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AUTOMATIC BRAKING SYSTEM USING ULTRASONIC SENSOR

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Abstract: The majority of successful mechatronic automatic braking systems have an ultrasonic wave emitter installed on the front of the vehicle, which generates and emits ultrasonic waves. Additionally, a reflecting Ultrasonic wave signal is operationally received by an ultrasonic receiver that is mounted to the front of the automobile. The distance between the obstruction and the vehicle is determined by the reflected wave (detected pulse). Then, for safety reasons, a microcontroller is used to manage the speed of the vehicle based on the information from the detecting pulse to depress the brake pedal and apply the brakes firmly to the automobile.

INTRODUCTION

Modern motor vehicle design has been significantly impacted by recent advancements in the new generation of sensor-rich, distributed autonomous control technologies. In particular, control systems that significantly improve vehicle performance in areas like safety, passenger comfort, and environmental impact, to name just a few, have been made possible by the intelligence provided by reliable embedded microelectronics throughout the vehicle in combination with the communications network topologies. Additionally, the development of software simulation approaches that use a variety of system dynamic models in order to achieve better vehicle control strategies can contribute to a better understanding of vehicle performance.

The objective we've established is to provide future cars with communication capabilities so they can alert drivers to any impending threats. In order to considerably lower traffic accidents in the medium term, driver assistance and communication technologies will both be included as integrated vehicle modules. Automatic Distance Control (ADC), which is designed to automatically maintain a minimum distance from the car in front through system-initiated braking and acceleration, is already an option for the top model in our line-up, the phaeton. It is common knowledge that driving mistake increases the severity of most accidents. Electronics and software are being used to operate an expanding number of vehicle systems, including the brakes, steering, and suspension. One of the key goals was to increase driver comfort while the ABS is engaged while preserving the system's peak effectiveness in terms of reducing the stopping distance of the vehicle in an emergency. It is generally known that the physical shock the driver receives from the brake pedal pulsations when the system is triggered is quite harsh in the current Bang-Bang control implementation. The benefits of such intelligent control include their ability to fully capitalise on advancements in Smart Tyre technology as well as the rising reliability of micro technology. . Future safety system architecture will be significantly impacted by the increased usage of electronics, micro controllers, sensors, actuators, etc. in the automobile industry.

BLOCK DIAGRAM

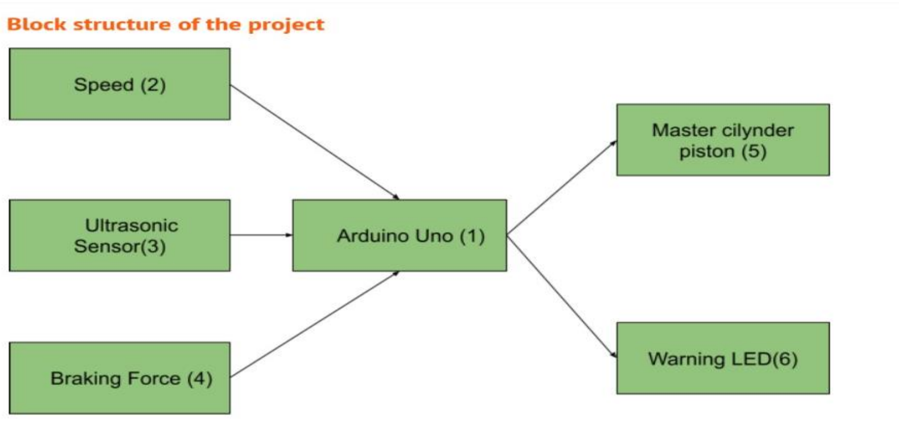

Fig 1: Block Diagram of Automatic Braking System

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- Arduino Uno(1), development board used to simulate the microcontroller of a real car, it will receive data from the braking force (braking pedal) , ultrasonic sensor, speed, and will send data to master cylinder piston and the warning led This data is received by the Arduino Uno.
- Speed(2), represents the speed from 0 - 100 Km/h, simulated using a potentiometer who will send the current speed to Arduino Uno
- Ultrasonic sensor(3), is the sensor used to measure the distance (radar), that data will be sent to Arduino Uno
- Braking Force (4), is a potentiometer which I've used to simulate the brake pedal in a car, and it is synchronized with Master cylinder piston (5).
- Master cylinder piston (5), is the master cylinder piston that pushes the hydraulic fluid.
- Warning LED(6), this led is on when automatic braking is applied or it turns on and off if the brake is applied but not hard enough to avoid a collision

Although each automaker has its unique version of the automated braking system, all of them accept some form of sensor input. The ultrasonic sensor has transmitter and receiver units. The ultrasonic transmitter transmits signals to the ultrasonic receiver unit, which then receives them when the obstacle has been detected. The presence of any obstacles in the route of the vehicle is subsequently ascertained using the ultrasonic sensor input. When an item is spotted, the system can assess whether the vehicle's speed is greater than that of the object in front of it.
According to the specified maximum distance, the distance between the automated system and impediment, and the Arduino dumped C programme, calculations will be performed using a PIC microcontroller. The servomotor braking mechanism phenomenon allows the DC gear motor to operate consistently at a fixed rpm and progressively reduce speed while automatically breaking the system. The technology is capable of immediately applying the brakes in the event of a collision, which may be indicated by a considerable speed disparity.

SCHEMATIC DIAGRAM

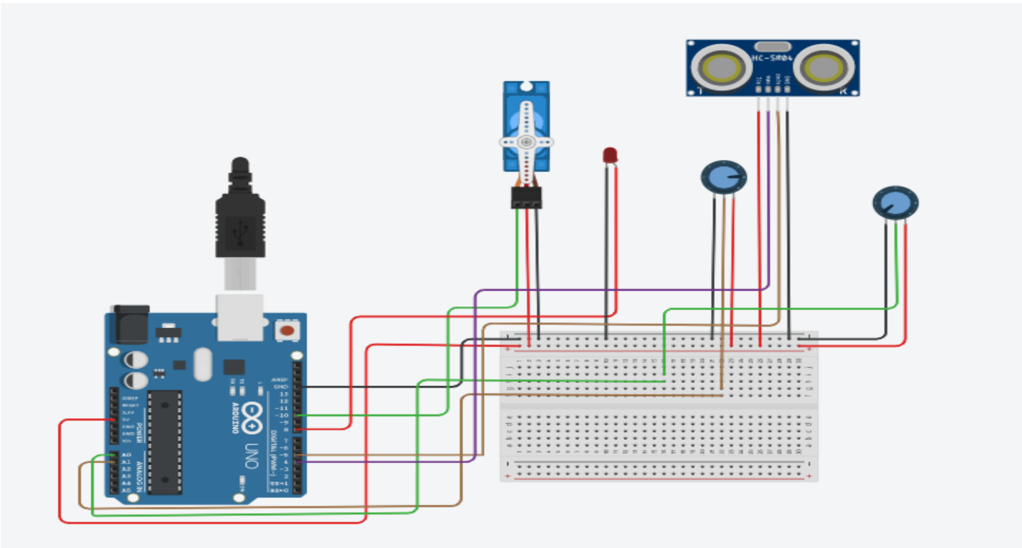

Figure 2: Schematic Diagram of Automatic Braking System

You can simulate this project by moving an object in front of the radar, adjusting the speed and braking force with the potentiometers, and reading the code (written in C for the Arduino IDE) to have a better idea of how everything operates. If the brake pedal is applied all the way, the real-world stopping distance for a car travelling between 1 and 5 km/h is 1 m (in my simulation, it is 0.5 m). In order to prevent a collision, the automated braking system (ABA) will automatically press the brake pedal to its maximum setting if the brake pedal is not applied at all and an obstacle is detected at a distance of less than 0.5 metres. If not, the led will turn on to let us know that the ABA actually pressed the brakes, else ABA will intervene and apply the brake to the maximum, and the led will blink to let us know that driver intervention was also engaged in the braking, if the brake pedal is pressed but not to the level at which it should be used to prevent an accident. At speeds between 1 and 5 km/h, ABA will not brake, the led will switch off, and the driver can use the brakes as he sees fit. If the distance from the obstruction in front is greater than 0.5 m, however, ABA will still apply the brakes. The ultrasonic sensor will keep checking the front of the vehicle for obstructions, and it will apply the brakes in accordance with the speed and the distance from any obstructions it detects.

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MAIN COMPONENTS OF SYSTEM

ARDUINO

Arduino/Genuine Uno is a microcontroller board based on the ATmega328P (datasheet). It contains 6 analogue inputs, a 16 MHz quartz crystal, a USB connection, a power connector, an ICSP header, and a reset button. It also has 14 digital input/output pins, 6 of which may be used as PWM outputs. To begin, power it with an AC-to-DC converter, a battery, or a USB connection to a computer. It will receive data from the braking force (brake pedal), ultrasonic sensor, speed, and will transmit data to the master cylinder piston and the warning light. The Arduino Uno development board is used to replicate the microcontroller of a real automobile. This data is received by the Arduino Uno.

The Arduino/Genuine Uno board may be powered by an external power source or by a USB connection. The power source is automatically chosen. An AC-to-DC adapter (wall wart) or a battery can provide external (non-USB) power. A 2.1mm centre-positive plug may be used to connect the adapter by inserting it into the board's power connector. Battery leads may be placed into the POWER connector's GND and Vin pin headers. The board may run off of a 6 to 20 volt external source. The 5V pin, however, may deliver less than five volts if supplied with less than 7V, and the board may become unstable. The voltage regulator might overheat and harm the board if more than 12V is used.

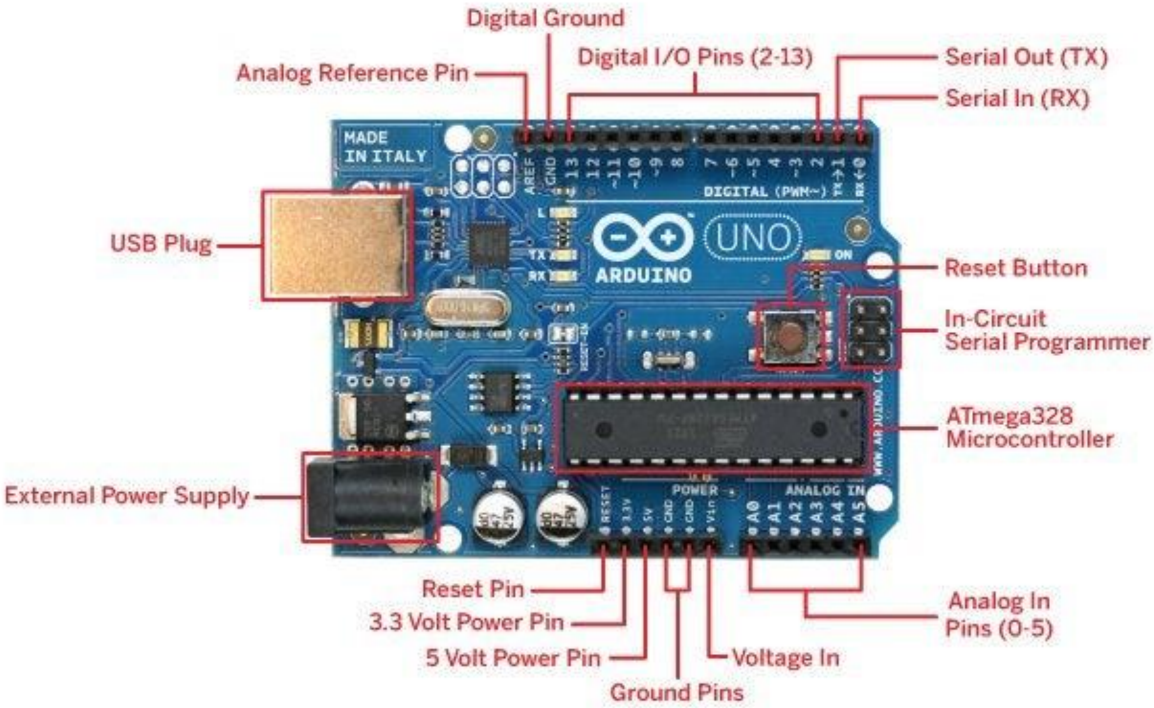

Fig 3: Arduino Uno

TECHNICAL SPECS

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz

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LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table 1: Technical Specs

ULTRASONIC SENSOR

The HC-SR04 Ultrasonic (US) sensor is a 4-pin module with the pin designations Vcc, Trigger, Echo, and Ground, as it is depicted above. This sensor is fairly common and is utilised in many applications where sensing objects or measuring distance is necessary. The ultrasonic transmitter and receiver are formed by two projects that resemble eyeballs on the front of the module. The sensor works with the simple high school formula that

Distance = Speed × Time

An ultrasonic wave is transmitted by the ultrasonic transmitter, travels through the air, and is picked up by objects that reflect the wave back toward the sensor and the ultrasonic receiver module. Now, we need to know the speed and the duration in order to compute the distance using the formulas above. Since we are employing an ultrasonic wave, we are aware of its 330 m/s room-temperature universal speed. The circuitry integrated into the module will determine how long it will take for the US wave to return and will turn the echo pin high for that same period of time so that we can also determine how long it will take.

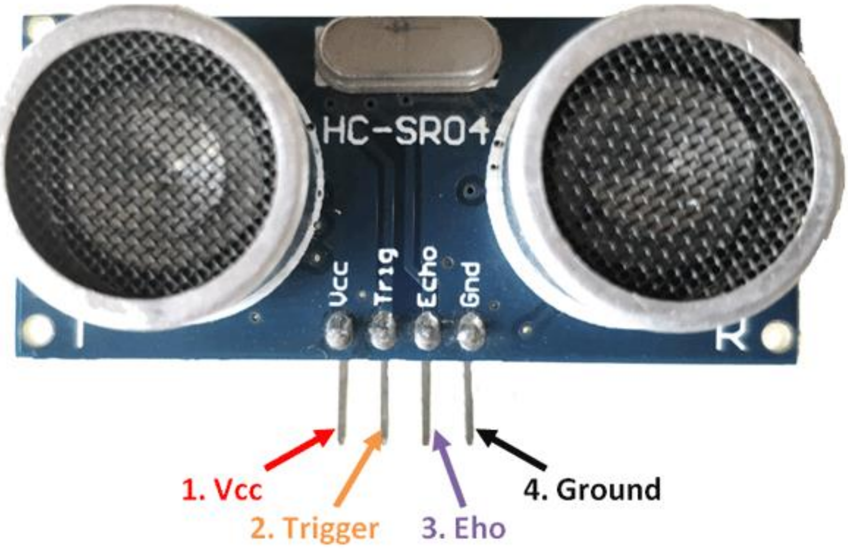

Figure 4: Ultrasonic Sensor

SERVO MOTOR

A little machine with an output shaft is called a servo motor. By providing the servo a coded signal, this shaft may be moved to particular angular locations. The servo will keep the shaft's angular position as long as the coded signal is present on the input line. The angular location of the shaft varies if the coded signal changes. In real life, radio-controlled aeroplanes employ servos to position control surfaces like the elevators and rudders. In addition to robots, they are utilised in puppets and radio-controlled automobiles. A servo motor often has a gear configuration that enables us to produce a very high torque servo motor in tiny and light designs. In kg/cm, servo motors are rated (kilogram per centimeter). The duration of the pulse supplied to the servo motor's Control PIN determines the angle at which it rotates, according to the PWM (Pulse Width Modulation) concept.

Servo motors can rotate from 0 to 180 degrees, however depending on the manufacturing process, they can also rotate up to 210 degrees. By providing an electrical pulse with the appropriate width to its Control pin, this degree of rotation may be regulated. Every 20 milliseconds, the servo examines the pulse. The servo may rotate to 0 degrees with a pulse of 1 ms (1 millisecond) width, 90 degrees (the neutral position) with a 1.5 ms pulse, and 180 degrees with a 2 ms pulse. All servo motors may be powered straight from your +5V supply rails, however if you want to utilise more than two, an appropriate servo shield has to be created due to the motor's current consumption.

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Fig 5: Servo Motor

IMPACT FACTOR

The functioning of the AEB system when the vehicle is moving depends on both the inherent and extrinsic qualities of the equipped vehicle. While intrinsic variables deal with on-board sensing, decision-making, and actuation, extrinsic factors are concerned with things that are not the vehicle itself. The research further divides these factors into three categories depending on the strength of their effects: vehicle, driver, and environmental factors.

Vehicle Factor

While driving, cars may encounter challenging crossings, overtaking situations, curving (both horizontally and vertically) roadways, and lane changes. Currently, high-speed traffic situations do not usually involve the employment of the AEB system; instead, low- and medium-speed traffic situations do. According to the international test standard, the test vehicle's highest speed is 80 km/h. While driving, it's important to identify the most dangerous target as soon as possible. The AEB's camera and radar can recognise the item in front of it. However, because they are a vehicle's main method of sensing, cameras and radars operate poorer in bad weather and in places with poor lighting. The sensor's field-of-view (FoV) angle is crucial for averting collisions, especially those involving automobiles and pedestrians (or bicyclists). Studies show that when the detection angle is adjusted to 30° to 50°, the AEB system can detect 78.5 percent to 92.2 percent of accidents with mild injuries and more than 95.3 percent of accidents with serious injuries and fatalities. A broader detection angle allows for the detection of more targets (especially walkers and cyclists) [24], which helps to reduce the number of accidents. The collision avoidance impact is affected by a number of system parameters, which are all reflected in the system error, braking delay, maximum deceleration, and control strategy. When a vehicle adopts full-braking behaviour, more vehicle deceleration will reduce the braking distance and maintain its safety, but excessive deceleration will degrade the driver's driving experience. With the advancement of sensor and brake technologies, the AEB system's ability to recognise targets, the volume and quality of data gathered, and the system delay time are all getting better.

Driver Factor

In cases where the driver's assistance is not required, the AEB system is "autonomous." But because each driver is unique in their age, gender, experience, receptivity, and psychological stamina, they all drive differently. As a result, it's probable that various drivers won't be able to employ the same collision avoidance reasoning and assessment standards. As a result, it is also required to some measure to assure the driver's comfort while driving in addition to safety.

In order to analyse the driving styles of different types of drivers and minimise discontent and confusion caused by control tactics that do not match to their driving styles, drivers are categorised according to the real test results of their driving characteristics. The data can be obtained using a Bayesian filter and support vector machine model or a driving characteristic identification model based on a hidden Markov chain. There are three types of drivers: radical, conventional, and conservative. After the driver style has been determined, various control parameters and methods may be configured for various types of drivers to enhance the system's control accuracy and comfort while driving.

Environment factor

External elements including the weather, light, and road conditions can affect how well the system works in addition to the car itself and the driver. The three primary types of roads are regular roads, cross roads, and tee portions roads. The road conditions, including the road adhesion coefficient, slope, and type, have a direct impact on how effectively the intended result is achieved after the application of the braking action.

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While AEB systems largely rely on sensors and are impacted by both weather and light, drivers can easily tell the difference between the two. Unusual weather conditions will affect both the system's perception of nearby objects and the vehicle's ability to slow down after braking (such as rain, snow, and fog). There are four types of weather: clear, overcast, wet, and severe. There are several sorts oflight, including daylight, nightlight, and streetlights. The percentage of excellent lighting among deaths and injuries, excluding crashes that occur on roads without lamps, were determined to be 75.58 percent and 85.51 percent, respectively. It is presumpted that the AEB system will only perform well in collisions that occur on days with favourable weather, such as clear and sunny ones.

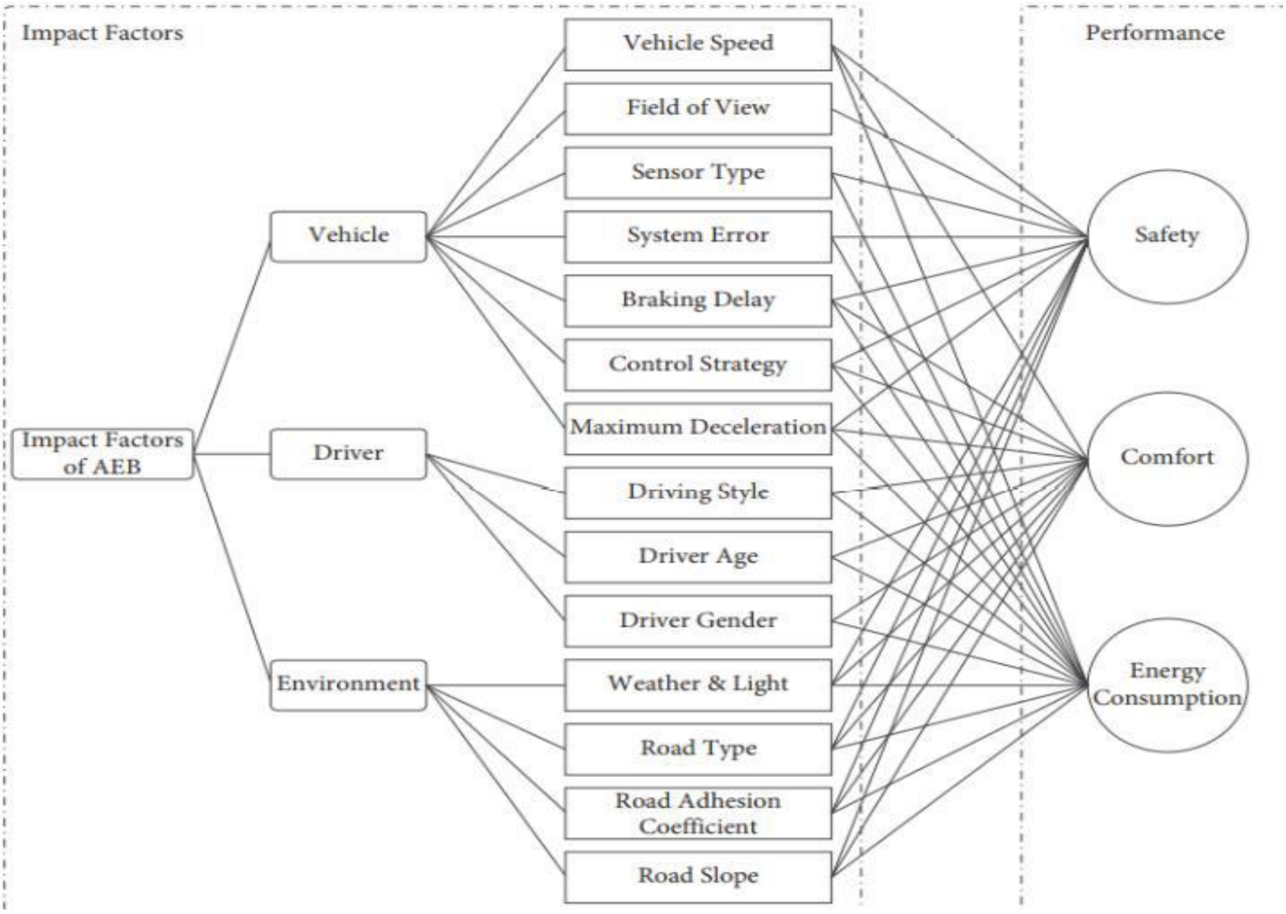

Fig 6: Impact factors of AEB performance

FUTURE SCOPE

The future scope is to design and develop a control system based on an automotive braking system is called ―Automatic Braking System When the distance between the vehicle and the obstruction is within the detecting range zone, the automatic braking system with an ultrasonic sensor will sound an alarm to the driver before applying the brakes. This is a brand-new feature in this prototype design that may be applied to all automobiles. This method will make it safer and give a stronger assurance for the safety of the vehicle while preventing losses. As a result, car safety systems will be improved and may see increased market demand. It may also be utilised for huge, heavy vehicles like tractors, buses, trucks, cranes, etc. According to the state of the vehicle, we can definitely obtain information about the obstacle detection sensing zone. It is definitely helpful to users and the public sector. Therefore, we believe that automated vehicle braking at a reasonable cost is a preferable concept.

CONCLUSION

This paper demonstrates the application of an automated braking system for forward collision avoidance in cars where the driver may not apply the brakes manually, but where the speed of the car is frequently decreased automatically as a result of the detection of impediments. Although we are aware that this will undoubtedly require a lot of work and learning, just like the programming and operation of microcontrollers and thus the automobile structure, we hope to

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advance the system with this further study and research into a more recently developed speed control system for automobile safety. We think that include every component in an automatic braking system will increase safety, as well as provide that system a competitive advantage and a much larger market.

REFERENCES

[1] T. Mohana Priya, Dr. M. Punithavalli & Dr. R. Rajesh Kanna, Machine Learning Algorithm for Development of Enhanced Support Vector Machine Technique to Predict Stress, Global Journal of Computer Science and Technology: C Software & Data Engineering, Volume 20, Issue 2, No. 2020, pp 12-20.

[2] H Jeppsson and N Lubbe, "Simulating automated emergency braking with and without torricelli vacuum emergency braking for cyclists: effect of brake deceleration and sensor field-of-view on accidents, injuries and fatalities," Accident Analysis & Prevention, vol. 142, Article ID 105538, 2020.

[3] W. Yang, X. Zhang, and Q. Lei, "Research on longitudinal active collision avoidance of autonomous emergency braking pedestrian system (AEB-P)," Sensors, vol. 19-21, 2019.

[4] Hemalatha B K, P Pooja, Chaithra M ,Megha S, Rakshitha R T Automatic Braking System for Automobiles Using IR Sensor(IJAREIE) International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering(An ISO 3297: 2007 Certified Organization)

[5] G.V.Sairam, B.Suresh, CH.SaiHemanth and K.Krishna Sai, "Intelligent mechatronic braking system", International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3,Issue 4, April 13

[6] Bhasin, Kartik. (2019). A Review Paper on Anti-Lock Braking System (ABS) and its Future Scope. 7. 372-375. 10.22214/ijraset.2019.8053.

[7] Wallen, L., 'Dynamic Tyre Models in Adaptive Slip control', Master's Thesis, Lund Institute of Technology, Sweden, March 2001, ISSN 02805316.

[8] H Jeppsson and N Lubbe, "Simulating automated emergency braking with and without torricelli vacuum emergency braking for cyclists: effect of brake deceleration and sensor field-of-view on accidents, injuries and fatalities," Accident Analysis & Prevention, vol. 142, Article ID 105538, 2020.

[9] Fletcher, I. & Arden, B.J.B. & Cox, Chris. (2003). Automatic braking system control. 411 - 414. 10.1109/ISIC.2003.1254670.

[10] Ganesh Kumar and P.Vasanth Sena, "Novel Artificial Neural Networks and Logistic Approach for Detecting Credit Card Deceit," International Journal of Computer Science and Network Security, Vol. 15, issue 9, Sep. 2015, pp. 222-234