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Design and Construction of a Vehicle Anti–Collision System

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ABSTRACT

In the past couple of years in Nigeria, records show that over three thousand (3,000) vehicles are involved in road traffic accidents annually. This is extremely high considering the loss of property and lives involved. The bid to minimize this appalling statistical record is the impetus for this work whose aim is to design and construct a vehicle anti-collision system that can be installed in vehicles to minimize car accidents. The vehicle anti-collision system is vital in improving vehicle safety design and reducing driver errors. It makes use of ultrasonic sensors connected to ATMEGA328P Microcontroller, programmed to give real-time audio-visual signals to the driver after sensing danger via an alarm and display panel installed on the dashboard of the vehicle. The system was designed, constructed and satisfactorily tested. It was able to provide audio-visual signals for possible obstacles from a distance of 200 cm to infinity. Hence, the system can successfully alert and arouse a driver thereby preventing collisions and minimizing accidents.

1. INTRODUCTION

Vehicle safety has become one of the important issues nowadays due to the fact that the number of road accidents, which cause injuries, deaths and also damages, keep on increasing. One of the main factors which contribute to these accidents is human lack of awareness (Aiman, 2017). Road accidents are commonly caused by bad driving behaviour like driving too fast and recklessly, driving under alcohol influence, changing the lanes without signaling, and breaching the safe distance between two vehicles (Ansari et al., 2000).

In Nigeria, road accidents pose a severe threat to lives physically as well as financially (Onyemaechi and Ofoma, 2016). The vehicle driver has been recognised as the main cause of accident especially in Nigeria (Mbachu and Onuora, 2014). Many people lose their lives every year in vehicle collision majorly due to driver's inability to keenly observe the vehicle's vicinity while driving and in traffic condition (Dubey and Ansari, 2013). The Federal Road Safety Commission of Nigeria reported that vehicle collision is as a result of human error due to wrong decisions and actions by drivers (Siyan et al., 2019). These faulty decisions are attributed to ignorance of traffic regulations and procedures.

A vehicle anti-collision system is a driver assistance system that can help reduce accidents on the highway by providing real time data of the distance from any obstacle. The system sounds an alarm to the driver when the distance between the vehicle and the obstacle is less than a preset value while also displaying the measured distance on a liquid crystal display on the dashboard of the vehicle.

Road traffic accidents cannot be completely eradicated. However, it is clear to a large extent that most road traffic accidents result from human errors rather than mechanical failure of vehicle, poor road or driving conditions and acts of nature. Therefore, if this human factor can be reduced to the barest minimum, a lot of lives and properties would be preserved. This works aims at closing the human loophole as a major cause of road traffic accident by designing and constructing a cheap, reliable and accurate vehicle anti-collision system. With this system, poor assessment of distance, sleepiness or drowsiness can almost be eradicated from the long list of possible human flaws that can lead to road traffic accidents.

2. MATERIALS AND METHODS

2.1. Materials

HC-SR04 ultrasonic sensor was the transducer of choice for this work. Its efficiency does not depend on the time of the day. Other basic electronic components were also used in the design of this vehicle anti-collision system such as Atmega328p microcontroller, LCD display, an alarm buzzer, resistors, capacitors, electronic switches, LM705 voltage regulator, Light Emitting Diodes (LEDs) and Vero board.

2.2. Hardware Description

Figure 1 shows the block diagram of the components used in the system and their interconnection. The red arrows indicate the direction of power flows while the black arrows indicate the direction of signal flows.

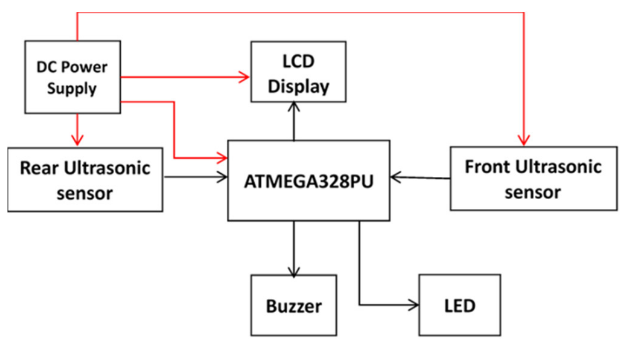

Figure 1: System block diagram

2.3. Design Method

The design of the vehicle anti-collision system was carried out in a systematic approach. First, a block diagram and flow chart of the system operation was developed as shown in Figure 1 and Figure 2 respectively. Next, the electronic circuit of the system was designed and simulated in Proteus version 8.0 software environments. After the successful simulation of the system, the components used in the software environment were selected physically and used to implement the functional design on a Vero board. The control program was written using Arduino integrated development environment (IDE), compiled and loaded onto the Atmega328p microcontroller. Preliminary tests were carried out to ascertain if the control program could communicate with the input and output devices, after which the system was then installed on a prototype car for further testing and measurements.

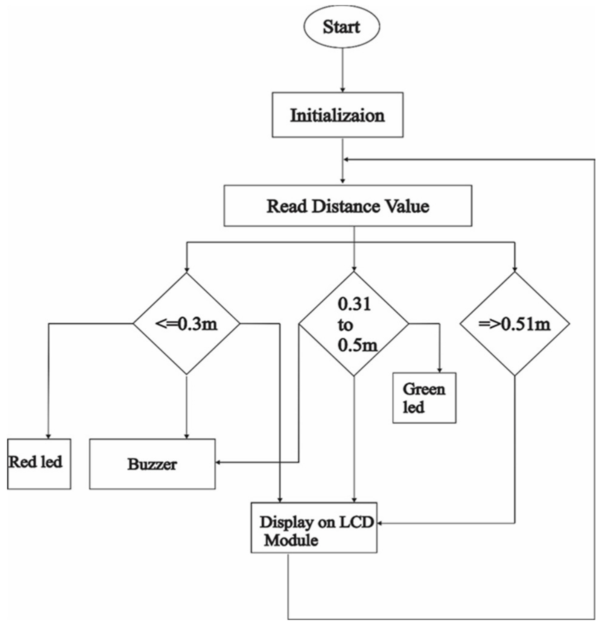

Figure 2: System flow chart

2.3.1. Power supply section

The power supply section converts the 9 V DC input supply from a battery source to 5V DC required by the circuit. An integrated circuit voltage regulator, LM7805 was connected across the supply as shown in Figure 3.

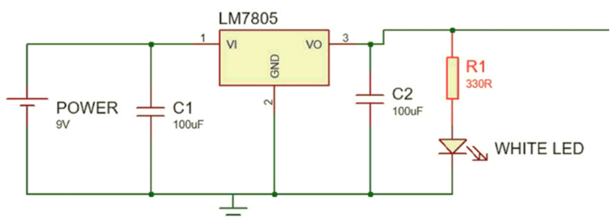

Figure 3: Power supply unit

2.3.2. External oscillator circuit

Atmega Microcontroller can be run at different speeds and the operating frequency is determined by the clock speed (Rajesh et al., 2017). The internal oscillator of Atmega328p microcontroller has a frequency of 8 MHz and a maximum clock speed is 20 MHz. To achieve a running frequency of 16 MHz, an external oscillator was connected to pin 10 and 9 of the Atmega328p as shown in Figure 4. The values of capacitors C3 and C4 were obtained from the datasheet of the crystal oscillator.

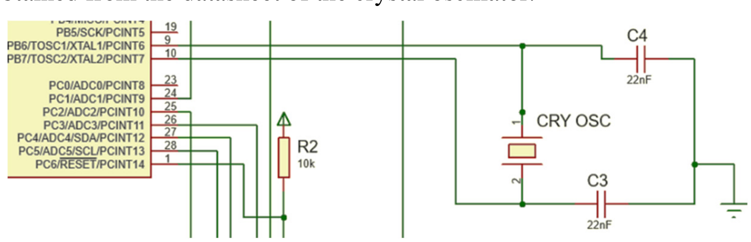

Figure 4: External crystal oscillator circuit

2.3.3. The display unit

The display unit (Figure 5) displays the measured distance between the vehicle and an obstacle. It also displays the system status. Pins RS, E, D4, D5, D6 and D7 of the LCD screen were connected to pins 14, 13, 15, 16, 17 and 18 of the Atmega328p microcontroller respectively.

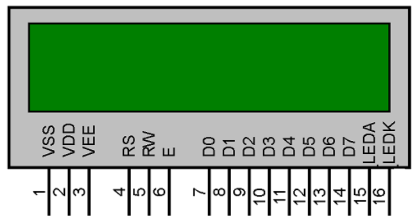

Figure 5: LCD screen

2.3.4. Front and rear ultrasonic sensors

HC-SR04 ultrasonic sensor was mounted on the prototype vehicle, one at the front and another at the rear. The trig pin and the echo pin of the sensor mounted at the front of the vehicle were connected to pin 28 and pin 29 of the Atmega328p microcontroller respectively while the trig pin and the echo pin of the rear sensor were connected to pin 26 and 25 of the Atmega328p microprocessor respectively. The Vcc pins of both sensors were connected to the regulated 5 V, while the ground pins were connected to the ground of the supply.

2.4 Operation of the Vehicle Anti-collision System

Figure 6 shows the complete circuit with all connections made. It shows in detail how each component makes up the entire circuit, from the ultrasonic sensors to the micro controller.

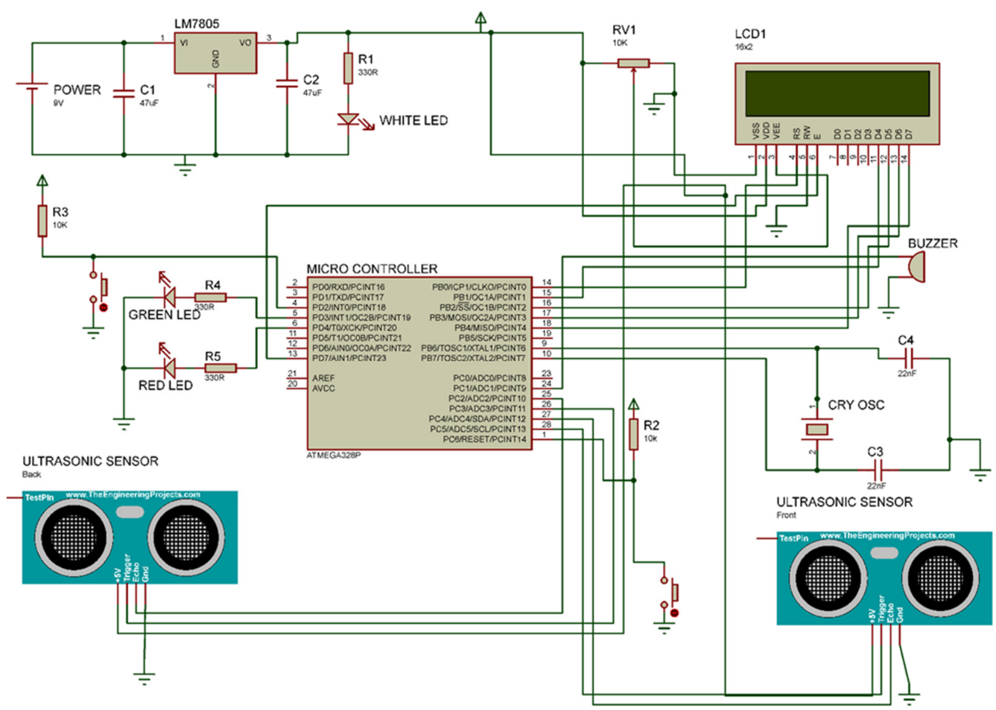

Figure 6: Complete circuit diagram of the vehicle anti-collision system

The prototype makes use of a 9 V battery in place of the 12 V or 24 V used in vehicles. This voltage is converted by the voltage regulator, LM7805 to the 5 V DC required for the circuit. With the availability of this voltage, the microcontroller activates the trigger pins of the front and rear ultrasonic sensors at the same time, and the sensors transmits ultrasonic waves continuously. When this wave hits any obstacle, it is reflected back and the reflected ultrasonic wave is captured by the receiver thereby activating the echo pin of the ultrasonic sensors. The total time taken by the wave to leave the transmitter and return to the receiver is computed by the atmega328p microcontroller. This measured time is a function of the distance between the perceived obstacle and the vehicle. The atmega328p microcontroller was programmed using C programming language. The microcontroller processes this time and sends signals continuously to the 16×2 LCD for display and an LED on the dashboard of the vehicle. Thus the driver is able see the displayed distance. The buzzer and LEDs give a notification that an object has reached a pre-set distance from the front or rear end of the vehicle. A push button was also provided to interrupt the sound of the buzzer to prevent continuous beeping after necessary precautions have been taken. The pre-set signalling distances can be changed by setting new values within the control C-program in the microcontroller.

2.5. Testing

The complete circuit of the vehicle anti-collision system was tested for functionality. A digital multi-meter was used to measure the output voltage of the voltage regulator and continuity test was carried out where necessary. The system was then installed on a prototype car for operational tests. An obstacle was placed at the front and at the rear of the prototype vehicle at different measured distances and response from the LCD screen; the LED lamps and the buzzer alarm were recorded.

3. RESULTS AND DISCUSSION

The system was tested for several obstacle distances and some of the results are presented in Table 1. When the obstacle was between 0 - 0.3 m from the vehicle, the red LED came ON and the buzzer sounded continuously; indicating that an obstacle is very close and the driver should be at alert and take precautionary actions. At the same time the LCD displayed the distance of the obstacle from the vehicle. When the obstacle was between 0.31 m and 0.5 m, the green LED came ON indicating that the obstacle is present but not dangerously close, the buzzer was beeping and the LCD displayed the distance. When the obstacle was over 0.51 m away, the red and green LEDs remained off, indicating that no obstacle is within range.

Table 1: Test results of the vehicle anti-collision system

Measured output of the voltage regulator = 4.95 V				
Obstacle distance	LCD display	Red LED	Green LED	Buzzer
200 cm	1.98 m	ON	OFF	Sound is continuous
400 cm	4.01 m	OFF	ON	Beeps
600 cm	5.99	OFF	OFF	No sound

4. CONCLUSION

A successful attempt has been made to design and implement a vehicle anti-collision system using cheap and readily available materials. The system is capable of detecting and alerting the driver of an imminent obstacle. The complete work was tested and it worked satisfactorily. This prototype is realizable to a very large extent, and if implemented in vehicles, it can reduce the rate at which car accidents occur on the highway and also aid safe parking in private and public parking areas.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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