International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 06 | June - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

DC MOTOR SPEED CONTROLLER USING ULTRASONIC SENSOR

GUIDE: MINAL BARHATE

AUTHORS: Rushabh Rode, Revati Shimpi, Simran Roham, Renuka Pawar, Vrushabh Revankar, Vedant Rawale.

F.Y.B.Tech Students' Engineering Design and Innovation (EDAI1) Project Paper, SEM 1 A.Y. 2022-23 Vishwakarma Institute of Technology, Pune, INDIA.

ABSTRACT:

In the year 2021 around 4 lakh accidents road accidents were reported in India. Most of the accidents these days have occurred due to negligence of drivers unable to control speed and bashing into obstacles causing fatal injuries. Sometimes there are sudden interferences while driving and lack of in-time reflexes to them causes accidents, we have inculcated this issue in our project. Our aim is to prevent accidents by controlling the speed of DC motors in case of any obstacles according to distance. In this paper, we would like to give an introduction followed by a brief idea of the components used, a flowchart of the system then it's hardware, software methodology, testing, and conclusion. The main concepts used for this device are Ultrasonic sensors to detect obstacles and PWM to vary the speed of the DC motor using the L298N motor driver. We believe our project can help reduce accidents and provide a safe traveling environment for everyone.

Keywords: DC Motor, Aurdino, Ultrasonic Sensor, Speed Control, PWM

INTRODUCTION:

As stated above, in the year 2021 around 4lakh accidents were reported in India. India tops in casualties caused due to road accidents with 11% of its share in the world and most of the time victims are old people who don't have the instant reaction to fast vehicles and youngsters riding in the needed rush of the hour these days. India is one of the fastest developing countries with the highest number of road networks, population and therefore more

number of motors in the world, therefore, the contribution is not astonishing. Through our project, we contribute by using engineering and innovation thereby, reducing tragic losses and a step toward the development of both urban and rural areas.

The government has taken many steps in order to prevent accidents. Identifying hotspots around the country, deploying emergency ambulances, installing security cameras around signals and hotspots, and reducing corruption among traffic policemen. Though such methods have made a significant contribution to decreasing accident rates, they require high capital and are error-prone due to human involvement. Our aim is to make such a device that is simple and affordable for the middle class as well.

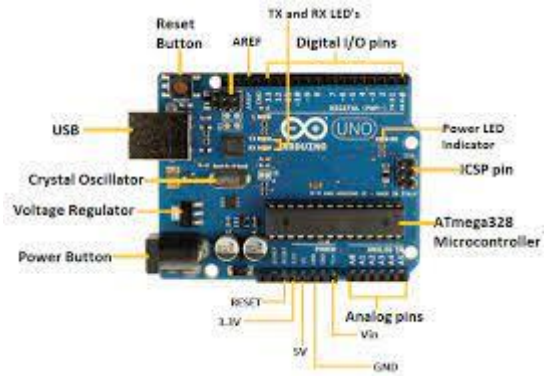
The dc motor speed controller can detect incoming or already existing cars or other vehicles and maintain its speed accordingly thereby maintaining safe distances between them in case drivers aren't aware of it without notifying them. Also, it can detect pedestrians or people/animals crossing roads hence reducing the possibility of hitting them and causing harm.

The main concept used here is related to ultrasonic sensors having various applications like security, communication systems, and safety which use the concept of echo to detect an object and find its distance. Using ultrasonic sensors to gauge the distance between the motor and an object and then adjusting the speed in response is one such method. It emits high-frequency waves to detect and sends back to Aurdino. This concept of echo thus helps to detect obstacles.

The concept of Pulse Width Modulation (PWM) helps to efficiently control the speed of dc motor by converting digital signals to analog signals by the Arduino. It has been used in many areas like communications, brightness controller, and conversion. The most common example of it is the street light brightness controller. The amplitude of the analog signals is decided by the width of the waves and its output depends on the duty cycle i.e. the amount of time the frequency was high divided by the high and low input signal (high/(high+low)). The higher the duty cycle the higher the applied voltage and higher the speed. In this way, the voltage is regulated, and also the speed of the dc motor.

A) *Components*

i. ARDUINO UNO



Dating back to 2005, Arduino was made by Massimo Banzi and David Cuartielles in Italy. It was the simplest easy-to-use microcontroller that students can use with Arduino Uno is an IC with 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. Till date, there have been 4 Arduino boards made but we will be using Arduino UNO. As the motor speed is needed to be controlled according to the distance of the obstacle we use a microcontroller for the same process. We use Arduino IDE to program in C and embed it in an Arduino board.

ii. DC MOTORS 5V

DC Motor is a mechanical device used to convert DC electrical energy into mechanical energy. They are made according to the application it has ranged from in toys to elevators and are mostly used where rotation is needed. We use a small 5V DC motor for our model with a no-load rotational speed of 5600 RPM and no-load current consumption of just 55mA with a diameter of 2mm.

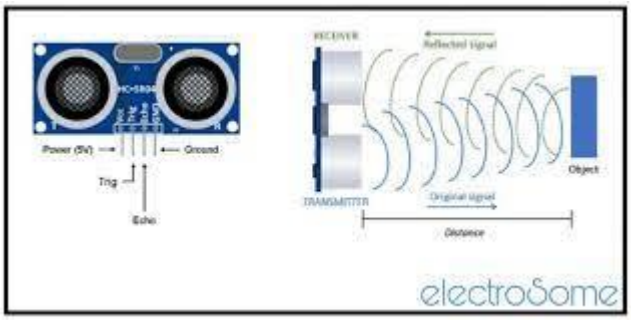
iii. I2C

I2C or Inter-Integrated device was made in 1982 by Philips Semiconductors. It is a single-ended, synchronous bus used to provide communication between to ICs on the same breadboard. Multiple chips or slaves can be connected to the same master in I2Cs and hence is most preferred.

iv. L298N MOTOR BRIDGE

A motor bridge is a device used to change the voltage polarity of the load. Since we use a dc motor where we are required to change the polarity every half-cycle so as to keep it revolving motor/H bridge is used here.

v. UltraSonic Sensor HC SR04



As said earlier ultrasonic sensors are devices to detect obstacles by sending high-frequency waves. We are using this particular model for our project since it is economical and gives a range of 3 to 400cm with an accuracy of 3mm.

Previous Research Work

In the research paper [1], we get to know one of the applications of this design is to build an obstacle detection robot. It uses the same components as us except for an I2C display to show the object distance, using this could give the user an idea of the obstacle distance increasing one feature to it.

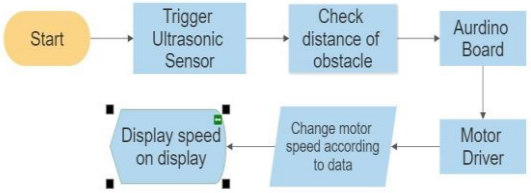
In the research paper [4], the authors used the concept of fuzzy logic and PID control which helped to increase the efficiency of the motor by manipulating uncertain information.

In the research paper [5], helps us to identify one more application of our system design that is useful for fishermen at sea from avoiding getting caught at hands of the government by mistake by using the concept of RADAR.

METHODOLOGY:

The implementation of the system involves the following steps:

Flowchart:

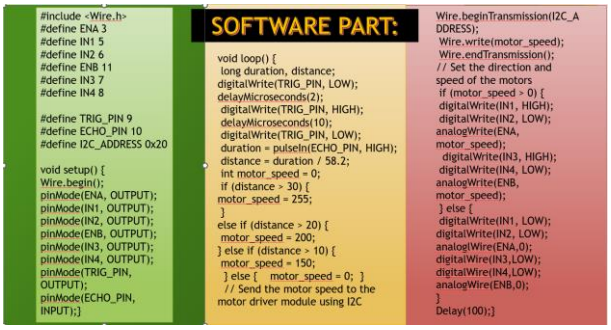


Hardware Setup:

The Arduino Uno board must be connected to the HC-SR04 ultrasonic sensor and the L289N motor driver module. The four pins of the ultrasonic sensor are connected to Aurdino Board. The ultrasonic sensor triggers to send pulses towards the obstacle and receives them back. The sound signal is converted to electrical signal by the ultrasonic sensor. This is used to calculate distance of the obstacle and the data is sent to Aurdino which calculates the speed accordingly as set in the Aurdino program. The motor driver module is linked to the Arduino board using the I2C protocol. To control the first motor, the motor driver module is connected to ENA,IN1 and IN2. To control the second motor, the motor driver module is connected to ENB,IN3 and IN4. The data when sent to motor driver module to change the speed and direction of motor.

The I2C module's address that is attached to the Aurdino board is I2C address. The LCD display with an I2C interface is linked to the I2C module. The connection to I2C LED displays speed and distance. This makes the driver aware of possible obstacle and it's distance ahead.

Software Development:



Here, the programming is done in C in Arduino IDE. The microcontroller according to the code sends instructions to the L298N motor driver. The motor speed numbers are sent to the motor driver module by the code using I2C connection.

We have included the <Wire. h> header file which helps to connect with I2C devices. Then we defined the connection of motor driver pins(ENA,IN1,IN2,ENB,IN3,IN4,TRIG_PIN,ECHO_PIN) to Aurdino pins(3,5,6,11,7,8,9,10).

In the setup function, we have defined the pin of each motor driver according to its pin mode i.e. (INPUT, OUTPUT).

In the loop function, We have set the TRIG_PIN Low for a duration of 2 microseconds and TRIG_PIN High for a duration of 10 microseconds, and the distance is calculated according to the formula :

distance=duration/58.2.

In the if-else loop, the DC motor speed changes according to the distance. Now, the motor driver changes the speed as it receives the instruction in the given function.

Now to set direction and motor speed we give the if else function where if motor speed is greater than 0 the respective pins in code get high and low and the DC motor moves forward and backward accordingly.

Testing:

During the testing phase, the system's precision and efficiency in managing the DC motors are assessed. By putting things at various distances from the ultrasonic sensor and monitoring how the DC motors react, the system is put to the test. Based on the DC motors' capacity to precisely react to changes in the distance detected by the ultrasonic sensor, the system's accuracy and efficiency are assessed.

Many Tests were carried out before the actual prototype was completed, and after that the changes were made according to get the expected result.

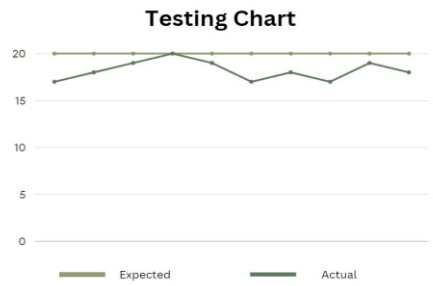
Test	Expected Stopping Distance(cm)	Actual Stopping Distance(cm)
1	20	17
2	20	18
3	20	19
4	20	20
5	20	19
6	20	17
7	20	18
8	20	17
9	20	19
10	20	18

Percentage error is calculated using:

$$P.E. = \frac{E_{sd} - M_{sd}}{M_{sd}} \times 100$$

where E_{sd} and M_{sd} are the average expected stopping distance and

average stopping distance respectively. P. E is the Percentage Error. P.E yields 9.89%.



The above chart gives graphical demonstration of our results.

We have also identified that at distance less than 30cm the motor travels at normal speed, while below 20cm the motor speed decreases gradually and below 10cm comes at immediate stop.

Conclusion

Hence, through our paper, we are able to find that the motor is able to stop the motor at the specified distance and come to an emergency halt when needed. Though in most of the research complex systems have been used to get the motor to build speed control we can build a simple low-cost device that will reduce accident rates in our country and will be affordable for the middle class. We have seen detailed descriptions of the components used, its circuit diagram, stimulation on TinkerCad, hardware of the system, and coding part of the Arduino programming.

Many problems vehicle-related problems exist and considering the number of vehicles depending on humans would be more error-prone yet expensive. We could add additional technology as a solution to it. Though our aim through this project is to decrease the speed of the motor, we can use multiple ways to enhance its features like:

- using a gyrosensor to measure the rotation of the motor by finding its angular velocity.
- a thermal sensor that detects a change in temperature using electrical signals. We measure the change in temperature of engines thereby detecting overheated engines and reducing car fires.
- Colour sensors to stop the motors at traffic signals.

Reference Links:

[1] “Ultrasonic Signal Implementation in Arduino-Based Obstacle Robot Control System” Hanifudin Sukri, Deni Tri Laksono*, Dedi Tri Laksono, and Miftachul Ulum

[2] “Speed Control of Electric Motor using Ultrasonic Sensor and Image Processing Technique” with Raspberry Pi 3 M Kalyansuriya1, S R Kaarthik Eswaran2, N Naveen3, R Kumaravel4, G Shanthi5

[3] “An ultrasonic sensor distance induced automatic braking automobile collision avoidance system” by Ahmed Aliyu; Jonathan G. Kolo; Olaniyi O. Mikail; James Agajo; Buhari Umar; Okechukwu I. Aguagba.

[4]“Speed control of DC motor using Fuzzy Logic Controller” by Yasser_Ali_Almatheel; Ahmed_Abdelrahman

[5] “Object Detection Using Ultrasonic Sensor” by Arun Francis G, Arulselvan M, Elangkumaran P, Keerthivarman S, Vijaya Kumar J