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Intelligent Autonomous Braking System for Accident Prevention

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ABSTRACT

There exist few objects and obstructions on the roads which we concern a lot about but these might not be visible from the vehicle's cabin, such as kids playing around or pets relaxing behind the vehicle. If the driver is unaware of these objects or obstructions, both the external obstructions and the vehicle will suffer significant damage and hence it is essential to have an intelligent system that automatically engages the brakes to limit the amount of damage caused during an unexpected situation. The "Intelligent Autonomous Braking System" is an electronically controlled car slowing mechanism in which the infrared sensor, ultrasonic trigger and receiver circuit, control unit, and pneumatic slowing mechanism are all housed in a sensor operated pneumatic braking system. The ultrasonic and infrared sensors are used to identify obstacles, and if an obstruction is found, the ultrasonic or infrared sensor sends a signal to the control unit to engage the slowing mechanism, which is a pneumatic slowing mechanism for vehicle safety. In essence, the vehicle brakes without the assistance of the driver by determining the best path away from the object. The ultrasonic and infrared sensors fixed both at the front and the rear of the vehicle provides the necessary signal to the control unit to engage the braking mechanism.
Keywords : Ultrasonic trigger, Infrared sensor, Intelligent Autonomous Braking System, Obstacle.

I. INTRODUCTION

Ultron and Infrared course circuits are used to operate a pneumatic slowing mechanism, resulting in an Intelligent Autonomous Braking System. The primary goal of this task is for the vehicle to be able to turn around and perform programmed braking in an event when an obstruction is being detected by the system as well as for the vehicle to disengage the system when appropriate space is detected. The braking circuit's role is to brake the vehicle appropriately after receiving a signal from the sensor. These concepts address the use of mechanical brakes to replace human intervention [1]. While traveling at a speed of fifty kilometers per hour, the automated slowing system can stop the vehicle in 2 to 3 seconds, within a distance of 1 meter. The intelligent braking system is completely automated, allowing the driver to let the vehicle stop once the obstacle is detected. It also includes a normal mode for basic conventional operation. In addition, the framework contains a late catch that, when held, supersedes the slowing mechanism. The present stopping mechanism is activated when the release button is depressed. This mode is activated when the night time factor is greater than the day time threshold for the sensors to detect the area ahead.

II. METHODOLOGY

This paper started with field research, in which numerous articles and papers relevant to the concept were reviewed and observed. This leads us into the next step, which was problem facing. The study explored various and common challenges/difficulties such as to overcome the limitations of the previously studied experiments that were recorded in the field study stage. Following this, auto-electronic sensors and the problems faced in their applications were studied. Finally, ideas were transformed into a physical project and the last phase, testing was carried out to evaluate the working of the model.

The ultrasonic sensor consists of transmitter and receiver units, with the ultrasonic transmitter transmitting signals that are reflected back to the ultrasonic receiver unit to detect the obstacle. The ultrasonic sensor information is then used to determine whether or not there are any objects in the vehicle's path. If an item is identified, the system can determine whether the vehicle's speed is greater than that of the object ahead of it. The computations will take done through a PIC microcontroller using an Arduino dumped C programme, based on the stated maximum distance and distance between the automatic system and the barrier. Through servomotor braking mechanism phenomena, the DC gear motor rotates consistently at a given rpm and gradually drops speed while automatically breaking the system. A large speed disparity may suggest the likelihood of a collision, in which case the system is capable of automatically applying the brakes.

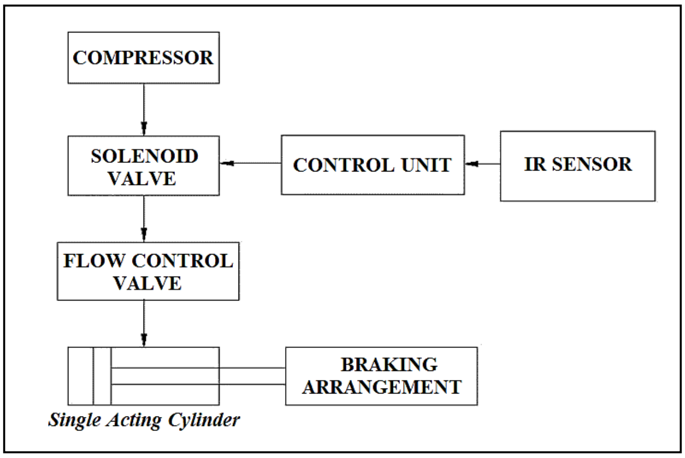

Figure 1: Primary segments canny switch stopping mechanism

Ultrasonic moving and spotting systems use high-recurrence sound waves to determine the distance and range of an object. An ultrasonic sensor often employs a transducer that generates an electrical yield signal when ultrasonic energy is applied. Fig. 1 shows the primary segments canny switch stopping mechanism. An Arduino is used to detect the pulses and apply brakes to the vehicle [2, 9]. There are two types of energy supply required, ie. the electric supply for the functioning of the ultrasonic sensor control unit, and the air supply for the pneumatic brake to work. Different surfaces exhibit different responses. Some surfaces scatter, reflect, and absorb infrared radiation, making it difficult to interpret sensor output as a distance measurement [3]. Ultrasonic STNT is made up of an ultrasonic transmitter and a receiver. An ultrasonic transmitter sends a constant stream of graded class waves. Ultrasonic waves are created when the vehicle gets too close to a deterrent, which are then picked up by the Ultrasonic receiver. The control unit is powered after receiving the reflected signal. This controls whether or not the solenoid valve is to be switched on. These tactics are entirely electronic, necessitating the use of computerized inventory.

III. COMPONENTS OF SYSTEM

The components and requirements for the complete operation of the pneumatic bearing press are as follows:

A. Control Unit

The main parts of the control unit are:

1) Arduino Uno: The ATmega328 microprocessor is used in the Arduino Uno microcontroller board (datasheet). It has 14 digital input/output pins, six analogue inputs, and a 16 MHz ceramic resonator (six of which can be used as PWM yields). A USB port, a power jack, an ICSP header, and a reset switch are also included. Everything a user needs to get started with the microcontroller is included. It merely requires a USB cable to connect to a computer, or an AC-to-DC adapter or a battery to power it.
2) Relay: Relays are electronic and electromechanical switches that are used to close and open circuits. It controls how connections in an electrical circuit open and close. The device is made up of a set of input terminals for a single or many control signals, as well as a set of operational contact terminals. The switch can have several contacts in any contact form, such as ‘make contacts', 'break contacts' and combinations of the two [4].

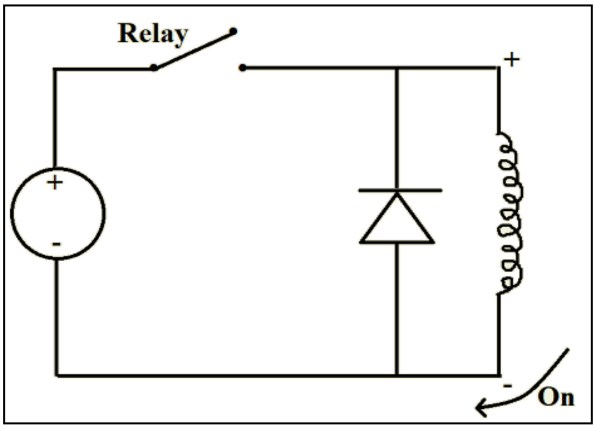

Figure 2: Snubber Diode Circuit

The switch connections on the relay are generally labelled 'COM,' 'NC,' and 'NO':

- COM stands for Common Terminal, and it is always connected to a terminal depending on the application.
- NC = Normally closed; while the relay coil is off, COM is linked to NC.
- NO = Normally open; when the relay coil is on, COM is linked to NO.

A snubber diode was used to protect the circuit from voltage spikes. Fig. 2 shows a snubber diode circuit being used.

B. Sensor Unit

The sensor unit consists of an ultrasonic transmitter for creating ultrasonic beams and an ultrasonic collector for receiving ultrasonic beams that are reflected back from obstacles. When Ultrasonic receiver receives waves reflected from the obstacle, it communicates the data to the control unit. The control unit then determines the distance between the deterrent and the vehicle, and if the distance is within a specific range, it sends a signal to the solenoid valve, which therefore engages the brake.

C. Ultrasonic Sensor

The ultrasonic sensor detects an obstruction in the path of movement and sends the signal to the microcontroller. It acts as the eyes of the control unit. The HC-SR04 Ultrasonic Sensor is a low-cost proximity or distance sensor that is primarily used for object detection in robotics applications. It simply acts as a pair of eyes for the Arduino. It comprises of 4 pins, that is: GND, Vcc, Trig (output) and Echo (input) [8].

D. Infrared sensor

An infrared sensor (IR sensor) is an electronic sensor that detects and analyses infrared radiation in its environment. Infrared detection and accuracy can outperform ultrasonic detection over long distances [5]. It accomplishes this by generating and detecting infrared radiation in numerous ways. Infrared sensors can also detect movement and measure the heat generated by an object. It has 3 pins, that is: Vcc, GND and Out [10].

E. Pneumatic cylinder

The compressor function is performed by the pneumatic cylinder. A compressor is a mechanical device that reduces the volume of a gas in order to increase its pressure [6]. When an action requires more than one movement and a device to transfer load in both directions, double acting cylinders come in handy. Double-acting air cylinders do not require a spring to inflate and retract, unlike single-acting air cylinders. Double acting cylinders have two ports via which air can flow in and out instead of a single port for providing pressured air. Few advantages of using a double acting cylinder are that they offer more control over movement since pressurized air moves both ways, they are both fast and strong and also use less energy. Double acting cylinders also feature design variations, ie. stroke and bore sizes which can be chose according to the design requirements.

F. Solenoid valve

To regulate the fluid flow automatically, solenoid valves are employed. A solenoid valve is an electrically controlled valve. The valve uses a solenoid, which is an electric coil with a moveable ferromagnetic core (plunger) at its centre. In the rest position, the plunger covers a small aperture. When a magnetic field is created by passing an electric current through the coil, the plunger is pushed higher by the magnetic field, which in turn opens the aperture. This is the basic principle which is employed to open and close the solenoid valves.

G. Flow Control valve

A flow control valve regulates the volume of air that flows in one direction alone. This valve is used to keep the compressor from being disrupted. A non-return valve and a variable throttle combine to make a flow control valve. Between the solenoid valve and the compressor, there is a flow control valve. The flow control valve, on the other hand, is usually attached to the cylinder. Because the piston moves faster when this valve is used, the time consumption is reduced.

Technical Data:

Size: $1/4^{th}$ inch.

Pressure: 0 to10 kg/cm2.

Media: Air.

H. Motor

A three-phase squirrel cage induction motor is a form of electromagnetic three-phase induction motor. A squirrel cage motor's capacity to change its speed-torque characteristics is a key advantage. This can be done easily by changing the shape of the rotor's bars. Squirrel cage induction motors are commonly used in industry because they are dependable, self-starting, and easy to tune.

IV. EXPERIMENTATION

The intelligent autonomous braking system consists of an ultrasonic sensor which when detects an obstruction ahead, engages the pneumatic brakes automatically. The goal of this project is to slow down the automobile when an obstacle or a barricade is sensed with the sensors which are placed both at the front and the rear of the vehicle. Furthermore, the usage of a button to apply the brakes is preferred by the vehicle's motive force.

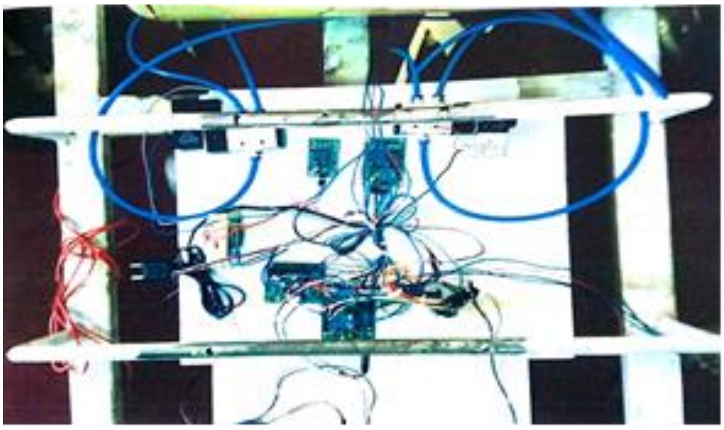

Figure 3: The circuit in application

An air storage tank, an ultrasonic sensor, a double acting pneumatic cylinder, a solenoid valve, and a control unit are all part of the system. A flow control valve is integrated in the air storage tank, which regulates the float of air pressure through the tank. The solenoid valve receives high-pressure air.

A solenoid valve is an electromechanically operated valve controlled by a solenoid that acts as an interface between the control unit and the pneumatic cylinder, with the control unit guiding the action.

The solenoid valve controls the double acting pneumatic cylinder, which generates force in a reciprocating linear motion using compressed air energy. The control unit is regarded to be the brains of the system, as it is powered from the outside and receives signals from the ultrasonic sensors.

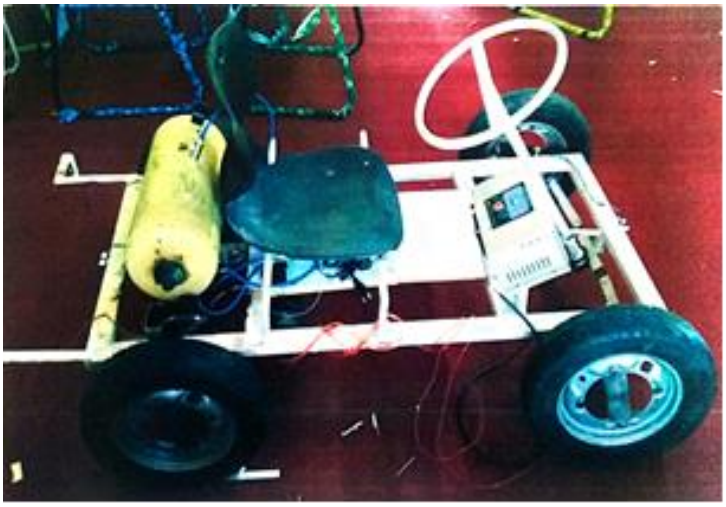

Figure 4: Side View of the test vehicle

The ultrasonic sensor consists of a trigger and a receiver. The trigger releases ultrasonic waves, which are absorbed by the receiver when the waves are obstructed by an object. If the ultrasonic wave is redeemed within the sensor's range, a response is given to the control unit, which then activates the solenoid valve, which ejects high-pressure air into the pneumatic cylinders. The shaft protruding from the cylinder now travels perpendicular to the shafts linked to each of the rear wheels [i.e. brakes]. As a result, the car is brought to a complete stop.

Figure 5: Rear View of the test vehicle

A rectifier converts AC to DC and serves as the control unit for the intelligent autonomous braking system. This system's speed controller transforms 250 V AC to 188 V DC, which drives a 1 horsepower motor. The two infrared sensors at the back of the car detect an obstruction or barrier and provide a signal to the pneumatic braking system to activate. By loosening or tightening the screw on the sensor circuit board, the infrared detection range can be manually changed. The vehicle's forward and reverse motion is controlled by pressing the corresponding switches on the velocity controller. The intensity of the brakes can be adjusted using the adjustment screw situated on each of the pneumatic cylinders. The ultrasonic sensors, which are located on both sides of the vehicle's chassis and have a detection range of up to 400cms, are mounted on both sides of the vehicle's chassis. The power is transmitted via the differential with the help of a ball joint, which eliminates the problem of meshing that can arise when gears are utilised.

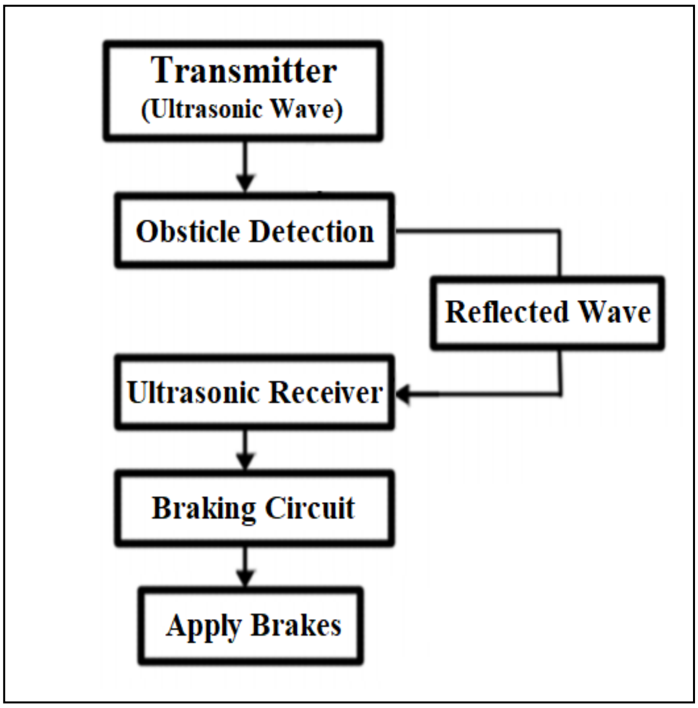

Figure 6: Sensor-Brake block diagram [7]

Also, the driver is provided with a button which can be pressed at any occasion anticipated by the driver, and when the button is pressed, a signal is sent to the control unit, which directs the solenoid valve for the application of brakes through the pneumatic cylinder, permitting for regular braking of the vehicle.

V. RESULTS AND DISCUSSION

Consider a vehicle driving through a crowded parking space at a speed of 15 Kmph. If there is an obstruction caused to the vehicles path, such as a random pedestrian getting into the path, pets moving around or a random object which is out of sight of the driver, the intelligent autonomous braking system detects these random objects present within the sensors range ie. up to 400cms and automatically applies the brakes to reduce the damage caused both for the obstructing object and for the vehicle itself.

The Fig. 7(a) and Fig. 7(b) represent the effectiveness of the intelligent autonomous braking system. When the obstruction at point ‘b’ is identified within the sensors range (~150cms) at point ‘a’, the autonomous brakes engage, as shown by the green line between points ‘a’ and ‘b’, thus slowing the vehicle to a standstill without colliding with the obstacle. The blue line indicates the absence of the automatic braking system and hence leads to a collision with the obstacle which is out of sight from the driver’s cabin.

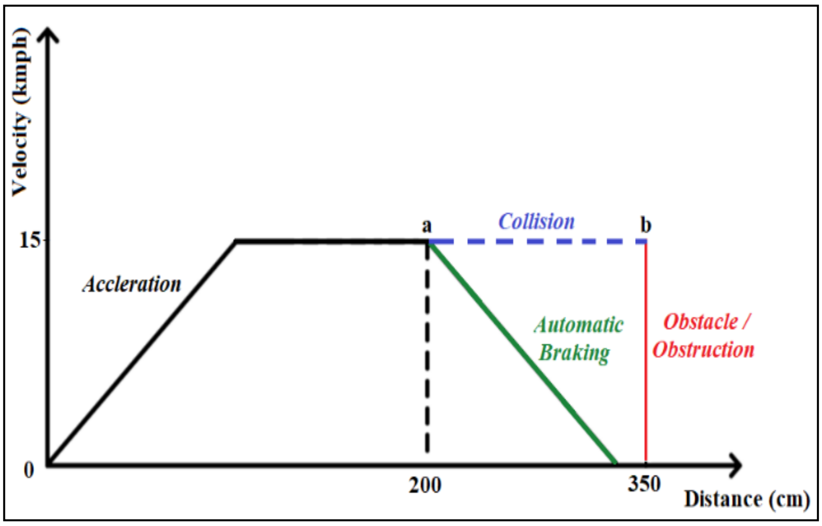

Figure 7(a): Absence of automatic braking

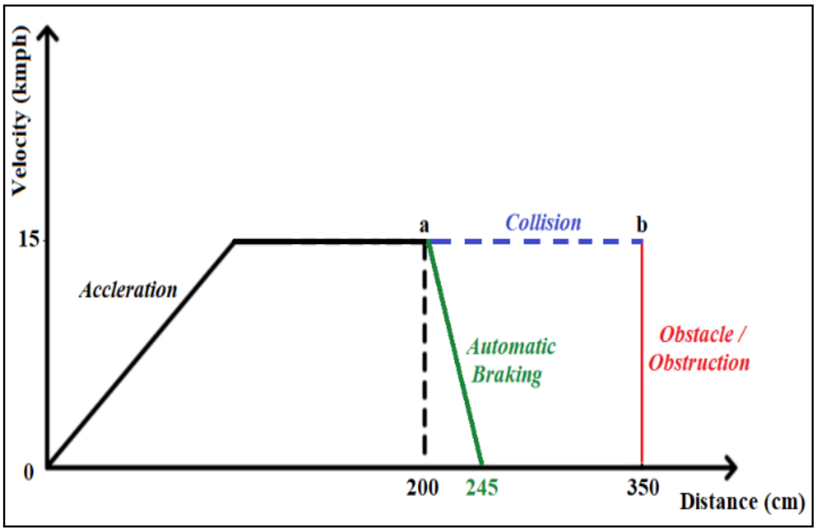

Figure 7(b): Intelligent automatic braking in action

The pneumatic cylinder in Fig.7 (a) is set at the lowest intensity and the vehicle moves up to 130cms with the brakes applied before coming to a complete stop. When the pneumatic cylinder is set to its full potential, the vehicle can reach a compete standstill within 45cms post the object detection, and this is represented in the Fig. 7(b).

VI. CONCLUSION

Every feature of each component present in the prototype test vehicle functions effectively and the whole system together reflects successful results. Once the obstruction or the obstacle is detected, the vehicle moves till the safe distance and is braked until the path of travel is free from any kinds of obstructions. The prototype's ultrasonic sensor has a range accuracy of around 2cm to 4m and operates perfectly within the prescribed range. The functioning of the system was analysed by plugging in the system into the battery, and by controlling the braking system with a DC motor and a servo motor's assistance. This is an immature approach, and this effort is towards to reduce the damages which may occur due to poor vision or during critical driving scenarios.

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