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Advance Collision Avoidance System with Automatic Vehicle Speed Control

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Abstract

Automobile safety is the study and practice of design, construction, equipment and regulation to minimize the occurrence and consequences of traffic collisions. Road traffic safety more broadly includes roadway design. Improvements in roadway and automobile designs have steadily reduced injury and death rates in all first world countries. Nevertheless, auto collisions are the leading cause of injury related deaths, an estimated total of 1.2 million in 2004 or 25% of the total from all causes. Of those killed by autos, nearly two-thirds are pedestrians. If any object suddenly comes in front of vehicle the driver might fumble and push accelerator pedal instead of brake pedal.

Keywords: Ultrasonic sensor • Microcontroller • Oscilloscope • DC motor • Buzzer

Introduction

Manufacturers of road vehicles have been working to reduce the number of accidents. They have used the latest of today's technology to make vehicles that are much safer than their predecessors. Advances in computers, materials, electronics and other areas have allowed them to decrease the number of accidents that their vehicles are involved in and improving the chance of the occupants walking away from an accident without injury.

But today's vehicles mostly have the object detection system, hence this paper presenting a system along with automatic speed control in order to reduce accidents efficiently. Commonly many road accidents are caused by collision between vehicles due to the inability of the drivers to gauge the perimeter of their vehicles and other reason is unawareness of nearby vehicles. The high incidence of on road accidents due to collision propels our concern on collision avoidance system mainly for hilly and dense fog affected areas.

In this paper we are proposing advance collision avoidance system along with automatic speed control because of which even the driver fumbles in accident prone condition the speed of vehicle will reduce automatically accordingly [1-3].

Literature Review

Major components

Ultrasonic sensor: Seed ultra-sonic sensor is used in this system having supply voltage 5 v, global current consumption 15 mA, ultrasonic frequency 40 k Hz, maximal range 400 cm minimal range 3 cm, resolution 1 cm, trigger pulse Width 10 μs, outline dimension 43 × 20 × 15 mm. Seeed ultrasonic sensor is non-contact distance measurement module, which is also compatible with electronic brick. The ultrasonic sensor is used to detect the presence of object nearby vehicle (Figure 1).

Figure 1. Ultrasonic sensor.

Microcontroller: ATmega328 is used to control the system. The arduino uno has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header and a reset button. It is working on operating voltage of 5 V (Figure 2).

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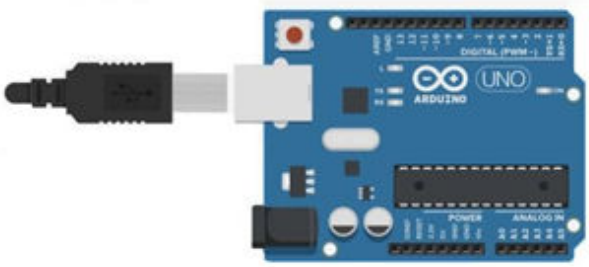

Figure 2. Microcontroller (Arduino Uno).

Oscilloscope: Oscilloscope is used to show the speed reduction of vehicle (*i.e.* DC motor). The indication is in the form of PWM waves. Which are reduced as per requirements according to conditions (Figure 3) [4].

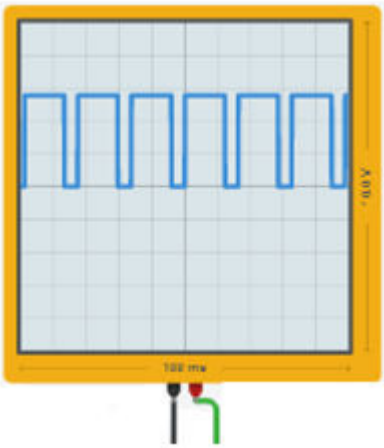

Figure 3. Oscilloscope.

Buzzer and bulb: A piezoelectric buzzer is used in the system to indicate that object is very near to the vehicle and will lead to accident. This specification is applied to the piezoelectric buzzer, which are used for alarm systems. Vibration buzzer shall be measured after being applied vibration of amplitude of 1.5 mm with 10 to 55 Hz band of vibration frequency to each three mutually perpendicular directions for 2 hours. A bulb is indicated as an airbag. Whenever accident happens the bulb will glow which shows the deployment of Airbag (Figures 4 and 5).

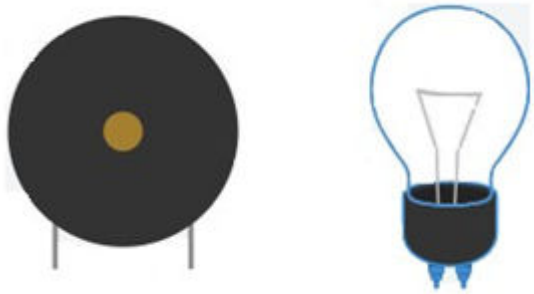

Figure 4. Piezo buzzer and bulb.

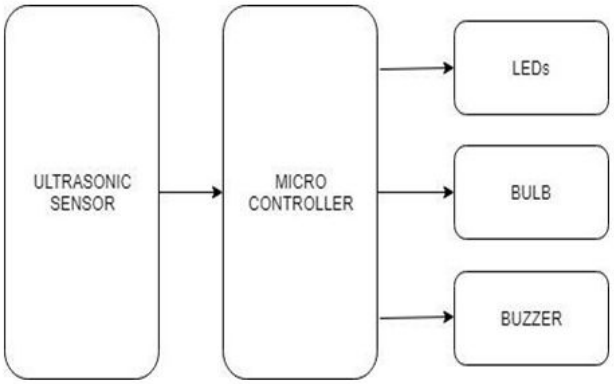

Figure 5. Block diagram.

Connections

Sensor to controller pin information: We are using 3 switches as distance sensors to indicate the distance of obstacle. Switch has three pins namely VCC, COM and GND. Connect.

- VCC pin to 5V on a controller.
- GND pin to GND on a controller.
- SIG to digital pin 2 on a controller.

Indicator to controller pin information: We are using different LEDs as indicator to indicate the obstacle depending on its distance from vehicle. LED has two pins:

- Connect one pin of red LED to digital pin 13 on a controller.
- Connect one pin of yellow LED to digital pin 6 on a controller.
- Connect one pin of green LED to digital pin 5 on a controller.
- Connect another pin to GND on a controller.

Motor to controller pin information: The motor has two pins:

- Connect one pin to digital pin 12 on a controller.
- Connect another pin to GND on a controller.

Oscilloscope to controller pin information: The oscilloscope is used to indicate the reduced speed of motor. It has two pins:

- Connect one pin to digital pin 12 on a controller.
- Connect another pin to GND on a controller.

Bulb to controller pin information: The bulb is used to indicate the airbag. It has two pins.

- Connect one pin to digital pin 8 on a controller.
- Connect another pin to GND on a controller.

Controller to computer connection information: You have a USB data cable that you get with buying the embedded controller. With this data cable, you connect the computer to the embedded controller board (Figure 6) [5-7].

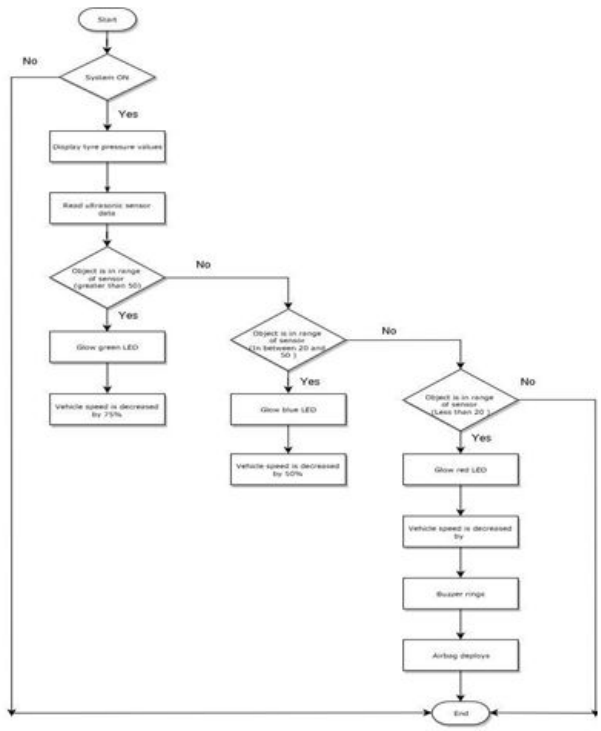

Figure 6. Embedded controller board Flow chart.

Discussion

An integrated algorithm for a full-range ACC system with CA was provided. The control algorithm was meant to create behaviour of the subject vehicle that would appear natural to a human driver in regular driving scenarios, as well as safe behaviour in severe braking situations requiring huge decelerations. To integrate the ACC and CA systems, the suggested algorithm causes the subject vehicle to operate in three modes: Comfort, large deceleration and severe braking. According to the World Health Organization (WHO), there were 1.25 million road accidents in 2015, with 270,000 people killed, resulting in over 700 life losses every day on average. Over 90% of crashes were reported to be caused by driver error [8].

To improve the situation, governments, car manufacturers and municipal departments have considered large investments to support the development of various technological solutions, such as autonomous driving and cognitive robotics, in which EU agencies have already invested around 1 billion euros. Companies such as Google and Uber, along with traditional automobile manufacturers such as BMW and FORD, created and piloted the first self-driving car prototype in 2009, which was tested in four states in the United States [9]. Since then, this type of technology has advanced and there are now 33 states in the United States with explicit legislation governing autonomous driving. Furthermore, according to the Victoria Transport Policy Institute (VTPI), this technology will be widely deployed after the 2040's and 2050's. The Society of Automotive Engineers (SAE) recommended several operational standards for self-driving (also known as unmanned) vehicles in 2014. SAE designated six levels in this field, with human drivers still monitoring the driving environment and operating conditions for levels 0-2. In comparison, for levels 3-5, a fully automated driving system is suggested to completely replace the function of human drivers (Table 1 and Figures 7-9) [10].

Working

When the object is not detected (ultrasonic off):

- No obstacle approaching in driver's range and driver is informed accordingly.
- Drivers safety is maintained by LED (Green: Off, Blue: Off, Red: Off) and Buzzer (off) indication.
- Dc Motor rotates in the usual speed.
- Bulb is turned off.

When the object is detected (ultrasonic on) when the range of the object is greater than 50 cm:

- Obstacle approaching driver's range is detected and driver is informed accordingly.
- Drivers safety is maintained by LED (Green: On, Blue: Off, Red: Off) and Buzzer (off) indication.
- Dc motor rotates at 75% of the usual speed.
- Bulb is turned off.

When the range of the object is in between 50 cm and 20 cm

- Obstacle approaching driver's range is detected and driver is informed accordingly.
- Drivers safety is maintained by LED (Green: Off, Blue: On, Red: Off) and Buzzer (off) indication.
- Dc Motor rotates at 50% of the usual speed.
- Bulb is turned off.

When the range of the object is less than 20 cm

- Obstacle approaching driver's range is detected and driver is informed accordingly.
- Drivers safety is maintained by LED (Green: off, Blue: off, Red: on) and Buzzer (on) indication.
- Dc motor rotates at 25% of the usual speed.
- Bulb is turned on indicating deployment of airbag.

Requirement ID	Requirement analysis	Input	Expected output	Actual output	Result
S_101	When engine is off	Ultrasonic is off	Circuit should inactive	Circuit is inactive	Pass
S_102	When the object is detected in far range	Ultrasonic is on	Glow green LED and speed is reduced by 75%	Green LED was glow and speed was reduced	Pass
S_103	When the object is detected in mid-range	Ultrasonic is on	Glow yellow LED and speed is reduced by 50%	Yellow LED was glow and speed was reduced	Pass

S_104	When the object is detected but very close	Ultrasonic is on	Glow red LED Speed is reduced by 25% and Airbag deploys	Red LED was glow, speed was reduced	Pass
S_105	When meet with accident	Ultrasonic is on	Airbag deploys	Bulb was glow indicating Airbag deployment.	Pass

Table 1. Unit testing of a system.

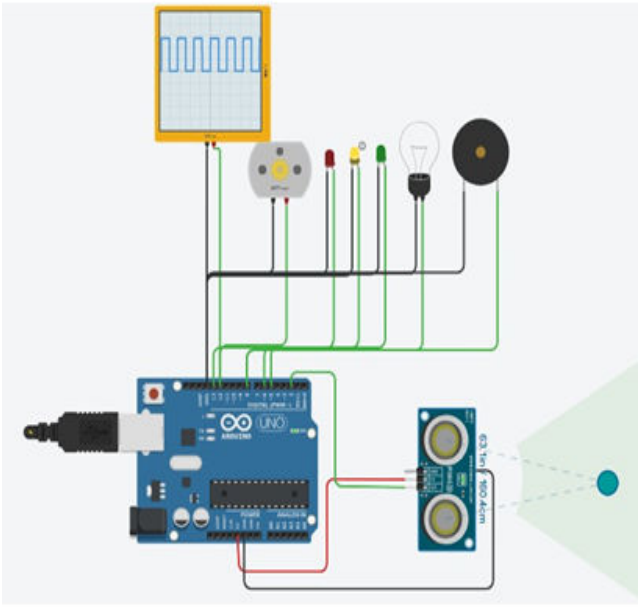

Figure 7. When object is far in ultrasonic range, speed=75%.

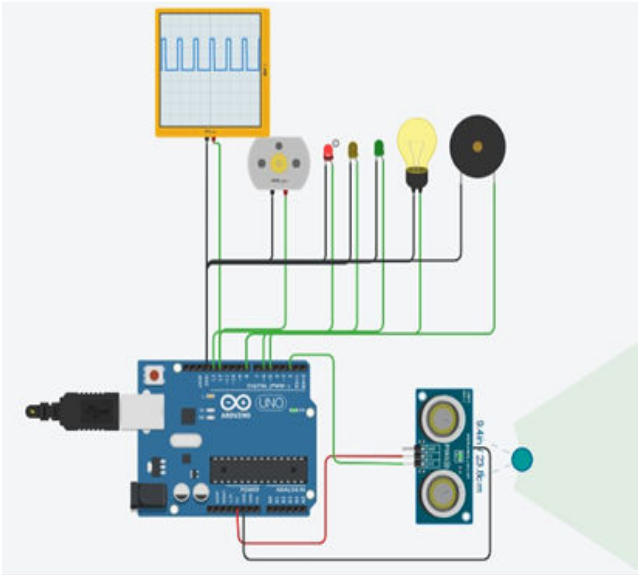

Figure 8. When object is in mid of ultrasonic range, speed=50%.

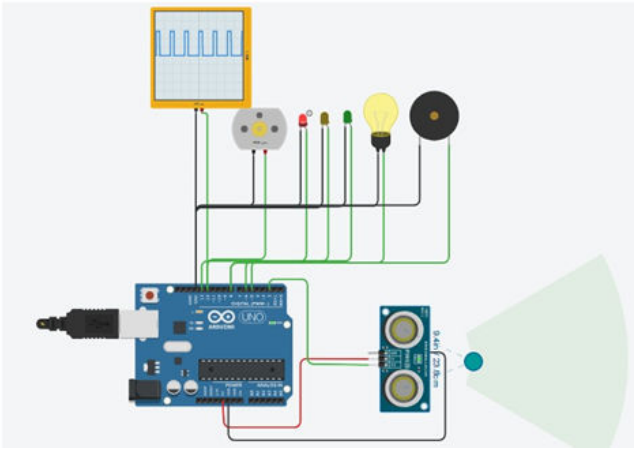

Figure 9. When object is near in ultrasonic range, speed=25%.

Advantages

Advantages which can be achieved by employing advance collision avoidance system with automatic vehicle speed control system are:

- It will reduce accidents and saves human life.
- It is helpful in developing efficient driver's safety system.
- Speed of vehicle reduces automatically while accident prone situation so chance of human errors while applying brakes is reduce.
- No separate system is required for deployment of airbag.
- Cost effective and reliable.

Conclusion

The proposed system is designed into a small car model as a prototype to control the distance between the car and the preceding car and also distance between the front obstacles and initiate speed control of vehicle. We need to understand about these systems to make sure that all technologies are working as expected; not only on test track performance but also on open road effects then there this system will be helpful to reduce accidents and advancement in driver's safety.

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