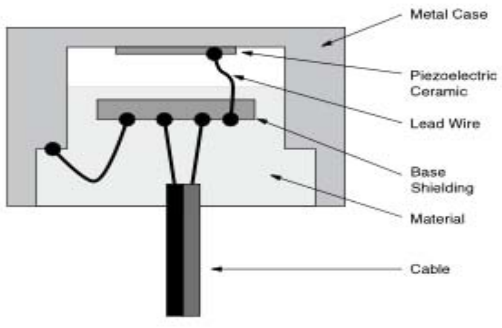

Figure 2: Construction of ultrasonic sensor

When the voltage is applied to the piezoelectric ceramics mechanical distortion is generated according the voltage and frequency. On the other hand, when vibration is applied to piezoelectric ceramics an electric charge is produced. When electric signal is added to a vibrator, constructed of two sheets of piezoelectric ceramics or one and a metal sheet, an electric signal is radiated by flexure vibration. As a reverse effect, when ultrasonic vibration is added to the vibrator, an electric signal is produced.

This sensor works on Doppler Effect. It consists of a ultrasonic transmitter and a receiver. The transmitter transmits the signal in one direction. This transmitted signal is then reflected back by the obstacle and received by the receiver. So the total time taken by the signal to get transmitted and to received back will be used to calculate the distance between the ultrasonic sensor and the obstacle. In fig no.3 describes the principle of ultrasonic sensor using Doppler Effect. Here, 's' is transmitter and 'R' is receiver.

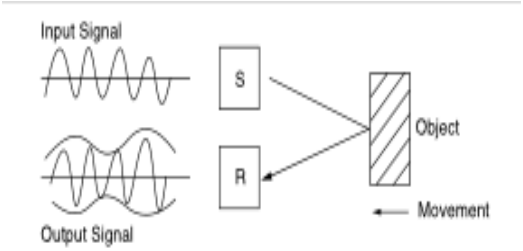

Figure 3: Performance principle of ultrasonic sensor

Below figure shows the principle of measuring distance and is called the "pulse reflection method" which makes it possible to count the number of reflection pulse. This method is used to measure reflection time up to the object between transmitting pulse and receiving pulse of ultrasonic wave. The relationship between the distance up to the object L and reflecting time T is expressed by the following formula:

L = c .T/2, where c is the velocity of sound. That is, distance to the object can be ascertained by measuring the reflecting time involved in reaching the object.

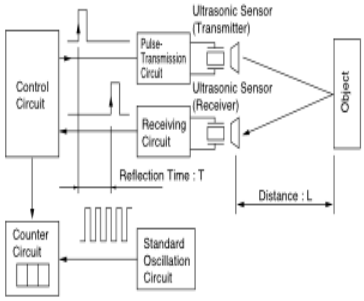

Figure 4: Principle of measuring distance

4. System Structure

The hardware of the system is shown in fig 4. The main components are described as below.

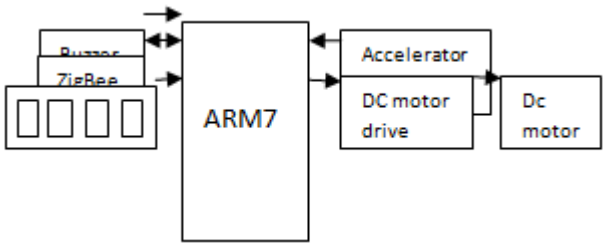

Figure 5: Block diagram for car 1

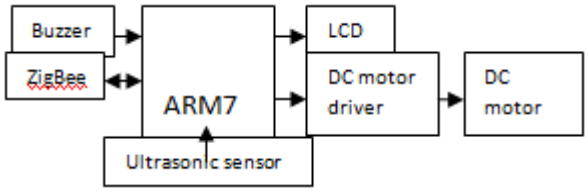

Figure 6: Block diagram for car 2

Buzzer: Buzzer is used in a system to indicate or to grab the emergency attention occurred. Buzzer act as a panic horn which indicates the need of instant attention as in the condition goes haywire. DC motor: DC motors are used to physically drive the application as per the requirement provided in software. The dc motor works on 12v. to drive a dc motor, we need a dc driver called L293D. The dc motor driver is capable of driving two dc motors at a time. In order to protect the dc motor while from a back EMF generated by the dc motor while changing the direction of rotation, the dc motor driver have an internal protection suit. We can also provide the back EMF protection suit by connecting four diode configurations across each dc motor.

Liquid Crystal Display: LCD is used in a project to visualize the output of the application. We have used 16x2 LCD which indicates 16 columns and two rows. So, we can write 16 characters in each line. So, total 32 characters we can display on 16x2 LCD. LCD can also used to check the output of different modules interfaced with the microcontroller. Thus LCD plays a vital role in a project to see the output and to debug the system module wise in case of system failure in order to rectify the problem. LCD is flat panel display, electronic visual display, or video display that uses light modulating properties of liquid crystals. Liquid crystals do not emit light directly.

LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays. They are common in consumer devises such as video players, gaming devices, clocks, watches, calculators, and television and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wide range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn in. LCD is more energy efficient and can be disposed of more safely than a CRT. It is an electronically modulated optical device made up of any number of segments filled with liquid crystals and arrayed in front of light source or reflector to produce images in color or monochrome.

ZigBee*:* ZigBee is a specification for suit of high level communication protocols using small low power digital

radios based on IEEE802 standard for personal area networks. ZigBee devices mainly used in mesh networks form to transmit data over longer distances, passing distance through intermediate devices to reach more distance ones. ZigBee is used in the applications that require low data rate, long battery life, and secure networking. ZigBee has a defined rate of 250 kbit/s, suited for periodic data or single signal transmission from a sensor to the input device. Applications include traffic management system, and other consumer and industrial equipment that require short range wireless transfer data at relatively low rates.

5. ZigBee Technology

ZigBee is low cost and low power, wireless mesh network. The low cost allows the technology to be widely used in wireless control and monitoring applications. Mesh networking provides high reliability and more extensive range. ZigBee operates in the industrial, scientific and medical (ISM) radio bands; 868 MHz in Europe; 915 MHz in USA and Australia, 2.4 GHz in most jurisdictions worldwide. The zigbee network supports both star and tree typical networks, and generic mesh networks. Every network must have one coordinate and device, tasked with its creation, control of its parameters and basic maintenance.

5.1 Devices Types

ZigBee devices are of three types:

ZigBee Coordinator (ZC): The coordinator forms the root of the network tree and might bridge to other networks. It stores information about the network, including acting as the Trust Centre and respiratory for security keys.

ZigBee Router (ZR): An router can act as an intermediate router, passing on data from other devices. ZigBee End Device (ZED): Contains enough functionality to talk to the parent node, it cannot relay data from other devices. A ZED requires least amount of memory. And therefore can be less expensive to manufacture than ZR or ZC.

5.2 Operational Flow

The system operational flow is depicted as fig. the second car will be equipped with an ultrasonic sensor which will continuously compare the distance given by the ultrasonic sensor. If the next car is at a same distance then the car will keep going at the same speed. If the distance keeps reducing indicating that front car is coming closer to current car then microcontroller will start applying brakes until the distance is within safe parameters. This process will continue in a loop until car comes to a stop. This is the main operational flow of the system.

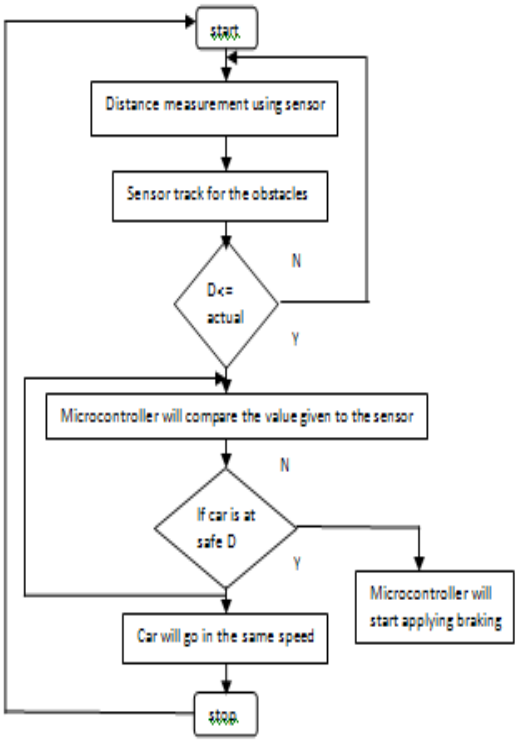

Figure 7: Operational flow of the system

6. Various Sensors and Types

There are different types of sensors used for collision warming system. These sensors fulfill the tasks of headway control and obstacle detection. They represent basis of collision avoidance systems and are divided into three types:

1. Optical techniques (Passive infrared, laser radar and vision): they all suffer from disadvantage of being sensitive to external environment conditions. Passive infrared and vision does not provide direct measurement of distance to an object. Laser radar is most useful than other technique despite its high cost.
2. Electromagnetic techniques: This consist of FMCW radar, impulse radar and capacitive. Although relatively expensive, FMCW radar seems to be best technique for long range distance measurement. It can be used at short and medium range, rendering a quite flexible technique.
3. Acoustic techniques (Ultrasonic): These are suited in application where only short term relative distance provides high resolution for low cost.

Passive infrared: These sensors measure the thermal energy by objects in the vicinity of the sensor. But these sensors are unable to determine precisely the distance to any detected object and have a slow response time.

Laser radar: there are two techniques exit, one uses high power pulsed beam of infrared light, while the other, amplitude of light is modulated with a sine wave. Its limitations are its cost, sensibility to external conditions and need keep laser power within safe levels.

FMCW radar: This type of uses modulated high frequencies, so that the frequency difference between the

reflected and transmitted signal is proportional to the distance of the object ahead. Despite its high cost, this technique offers the advantages of being insensitive to mud and poor visibility conditions, and allows the beam width to be modified depending on the particular application.

Impulse Radar: It performs as well as FMCW radar in terms of environmental immunity. However this technique presents a sensible diminution in maximum range and is susceptible to external electromagnetic interference.

Capacitive: Capacitive sensors are able to detect close objects capacitance variations between electrodes excited at low frequencies. Despite their limited range, they are low in cost and robust to external environmental effects. They may be useful in slow speed collision warning such as obstacle detection during backup maneuvers.

Vision system: These techniques are based on use of video camera and image processing software. They have high cost and high sensitivity to the external environmental effects makes their use unlikely in most vehicle applications.

7. Conclusion

Thus, we have discussed many issues pertaining to the communication protocols. That uses sensor information to avoid potential accidents. The system also useful in giving warning signals with continues tracking of front-side obstacles. This system will have a proportionate increase in the level that avoids potential accidents and result in improved intercommunication using latest technologies.

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