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Intelligent Braking System Using Ultrasonic Sensor

Manju Kumari[1], Shambhu Kumar[2], Anand Kumar[3], Nikita Kumari[4]

[1]New Government Polytechnic, Patna-13, Dept. of Basic Science

[2, 3, 4] New Government Polytechnic, Patna-13, Dept. of Mechanical Engineering

Abstract: ***On an average, 1214 accidents take place every day in our country. Most of the accidents occur due to the poor infrastructure, lack of road protocols, almost nonexistence of measures to enforce laws of the road and the delay of the driver to hit the brake. The control on the speed of vehicles can play a vital role in the reduction of number of accidents which can be achieved by the Intelligent Braking System (IBS). The braking system was designed and applied on a vehicle to make the driving process safe using embedded system design. A mechatronic braking system discussed in this paper is developed and designed in such a way that, when it is active it can apply break automatically encountered by any object sensed by the ultrasonic sensor.This system employs different types of sensors to constantly monitor the conditions of the vehicle, and respond in an emergency situation.***

Keywords: Ultrasonic Sensor, Processor (Arduino Uno), Intelligent Braking System (IBS), Antilock Braking Systems (ABS), Microcontroller

1. Introduction

An intelligent mechatronic system includes an ultrasonic wave emitter provided on the front portion of a vehicle producing and emitting ultrasonic waves frontward in a predetermined distance. An ultrasonic receiver is also placed on the front portion of the vehicle operatively receiving a reflective ultrasonic wave signal. The reflected wave (detected pulse) gives the information of presence of the object. After that it stop and move backward and detect obstacle in other direction and move forward in direction when it didn't detect any object without crashing with the obstacle. The microcontroller is used to control the braking of the vehicle based on the detected pulse information to automatically stop the vehicle.

Intelligent Braking System (IBS):

Braking systems of vehicles were always specifiedas the highest important factor concerning safety matters. Inappropriate braking of the vehicles may cause heavy accidents due to relatively longer stopping distances and higher energy output of brakes particularly in the case of vehicle combinations. The traditional medium used for Brake system (compressed air) can be now controlled with the speed and precision offered by modern electronic abilities. The previous research study clearly explains that Ultrasonic sensor and microcontroller action plays vital role in determining intelligent braking torque generated by brake actuation assembly. [1] Intelligent Braking System (IBS) introduced in vehicles providing rapid brake response and release for every single Wheel therefore ensuring safety. The extremely rapid response time provided by the electronic control can be used for crucially Shortening the braking distance by introducing advanced control of braking system operation. Intelligent braking system Has a lot of potential applications especially in developed countries where research on smart vehicle and intelligent highway are Receiving ample attention. The system when integrated with other subsystems like automatic traction control system, intelligent Throttle system, and auto cruise system, etc. Will result in smart vehicle manoeuvre. The Emergence of digital signal processor enhances the capacity and features of universal microcontroller.[2] The overall system is Designed in such a way that the value of inter-vehicle distance from infrared laser sensor and speed of follower vehicle from speedometer are fed into the DSP for processing, resulting in the DSP issuing commands to actuator to function appropriately.Figure-2 and 3

The most popular Systems like Antilock Braking Systems (ABS), Traction Control and Stability Control employ different types of sensors to Constantly monitor the conditions of the vehicle, and respond in an emergency situation. An Intelligent Breaking System (IBS) includes an ultrasonic wave emitter provided on the front portion of a vehicle producing and emitting ultrasonic waves frontward in a predetermined distance.[3] An ultrasonic receiver is also placed on the front portion of the vehicle operatively receiving a reflective Ultrasonic wave signal. Fig - 4 The reflected wave (detected pulse) gives the distance between the obstacle and the vehicle. Then a Microcontroller is used to control the speed of the vehicle based on the detection pulse information to push the brake pedal and Apply brake to the vehicle stupendously for safe breaking.

2. Working Principle

The extremely rapid response time provided by the electronic control can be used for crucially shortening the braking distance by introducing advanced control of braking system operation. The control of commercial vehicle's braking system operation is related not only to vehicle speed but also to lateral acceleration together with the yaw moment control and significantly reducing the possibilities of the vehicle rolling over.[4] Obviously, such a complex task imposed to the control of braking system cannot be based on the driver abilities and need to be done operated independently of the driver.

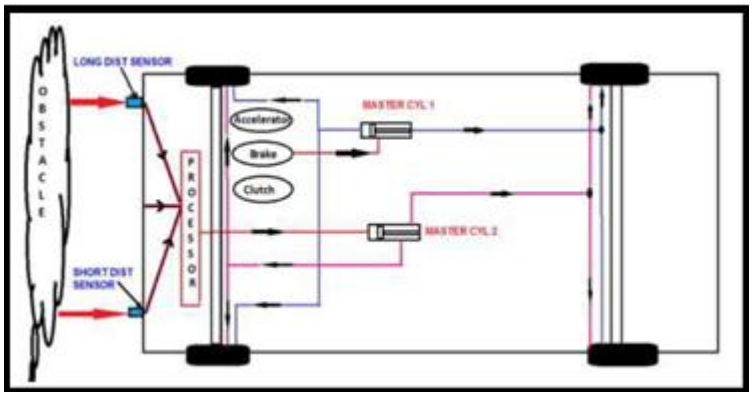

Figure 1: Schematic Diagram

Principle of ultrasonic detection

Sound is a mechanical wave travelling through the mediums, which may be a solid, or liquid or gas. Sound waves can travel through the mediums with specific velocity depends on the medium of propagation. The sound waves which are having high frequency reflect from boundaries and produces distinctive echo patterns. Sound is a mechanical wave travelling through the mediums, which may be a solid, or liquid or gas. Sound waves can travel through the mediums with specific velocity depends on the medium of propagation. The sound waves which are having high frequency reflect from boundaries and produces distinctive echo patterns.

Ultrasonic detection is most commonly used in industrial applications to detect hidden tracks, discontinuities in metals, composites, plastics, ceramics, and for water level detection. For this purpose, the laws of physics which are indicating the propagation of sound waves through solid materials have been used since ultrasonic sensors using sound instead of light for detection.

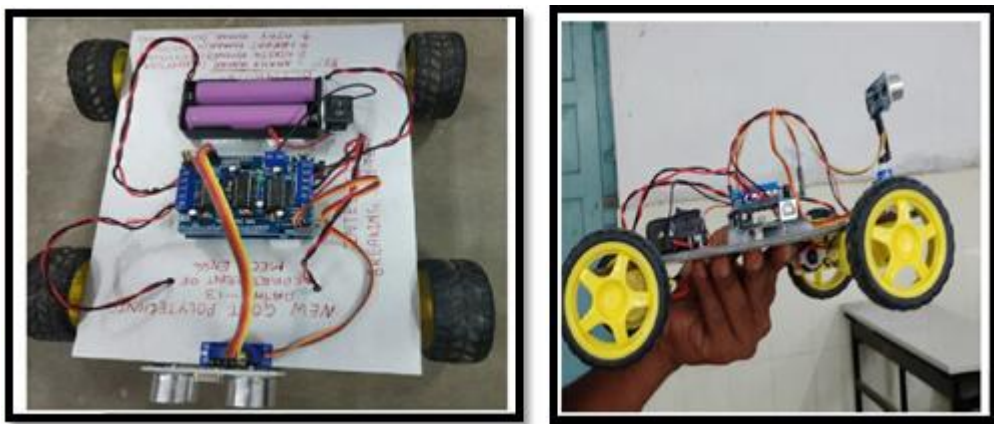

Figure 2: Actual Setup

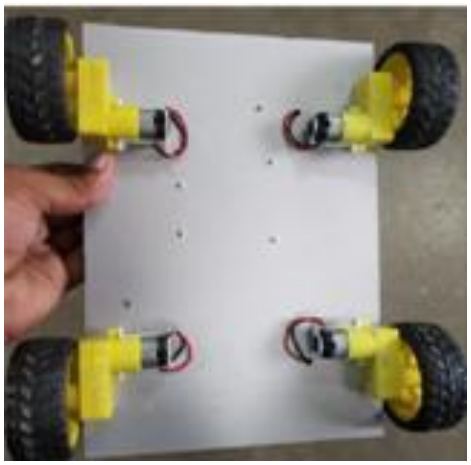

Figure 3: Bottom view

3. Main Component

1) **Ultrasonic Sensor**-: Ultrasonic sensor is a ranging and detecting devices which make use of high-frequency sound waves to detect the presence of an object and its range.[5] These systems either measure the echo reflection of the sound waves from objects or detect the interruption of the sound beam as the objects pass between the transmitter and receiver. An ultrasonic sensor typically utilizes a transducer that produces an electrical output pulse in response to the received ultrasonic energy. In such case, the horizontal aperture angle must be at least 8 degrees for an inter-vehicle distance of 75 meter. The vertical aperture is fixed to be 1 degree and is positioned in such a way to avoid fault reading due to the road conditions.

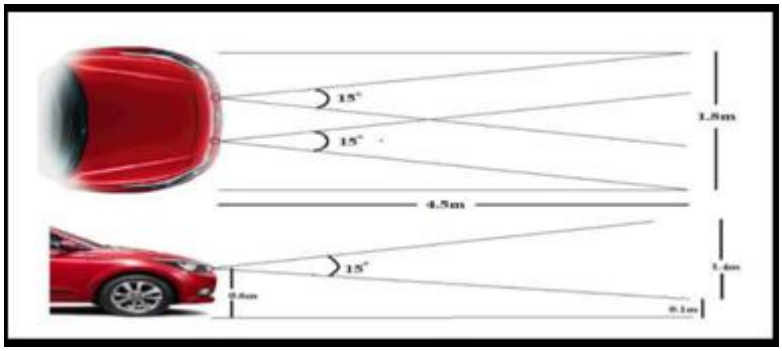

Figure 4: Sensor Position

Features-:
Test distance = high level time × velocity of sound (340M/S) / 2,
Working Voltage DC 5 V, Working Current 15mA, Working Frequency 40Hz, Max Range 4m
Min Range 2cm, Measuring Angle 120 degree

2) **Processor (ARDUINO UNO):** The Arduino Uno is a microcontroller board based on the atmega328. It has 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. 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. "Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions. Figure-5

Figure 5: Arduino Uno

3) **Microcontroller (Motor Driver)**

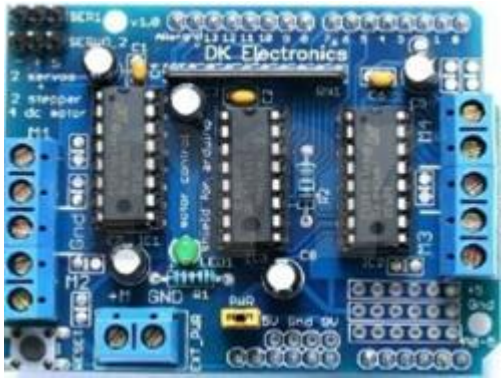

Figure 6: Motor Driver

Specifications: Operating Voltage -5V, Operating Current-15ma, Counter limit -5000rpm

4) **Servo Motor:** The need for automation, miniaturization and quality components in most of today's products requires excellent cooling solutions, high quality small motors and ultra-precision machined ball bearing. Servo motor also called an executive motor, is an executive component in an automatic control system.[6] Its work is to convert the received electrical signal into angular velocity output or angular displacement output on the motor shaft. Since the introduction of the servo motor, the servo motor has proved to be quite useful in many industries. For many years, servo motors have been involved in large tasks. They may be small in size, but they are very powerful and energy-efficient.

Figure 7: Servo Motor

5) **Battery and Wheels:** Tyre is used to support the frame on its hub present on the wheel so that the body weight can equally distributed over all the surface after the load

is applied on the frame. The friction cause tyre rotate on move the shaft in the hub which is hold by bearing to rotate freely on its own by transmission of power from engine through chain.

Figure 8: Battery and Wheels

4. Advantages

As mentioned [7], an IBS prevents lock-ups and skidding, even in slippery conditions. An IBS shares some of the infrastructure of a traction control system, where new technology helps ensure that each Wheel has traction on the road. It is easy for manufacturers to install both of these features at the factory. Intelligent braking systems coordinate wheel activity with a sensor on each wheel that regulates brake pressure as necessary, so that all wheels can operate in a similar speed range, and help drivers to have better control of a vehicle in any road conditions (where hard braking may be necessary) [7, 8, 9].

An ultrasonic sensor is cheaper and less demanding of hardware in comparison to other types of sensors presently used.As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with Pedestrians, or can at least reduce the injuries occurring.[10, 11] The low cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle-free driving experience at a reduced cost.As system does not take whole control from driver, the 'risk 'factor due to false indication gets reduced.

5. Result & Discussion

In the present work, a model of an ultrasonic distance measurement for stationary obstacle is obtained. Controlling the speed of vehicle accordingly to predetermined distance is shown. An ultrasonic sensor, cheaper and less demanding of hardware than other types of sensors presently used, such as the sensors based on computer vision or radar, is used to measure the distance between vehicle and the obstacle. The relative speed of the vehicle with respect to the obstacle is estimated using consecutive samples of the distance calculated.[13] These two quantities are used by the control system to calculate the actions on both the accelerator and also the brake, thus to adjust the speed in order to maintain a safe distance to prevent accidents. As ultrasonic sensors can detect any kind of obstacle, this system can also prevent collision of the vehicle with pedestrians, or can at least reduce the injuries occurring. Since the control system does not use the absolute speed to calculate the safety distance as done by the currently existing systems, the interaction with automotive electronics is limited to actions on the accelerator and brake. This matter, coupled with the fact of lower cost of ultrasonic sensors compared with other kinds of sensors, could facilitate the application and mounting of the system in many low-end vehicles, helping to improve comfort and safety and offer a hassle-free driving experience at a reduced cost

6. Conclusions

A mechatronic braking system discussed in this paper is developed and designed in such a way that, when it is active it can apply break automatically encountered by any object sensed by the ultrasonic sensor. Intelligent braking is one of the smart options which can be instigated in various automobileapplications for stopping a moving body without spasmodic motion. Design of intelligent brake applications basically depend upon effectiveness of Ultrasonic sensor and microcontroller (motor driver),and controlling the speed of vehicle accordingly to programmed distance is revealed in the study done by our team. Our present work comprehended us that enactment of this smart system can achievable and of real time use. Approaches and conclusions that we present are somewhat preliminary and need further significant research. While vehicle is taking a turn sensor can give the false indication of obstacle. To overcomethis, we will arrange such that this system goes off while turn. This can be attained by fitting sensors on wheel that are capable of measuring wheel turning. At present, this system is eagerlyappropriate for automatic transmission. Though making some changes we can use this on any available vehicle. Also, upgraded and detailedprogramming is necessary for real time operation. Application of Intelligent braking system for critical dynamic condition need to be investigation.

7. Future Aspect

This will make the driving process safe using enhanced braking system and design. Use of rpm counter will be helpful to measure relative velocity. This will ensure quick breaking response.Reduce road accidents due to delay breaking. By using a greater number of ultrasonic sensor and IR sensor we can develop it as a driverless vehicle.

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