

Automatic Braking System Using Ultrasonic Sensor

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Abstract— Driving is a common activity for most of the people. The number of vehicles is increasing day by day. Now a days, the technology has got vast changes which leads increase in speed. The speed plays a vital role to maintain time for longer distances. But, this speed also getting a major problem for causes of road accidents. The common braking is not sufficient for avoidance of accidents when driver is not active. Further improvement has to done in braking system in order to brake a vehicle when driver is not able to brake i.e., it may needs automatic braking system. This automatic braking system allows the vehicle to brake without support of the driver. The main target of the ultrasonic braking system is that, vehicles should automatically brake when the sensors sense the obstacle. This is a technology for automobiles to sense an imminent forward collision with another vehicle or an obstacle, and to brake the vehicle accordingly, which is done by the braking circuit. This system includes two ultrasonic sensors viz. ultrasonic wave emitter and ultrasonic wave receiver. The ultrasonic wave emitter provided in front portion of an automatic braking system vehicle, producing and emitting ultrasonic waves in a predetermined distance in front of the vehicle. Ultrasonic sensor is an effective equipment to complete the expectation of this project.

Keywords: Ultrasonic Sensor

I. INTRODUCTION

Driving is a common activity for most of the people. The number of vehicles is increasing day by day. Now a days, the technology has got vast changes which leads increase in speed. The speed plays a vital role to maintain time for longer distances. But, this speed also getting a major problem for causes of road accidents. The common braking is not sufficient for avoidance of accidents when driver is not active.

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The main target of the ultrasonic braking system is that, vehicles should automatically brake when the sensors sense the obstacle. This is a technology for automobiles to sense an imminent forward collision with another vehicle or an obstacle, and to brake the vehicle accordingly, which is done by the braking circuit. This system includes two ultrasonic sensors viz. ultrasonic wave emitter and ultrasonic wave receiver. The ultrasonic wave emitter provided in front portion of an automatic braking system vehicle, producing and emitting ultrasonic waves in a predetermined distance in front of the vehicle. Ultrasonic wave receiver is also provided in front portion of the vehicle, receiving the reflected ultrasonic wave signal from the obstacle. The reflected wave (detection pulse) is measured

to get the distance between vehicle and the obstacle. The DC gear motor is connected to the wheels of vehicle and power input is given to it from Arduino board. Then PIC microcontroller is used to control the servo motor based on detection pulse information and the servo motor in turn automatically controls the braking of the vehicle. Thus, this new system is designed to solve the problem where drivers may not be able to brake manually exactly at the required time, but the vehicle can stop automatically by sensing the obstacles to avoid an accident.

II. SCOPE OF PROJECT

The scope of this project is to develop an ultrasonic sensor to detect the obstacle and to process the output from the ultrasonic sensor to drive the servomotor as an actuator. Vehicles can automatically brake due to obstacles when the Sensor senses the obstacles. The focus of this project is designing an automatically braking system that can help us control the braking system of a vehicle. The automatically braking system also needs to work with an ultrasonic sensor, which produce sound pulse by a buzzer. The ultrasonic wave is generated from a transmitter and sends to a receiver.

III. METHODOLOGY

Ultrasonic Sensor signals	Range
Maximum	1 metre
Minimum	2 centimetres

Table 1: Maximum and minimum ranging of Ultrasonic Sensor

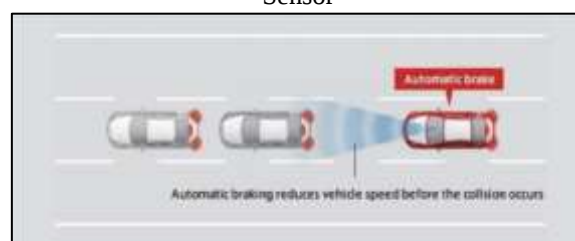


Fig. 1: Reduction in speed of vehicle

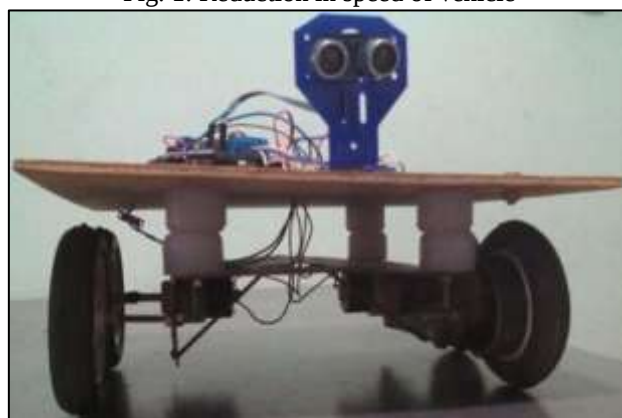




Fig. 2: Plate of Automatic Braking System

IV. PRINCIPAL COMPONENTS OF AUTOMATIC BRAKING SYSTEM

A. Sensor

A sensor is an electrical device that maps an environmental attribute to a quantitative measurement. Each sensor is based on transduction principle which is conversion of energy from one form to another form. There are two important terms related to any sensor – Target Angle – This term refers to the ‘tilt response’ limitations of a given sensor. Since the ultrasonic waves reflect off the target object, target angles indicate acceptable amounts of tilt for a given sensor.

Beam Spread – This term refers to the maximum angular spread of the ultrasonic waves as they leave the transducer.



Fig 3: Ultrasonic sensor

1) Ultrasonic Sensor

Ultrasonic ranging and detecting devices use high frequency sound waves called ultrasonic waves to detect presence of an object and its range. Normal frequency range of human ear is roughly 20Hz to 20,000Hz. Ultrasonic sound waves are sound waves that are above the range of human ear, and thus have frequency above 20,000Hz. An ultrasonic sensor necessarily consists of a transducer for conversion of one form of energy to another, a housing enclosing the ultrasonic transducer and an electrical connection. These sensors are of two types:

- Ultrasonic Transmitter – Before transmitting the ultrasonic wave, there is a part which is ultrasonic wave generator that functions to generate ultrasonic wave. In that part, there is timing instruction means for generating an instruction signal for intermittently providing ultrasonic waves. This signal will send to an ultrasonic wave generator for generating ultrasonic

waves based on the instruction signal from said timing instruction means (transform electrical energy into sound wave). After ultrasonic wave was produced, ultrasonic transmitter transmits the ultrasonic waves toward a road surface to find out the obstacle. The range that obstacle detected is depends on the range of ultrasonic sensors that used.

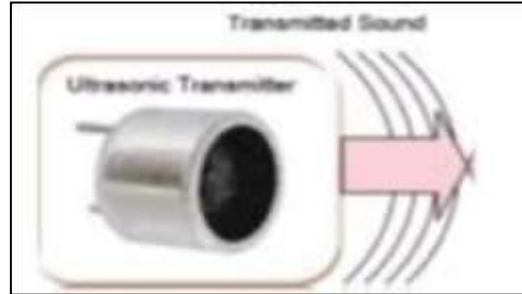


Fig. 4: Ultrasonic Transmitter

Ultrasonic Receiver – If the ultrasonic wave detects the obstacle, it will produce a reflected wave. An ultrasonic receiver is used for receiving the ultrasonic waves reflected from the road surface to generate a reception signal. There is ultrasonic transducer that will transform back the sound wave to electrical energy. This signal amplified by an amplifier. The amplified signal is compared with reference signal to detect components in the amplified signal due to obstacles on the road surface. The magnitude of the reference signal or the amplification factor of the amplifier is controlled to maintain a constant ratio between the average of the reference signal and the average of the amplified signal.



Fig 5: Ultrasonic Receiver

2) Transducer

A transducer is an energy conversion device which converts one form of energy into another. In the ultrasonic sensors they are used to convert electrical energy into ultrasonic energy and vice-versa. In this system piezoelectric transducers are used, which create ultrasonic vibration through use of piezoelectric materials such as certain forms of crystals or ceramic polymers. Their working is based on the piezoelectric effect. This effect refers to the voltage produced between surfaces of a solid, (non-conducting substance) when a mechanical stress is applied to it. Conversely, when a voltage is applied across surfaces of a solid that exhibits piezoelectric effect, the solid undergoes mechanical distortion.

3) DC Gear Motor

A DC gear motor is a fairly simple electric gear motor that uses electricity, gear box and magnetic field to produce torque, which turns the motor. At its most simple, DC gear motor requires two magnets of opposite polarity and an electric coil, which acts as an electric magnet. The repellent and attractive electromagnetic forces of the magnets provide

the torque and causes the DC gear motor to turn. A gear box is present just after the DC motor and a rotary shaft is connected to it, with the help of this DC gear motor setup the vehicle wheels can be rotated in this project.

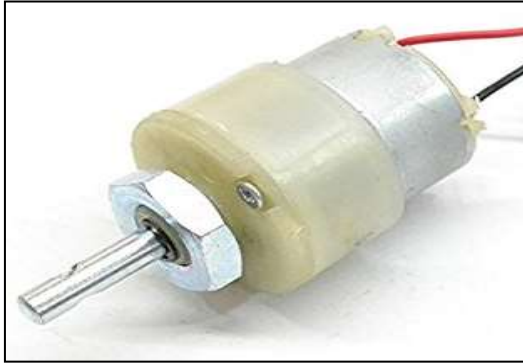


Fig. 6: DC Gear Motor

4) Servo Motor

The output of the PIC is the input of the servo motor. The servo motor allows for precise control of angular position, velocity and acceleration. It consists of a motor coupled to a sensor for position feedback. Thus, it is a closed loop mechanism that uses position feedback to control its motion and final position. The input is a signal, either analog or digital, representing the position commanded for the output shaft. The measured position of the output shaft is compared to the command position (the external input to the motor). If the output position differs from that required, an error signal is generated which then causes the motor to rotate in either direction as needed, to bring the output shaft to the appropriate position. As the required position approaches, the error signal reduces to zero and the motor stops.

The output shaft of servo motor is capable of travelling somewhere around 180 degrees. A normal servo motor is used to control an angular motion between 0 and 180 degrees, and it is mechanically not capable of turning any farther due to a mechanical stop built on to the main output gear. The angle through which the output shaft of the servo motor need to travel is determined according to the nature of the signal given to the motor as input from the PIC.

The servo motor controls the braking through mechanical arrangements. This is done by using a pair of crossed helical gears and a grooved cylindrical component. The larger gear is mounted on the output shaft of the servo motor and the smaller is mounted on the master cylinder piston rod. Thus, when the output shaft of the servomotor gets signals and hence the larger gear rotates in say anticlockwise direction, the smaller gear and hence the master cylinder piston rod rotates in clockwise direction. Due to the groove on the cylindrical component translatory motion is also produced. This is due to a pin, one end of which is inserted in the groove and the other end is fixed rigidly to a support. Thus, a combination of translatory as well as rotary motion is produced.



Fig. 7: DC Servo Motor

5) Breaking Circuit

The processed i.e. the amplified digital signal is sent to the braking circuit. PIC (Peripheral Interface Controller (or) Programmable Interface Controller) – The microcontroller used is PIC 16F84 which is 8-bit microcontroller. PIC microcontrollers are made by microchip technology. PICs are used in this system due to their low cost and wide availability. The numbers of instructions to perform a variety of operations vary from 35 instructions in low-end PICs to about 70 instructions in high-end PICs. It is programmed by using C language.

The signal from the ADC is processed by the PIC microcontroller, and it gives an instruction as an output, based on the condition of the signal, to the servo motor. The signal received from the ADC can also be displayed on the LCD display (which gives an audio-visual warning on the windshield in the driver's field of view), and it gives the distance between the front of the vehicle and the obstacle. The distance value at which automatic braking should start is already stored in the microcontroller. When the measured distance reaches this value, the PIC automatically sends the signal to the servo motor which in turn controls braking through mechanical arrangements.

V. REVIEW OF LITERATURE

A. Ultraonic Sensing and Control

Ultrasonic signals are like audible sound waves, except the frequencies are much higher. Our ultrasonic transducers have piezoelectric crystals which resonate to a desired frequency and convert electric energy into acoustic energy and vice versa. The illustration shows how sound waves, transmitted in the shape of a cone, are reflected from a target back to the transducer. An output signal is produced to perform some kind of indicating or control function. A minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted. Variables which can affect the operation of ultrasonic sensing include, target surface angle, reflective surface roughness or changes in temperature or humidity. The targets can have any kind of reflective form - even round objects.

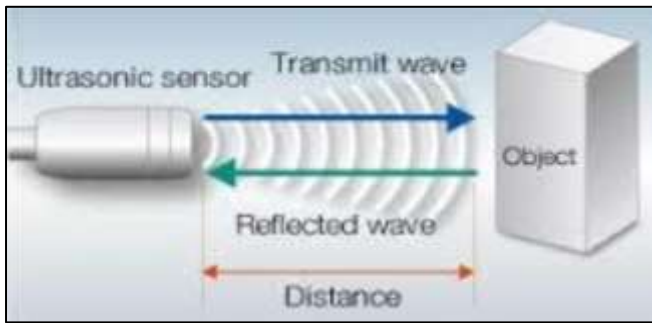


Fig. 8: Ultrasonic ranging

B. Measurement Principle and Effective Use of Ultra Sonic Sensor

Ultrasonic sensor transmits ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an object. Basically, in our project ultrasonic sensor ranges of about 2 centimetres to 1 metre. By measuring the length of time from the transmission to reception of the sonic wave, it detects the position of the object. The ultrasonic transducer produces ultrasonic signal. These signals are propagated through a sensing medium and the same transducer can be used to detect returning signals. In most applications, the sensing medium is simply air. An ultrasonic sensor typically comprises at least one ultrasonic transducer which transforms electrical energy into sound and in reverse sound into electrical energy, a housing enclosing the ultrasonic transducer, an electrical connection and optionally, an electronic unit for signal processing also enclosed in the housing.

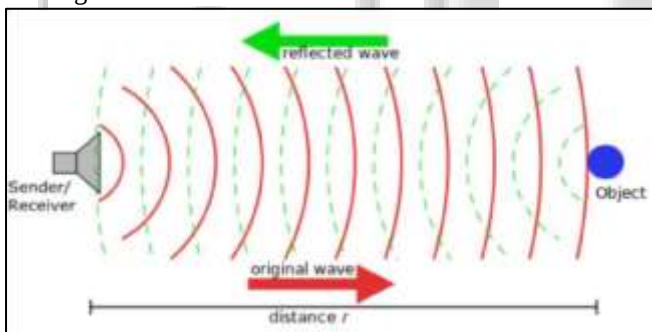


Fig. 9: Basic Ultrasonic operation

C. Target Angle and Beam Spread

This term refers to the "tilt response" limitations of a given sensor. Since ultrasonic sound waves reflect off the target object, target angles indicate acceptable amounts of tilt for a given sensor.

This term is defined as the area in which a round wand will be sensed if passed through the target area. This is the maximum spreading of the ultrasonic sound as it leaves the transducer.

D. TARGET ORIENTATION

To produce the strongest echoes, the sensor's beam should be pointed toward the target. If a smooth, flat target is inclined off perpendicular, some of the echo is deflected away from the sensor and the strength of the echo is reduced. Targets that are smaller than the spot diameter of the transducer beam can usually be inclined more than larger targets. Sensors with larger beam angles will generally

produce stronger echoes from flat targets that are not perpendicular to

VI. SENSING AND CONTROLLING UNIT

A. Arduino Uno R3

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 Analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The structure of Arduino is its disadvantage as well. During building a project you have to make its size as small as possible. But with the big structures of Arduino we have to stick with big sized PCB's. If you are working on a small micro-controller like ATmega8 you can easily make your PCB as small as possible.



Fig. 8: Arduino Uno Layout

Brand name	Arduino
Height	25 Millimetres
Width	5.5 Centimetres
Weight	91 Grams
Dimensions	8 x 5.5 x 2.5 Centimetres
RAM Size	8 kb
Voltage	5 Volts
Digital Pins	14

Table 2: Technical Specification of Arduino Uno

B. Ultrasonic Transducer

Ultrasonic transducers are transducers that convert ultrasound waves to electrical signals or vice versa. Those

that both transmit and receive may also be called ultrasound transceivers; many ultrasound sensors besides being sensors are indeed transceivers because they can both sense and transmit. These devices work on a principle similar to that of transducers used in radar and sonar systems, which evaluate attributes of a target by interpreting the echoes from radio or sound waves, respectively. Active ultrasonic sensors generate high-frequency sound waves and evaluate the echo which is received back by the sensor, measuring the time interval between sending the signal and receiving the echo to determine the distance of an object.

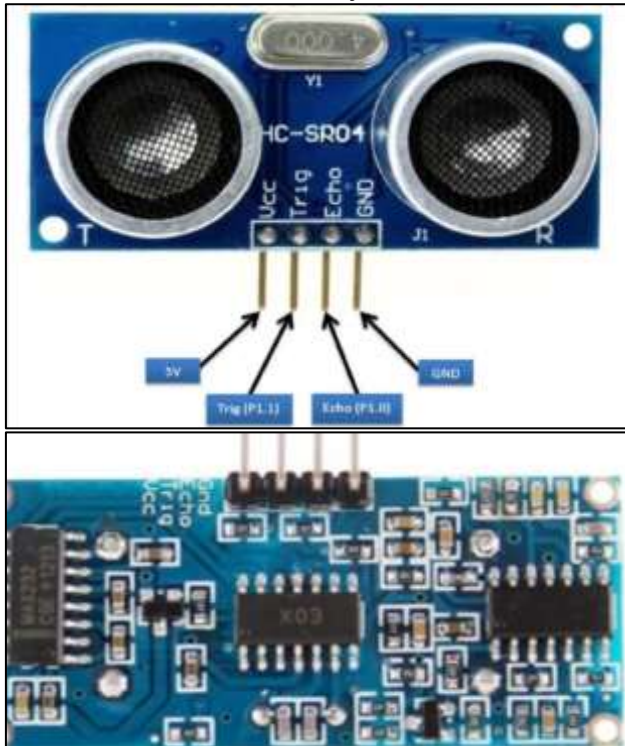


Fig 9: Ultrasonic Transducer HC-SR04 (Front and Back view)

VII. CONCLUSION

We have successfully completed the fabrication of automatic braking system model prototype and this project presents the implementation of an Automatic Braking System for Forward Collision Avoidance, intended to use in vehicles where the drivers may not brake manually, but the speed of the vehicle can be reduced automatically due to the sensing of the obstacles. It reduces the accident levels and tends to save the lives of so many people. By doing this project practically we gained the knowledge about working of automatic braking system and with this future study and research, we hope to develop the system into an even more advanced speed control system for automobile safety, while realizing that this certainly requires tons of work and learning, like the programming and operation of microcontrollers and the automobile structure. Hence we believe that the incorporation of all components in Automatic Braking System will maximize safety and also give such system a bigger market space and a competitive edge in the market.

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