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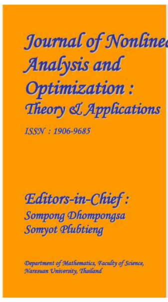

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DESIGN AND ANALYSIS OF INTELLIGENT BRAKING SYSTEM

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ABSTRACT: The vehicle's braking system was developed and installed using embedded system design to enhance driver safety. The most common reason for accidents is when drivers do not quickly apply the brakes. As part of this project, the vehicle's speed and the object detected by the ultrasonic sensor are used to trigger the braking system. Nowadays, active safety systems are commonly placed in cars to lower the probability of crashes, which are widespread in urban areas. Three of the most common are antilock brake systems (ABS), stability control (SC), and traction control. Various sensors are utilized by each of these systems to keep tabs on the vehicle's condition and react to any emergencies. As part of a sophisticated mechatronic system, an ultrasonic wave emitter installed on the front end of a vehicle creates and sends out ultrasonic waves in a forward direction at a predetermined distance. At the front of the vehicle, there is an ultrasonic receiver that is used to receive reflected ultrasonic wave signals. While the RPM counter shows the vehicle's speed, the reflected wave (detected pulse) shows the distance between the vehicle and the obstacle. The microprocessor sends signals from the detection pulses to the braking system, making the vehicle brake heavily for safety reasons.

Keywords: Ultrasonic Sensor, Intelligent Mechatronic system, RPM counter, Microcontroller.

I. INTRODUCTION

All other safety issues, especially active safety, have historically taken a back seat to commercial vehicle braking systems. Poor braking can cause major accidents, especially when there are several cars involved, because these vehicles have much longer stopping distances and brakes with a higher energy output. Compressed air, the classic brake system medium, can now be controlled with the speed and accuracy afforded by modern electronic capabilities. A commercial vehicle's safety is ensured by an Intelligent Braking System (IBS) that responds and releases the brakes quickly for each wheel. Using the electronic control's lightning-fast response time, the brake system function may be fine-tuned to drastically reduce stopping distance.

It is not safe to leave the driver alone to operate the braking system because of how complicated it is. It is certain that the assigned task might be accomplished with improved IBS brake forces management. A power-driven vehicle's front and rear axles, as well as combinations of towing and trailering and tractor/semi-trailers, are all part of the braking force distribution that the suggested enhanced method for managing braking forces should intelligently control. Intelligent braking systems have many potential uses, especially in developed countries that are investing heavily in smart vehicle and intelligent highway research.

Intelligent vehicle maneuvering will be possible when this technology is integrated with other subsystems like auto cruise, intelligent throttle, and automatic traction control.

Ultimately, the driver will take on the role of a passenger, prioritizing safety and ensuring the most efficient, comfortable, and least expensive journey possible. Adapting to technological advances, especially in the realm of smart sensors and actuators, this kind of design and development will satisfy the demands of a contemporary culture that prioritizes quality. Universal microcontrollers' capacities and capabilities have been enhanced with the advent of digital signal processors. The system is configured to receive data from the following vehicle's speedometer and the infrared laser sensor, which measure the distance between vehicles, and feed it into the digital signal processor (DSP). The actuator is then able to carry out its intended function thanks to the instructions provided by the DSP [1]. Regularly used systems, such as A.B.S., traction control, and stability control, employ a plethora of sensors to keep tabs on the car at all times and react accordingly. As part of a sophisticated mechatronic system, an ultrasonic wave emitter mounted on the front end of a vehicle produces and sends out ultrasonic waves in a forward direction at a predetermined distance. An ultrasonic receiver mounted on the front of the vehicle also picks up reflected ultrasonic wave signals. By measuring the reflected wave (detected pulse), one can determine the distance between the vehicle and the barrier. The data from the detected pulses are then used by a microcontroller to control the speed of the vehicle, apply heavy brakes to ensure safety [2].

II. SYSTEM SURVEY

Acquiring a thorough understanding of the ABS requires extensive research (in books and online), careful observation of component mounting (including the hydraulic control module warning system and ECM), and visits to various workshops (such as those run by Maruti Suzuki, Bafna Motors, and Naik Motors). Owners of ABS-equipped autos supplied workshop technicians with different perspectives. Reports from drivers indicate that, under normal circumstances, ABS lengthens stopping distances. This could be due to systemic faults or the noise or clinking of the ABS, which can cause the driver to brake less rapidly.

Consequently, we deduced that car braking systems are either not sophisticated enough to function properly or are too sophisticated, removing the driver's agency and heightening the risk factor. In order to reduce potential danger in an emergency, we devised a system that combines the driver's ability to manually apply the brakes with the system's ability to regulate the brakes. It could be expensive to maintain an ABS. It can cost hundreds of dollars to fix each tire's pricey sensors if they fail or get miscalibrated. This is a major argument against anti-lock brake systems (ABS) in cars.

In addition, many Indian commuter cars do not have ABS because of how expensive they are. An ABS failure could easily occur if you fiddle with the brakes. One of the problems is ABS disorientation, which happens when a compensating brake sensor makes noise, makes the vehicle tremble, or makes the brakes not work at all. To be effective, ABS must be manually engaged at the correct times and distance computations must be carefully monitored by the rider. The stopping distance is different for each ABS. When it rains or snows, Volvo's laser assisted braking system won't work since the laser is sensitive to environmental factors. We propose a system that uses a microcontroller and ultrasonic sensors to automatically detect nearby objects and vehicles, slow down the vehicle, and alert the driver through sound when an obstacle is detected.

III. METHODOLGY

A vehicle's front end features an ultrasonic wave emitter that, as part of an intelligent mechatronic system, generates and sends out ultrasonic waves in a forward direction at a set distance. An ultrasonic receiver mounted on the front of the vehicle also picks up reflected ultrasonic wave signals. By measuring the reflected wave (detected pulse), one can determine the distance between the vehicle and the barrier. Brakes may be securely and firmly applied thanks to the microprocessor, which controls the vehicle's speed. It does this by making use of information gleaned from pulse detection.

Using the electronic control's lightning-fast response time in conjunction with sophisticated braking system control allows for a significant reduction in stopping distance. Parameters including lateral acceleration, yaw moment control, and vehicle speed influence the operation of commercial trucks' braking systems, which greatly lower the chance of the truck rolling over. An autonomous operator is clearly required for a job as intricate as regulating the brake system, since the driver simply does not possess the necessary skills.

Development of an idea

- Detail study of literature
- System survey
- Drawbacks in existing approach
- Cost estimation and specification for standard parts
- Load distribution analysis
- Braking force and pressure analysis
- Experimentation
- Results and discussion

Development Of Initial Concept Model

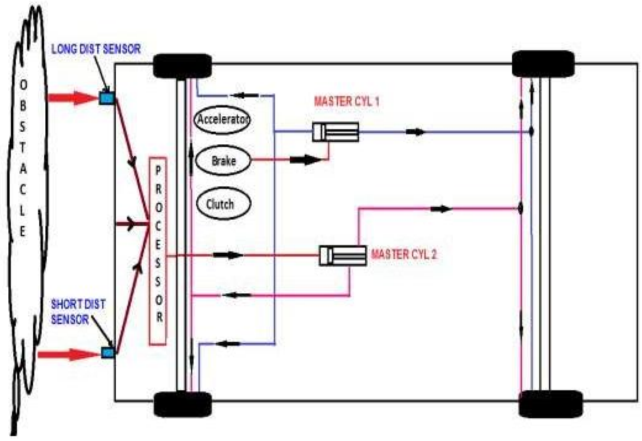


Figure 1 Concept model

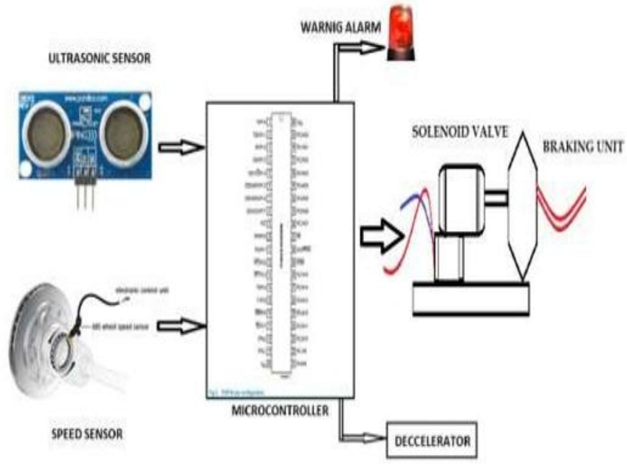


Figure 2 System layout

This project's conceptual model is shown in Figure 1. The braking system is being automated as best we can. The microcontroller, ultrasonic sensor, RPM counter, and timing/braking choice components are shown in Figure 2. The master cylinder receives the required braking pressure from the actuator cylinder.

Main Intelligent Brake System Components

Ultrasonic Sensor

Ultrasonic ranging and detection devices measure item range and presence using high-frequency sound waves. These gadgets can identify when an object blocks the sound beam between the transmitter and receiver or measure how much it reflects sound waves. Ultrasonic sensors use transducers to convert ultrasonic energy into electrical pulses. This scenario requires an 8-degree horizontal aperture angle for a 75-meter vehicle gap. The vertical aperture is fixed at 1 degree because road conditions impede fault reading.

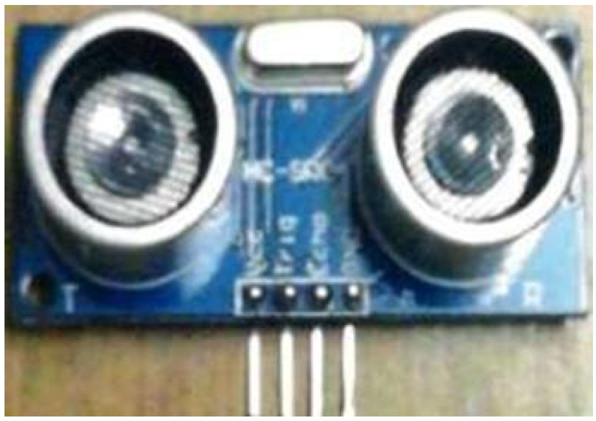


Figure 3 Ultrasonic Sensor

Test distance = (high level time × velocity of sound (340M/S) / 2,

Summary

Working Voltage	DC5 V
Working Current	15mA
Working Frequency	40Hz
Max Range	4m
Min Range	2cm
Measuring Angle	15 degree
Trigger Input	Signal 10uS TTL pulse
Echo Output	Signal Input TTL lever signal and the range in proportion
Dimension	45*20*15mm

Timing Diagram

You can find the timing diagram below. You can start range by feeding a brief pulse of 10Us into the trigger input. Afterwards, the module will increase its echo and emit an 8-cycle blast of ultrasonic sound at 40 kHz. An object's echo is a function of both the width and range of its pulse. Time between the trigger signal and the echo signal allows one to determine the range. With a measurement cycle longer than 60 milliseconds, you may avoid the problem of a trigger signal becoming an echo signal, which reduces the range to high level time * velocity (340 M/s) / 2.

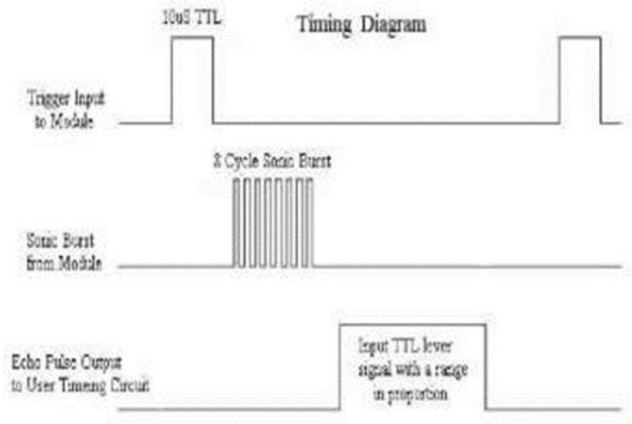


Figure 4 Timing diagram of Ultrasonic sensor

The HC-SR04 ultrasonic ranging module can measure non-contact distances between 2 cm and 450 cm with an accuracy of up to 3 mm. Ultrasonic transmitters, receivers, and control circuits are all part of the modules.

The Basic Principle Of Work

Signal strength must be at least 10 microseconds when using an IO trigger. In response to a detected pulse signal, the Module will automatically transmit eight pulses at 40 kHz. The duration of the high-level output signal is the time it takes for the ultrasonic signal to travel from its source to its destination.

Processor (Arduino Uno)

One such microcontroller board is the Arduino Uno, which is based on the ATmega328. Components include a ceramic resonator operating at 16 MHz, 6 analogue inputs, 14 digital I/O pins (including 6 PWM outputs), 1 power jack, 1 USB port, 1 ICSP header, and 1 reset button. It has everything you need to support the microcontroller, so all you need is a battery, an AC-to-DC adapter, or a USB cable to get started. In anticipation of the 1.0 release of Arduino, the Italian word "uno" is being used. The Uno and Arduino version 1.0 will be the reference versions moving forward. Just look at the most current USB board in the series, the Uno, to see how different versions of the Arduino platform stack up against each other.

Figure 5 Arduino uno diagram

Features

Microcontroller	ATmega328
Operating	Voltage 5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O	Pins 14 (of which 6 provide PWM output)
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25gm

Rpm Counter (H 2010 Opt Coupler Photoelectric Sensor)

Specifications;

1. Operating Voltage -5V
2. Operating Current-15mA
3. Counter limit -5000rpm

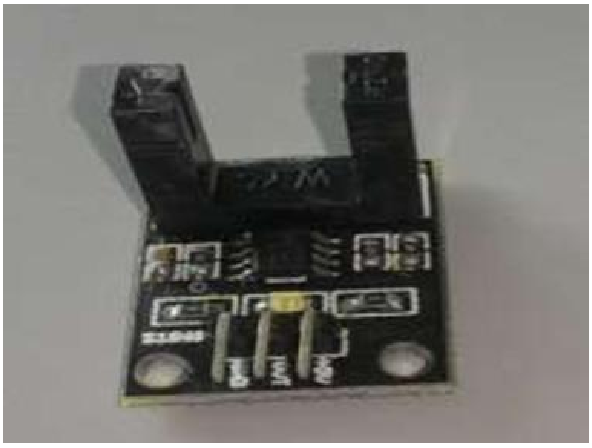


Figure 6 Rpm counter,

Figure7 DC Motor linear actuator

Dc Motor Linear Actuator

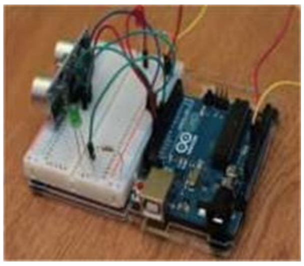
Specifications:

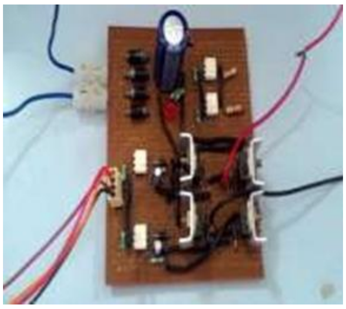
- Voltage:12V DC
- Strokelength:2inch
- Duty cycle: 25%
- Maxloadcurrent:3Amp
- No load current<1Amp

StepDownLowFrequencyTransformer

Specifications:

- Power:0.5V-ampto200V-amp
- Coil structure : Toroidal
- Phase: Single phase
- Winding turns: Encapsulated Transformer / Autotransformer
- Cooling: Air cooled





Pictures of 12V 2Amp transformers (Figure 8), sensor-microcontroller interface (Figure 9), and power supply circuit (Figure 10).

IV. EXPERIMENTATION

Building a system on a car and running experiments with varied parameters is our next move. Here are the parameters:

- Vehicle Speed
- Obstacle distance
- Sensor Position
- Varying deceleration rate

Combining various flow rates to accomplish smooth braking and eliminate vibrations is one way to prevent jerky motion of the vehicle caused by rapid braking; another option, while more expensive, is to utilize an electronically operated flow control valve to speed up the system's response.

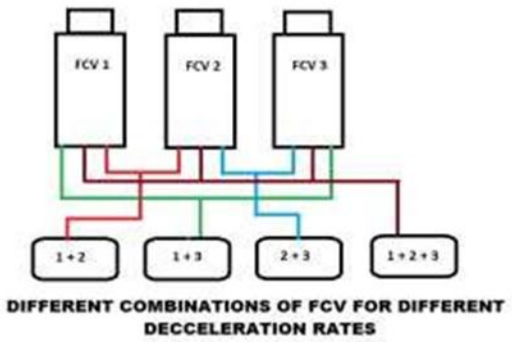


Figure 10 Braking fluid distributions

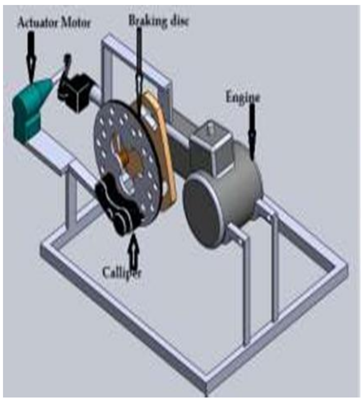
Draw Backs In Using Hydraulic Actuation

- A lower level of efficacy is achieved by the system as a consequence of the longer actuation time and response time that is required.
- Does not necessitate components that are fewer
- The complexity of the system increases, which means that the installation process gets considerably more difficult.
- You should not add any weight to the vehicle that is not required.
- More expensive than it was previously.

As a result of the aforementioned factors, we decided to switch to an electrically actuated solenoid, which offers a number of benefits, including the following:

- A less amount of time is required to react to questions.
- The amount of components that are required is substantially lower when compared to hydraulic actuation.
- If the system is made more straightforward.
- There is a reduction in cost.

Experimental Setup Schematic



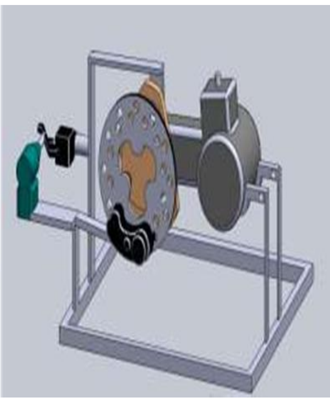
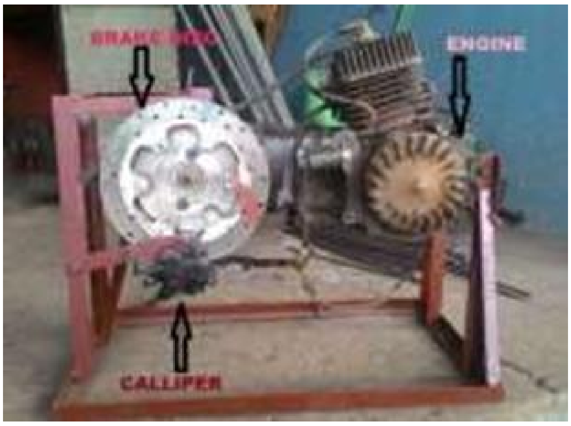


Figure 11 Schematic setup Figure 12 Schematic setup

Actual Experimental Setup



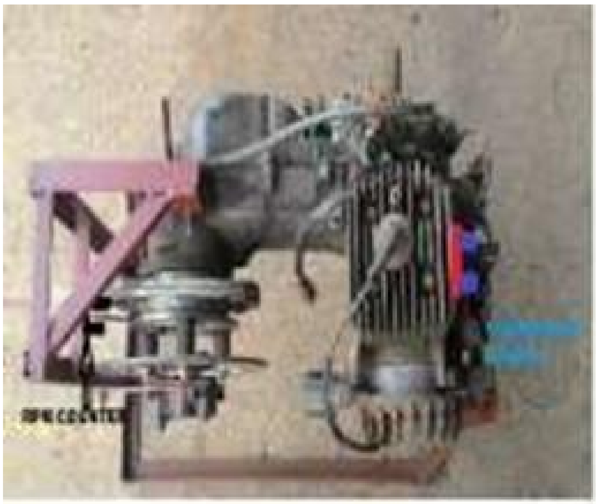


Figure 13 Actual test bench Figure 14 Sensors position Figure 15 Rpm counter position

From the results of our experiment, we were able to draw inferences, and this is the experimental setup that we built. During the course of our experiment, the object in question remains in a stationary position; nevertheless, the obstacle distance is shifting in the context of obtaining readings while the obstacle distance is simultaneously shifting.

Advantages Of Intelligent Braking System (Ibs)

- Even on wet or slick surfaces, an IBS will keep you from locking up or sliding. In certain cases, IBS brakes have prevented fatalities by allowing drivers to maintain control of their vehicles.

- By utilizing some of the same components as a traction control system, an IBS can make sure that every wheel is grabbing onto the road. That facilitates their installation at the factory for both features.
- Each wheel has its own sensor that communicates with the intelligent braking system, which helps keep the wheels moving in a consistent speed range by adjusting the brake pressure as needed. And make it easier for drivers to maintain control of their vehicles when cornering becomes required.
- In comparison to other sensors on the market, an ultrasonic sensor is both more affordable and easier to implement.
- Because ultrasonic sensors are able to identify any type of impediment, this technology can also help avoid or significantly lessen the severity of pedestrian accidents.
- Ultrasonic sensors are more affordable than other types of sensors, which means they might be installed in more affordable automobiles. This would increase comfort and safety while offering a less expensive, more hassle-free driving experience.
- The "risk" component owing to incorrect indication is diminished since the technology does not assume complete control from the driver.
- as a vehicle is in motion, it experiences a variety of forces as it brakes. that is, the total of all forces, both static and dynamic, enters the picture.We play around with the following parameters to get a brake system that works smoothly and safely.

1. Obstacle distance:

We conducted experiments with varying distances from the vehicle to obstacles. Within 5 meters, our prototype model aims to accomplish safe anti-collision braking.

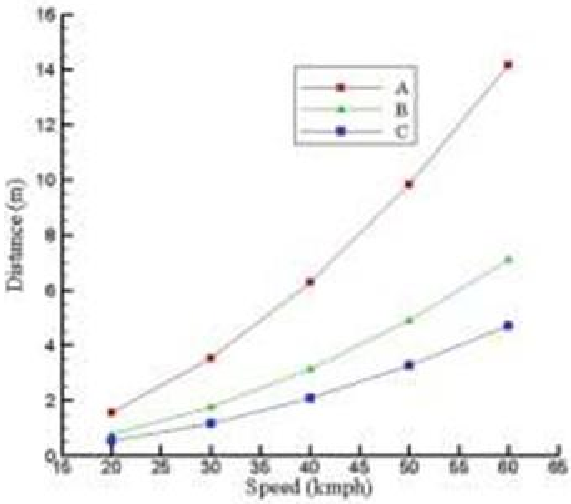


Figure 16 Graph of Speed Vs Stopping distance

2. Current variation to actuator:

Our actuator may be adjusted to move at speeds ranging from 3 mm/sec to 20 mm/sec. In high-speed situations requiring rapid, jerk-free braking, we can accomplish this variation by adjusting the current rating from 1 amp to 3 amps.

3. Ultrasonic Sensor position:

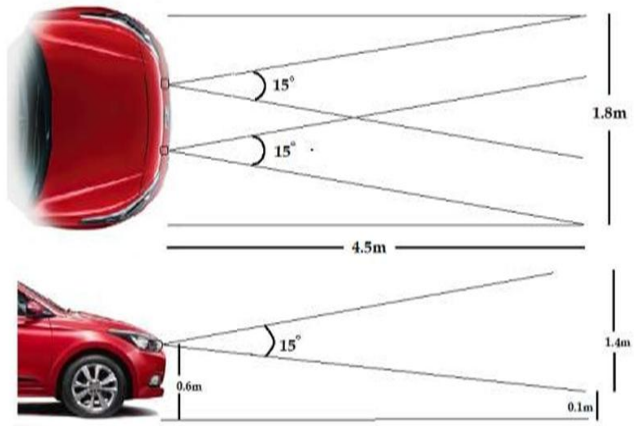


Figure 17Ultrasonic sensor position

To avoid inaccurate readings, we must relocate the sensor such that it covers the maximum area ahead of the vehicle. It is essential to have a sufficient number of sensors so that the system can continue to function even if one of them fails.

V. DISCUSSIONS

The outcomes of a stationary barrier ultrasonic distance measurement prototype are detailed in this article. To do this, the vehicle's speed is modulated in respect to a certain distance. To find out how far away the barrier is from the vehicle, an ultrasonic sensor can be used instead of the already-used, costly and resource-intensive radar or computer vision sensors.

To get a ballpark idea of how fast the car is going in comparison to the obstacle, we can take many distance readings. Keeping a safe distance from obstacles and avoiding collisions is made possible by the control system, which uses these two figures to determine when to engage the brakes and acceleration. Ultrasonic sensors can detect any obstacle, which means this technology can also assist prevent or greatly reduce the impact of pedestrian accidents.

Due to the control system's failure to utilize the vehicle's speed to establish the safe distance, the sole means of interacting with the car's electronics is by pressing the accelerator or brake pedal. This, together with the fact that ultrasonic sensors are more cost-effective than other kinds of sensors, means that the system may be integrated into a wide range of affordable automobiles. This would be fantastic for enhancing safety and comfort while providing a less expensive and more convenient driving experience.

VI. CONCLUSION

This study introduces an intelligent braking system and analyzes its numerous characteristics for everyday use. Intelligent braking is a smart way to stop a moving thing without jerking. Previous study demonstrated how the brake actuation assembly determines intelligent braking torque and how the ultrasonic sensor and microprocessor play a role. The performance of an ultrasonic sensor and RPM counter is vital to intelligent brake applications. This study examined how sensor position, output current, and obstacle distance affects vehicle braking. Variations in sensor setups and current densities produced varied findings.

The results of a stationary barrier ultrasonic distance measurement prototype are presented here. The vehicle's speed is adjusted to a distance. Ultrasonic sensors can measure the barrier's distance from the vehicle instead of expensive and resource-intensive computer vision or radar sensors. The RPM counter estimates vehicle speed. The control system adjusts speed to avoid obstacles based on these two values of brake action. Ultrasonic sensors can detect any impediment, preventing or reducing pedestrian accidents.

The car's electronics can only be controlled by pressing the accelerator or brake pedal because the control system doesn't use speed to establish the safe distance. Ultrasonic sensors are cheaper than conventional sensors, thus the technology might be fitted in many budget automobiles to improve safety and comfort and make driving easier. We used advance braking system research to characterize the underlying brake control problem and provide an intelligent control approach for this system.

Our methods and findings are tentative and require further study. Stable, hassle-free braking is one use of this safety-critical auto braking technology. Even though our approach has been suitable for constructing microcontroller systems tested on a vehicle, field evaluation of the created controllers would be advantageous. Implementing intelligent braking systems in real time would require a thorough assessment. Our research shows that this smart system is feasible and beneficial currently.

We need more research to confirm our methodologies and findings. When turning, the car's sensors may misidentify an obstruction. To avoid this, we shall disable this system during turns. Installing sensors on the vehicle's wheels to detect turning can help. This arrangement currently works with automatic gearboxes. It can fit any car with a few changes. In addition, real-time operation requires precise programming. An intelligent braking system must be tested in critical dynamic conditions.

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