Automatic Pneumatic Bumper with Braking System

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ABSTRACT: The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation from old-fashioned timber works and coal mines to modern machine shops and space robots. It is therefore important that technicians and engineers should have a good knowledge of pneumatic system, an Ultrasonic operated valves and accessories. The aim is to design and develop a traffic control system based on an intelligent electronically controlled automotive bumper activation system is called "automatic pneumatic bumper" also incorporated with smart braking system. This system is consists of ultrasonic transmitter and Receiver, ultrasonic circuit, Control Unit, Pneumatic cylinders, wheels, brake drums and bumper system. The ultrasonic sensor is used to detect the obstacle. There is any obstacle closer to the vehicle; the control signal is given to the bumper activation system. The pneumatic bumper system is used to product the man and vehicle.

Keywords:Ultrasonic sensor,pneumatic bumper,control unit.INTRODUCTION

Vehicles are the revolutionary invention of mankind. With innovations in technology, they made their impression, in every aspects of life. Inflating demand for vehicles has led to substantial increase in number of vehicles. Safety of the vehicle is a major concern even from the design stage of the vehicle. Several technologies like seat belts and air bags have successfully worked out well in accidental situations and proved to be useful. Automated collision avoidance system is one among such system to avoid the severity of accidents. It is an electrically controlled pneumatic circuitry, which aims to avoid forward collision of the vehicle and improve crashing safety. This is achieved by means of automatic pneumatic circuits. The system senses the obstacle by means of high frequency Ultrasonic waves and calculates the distance between the obstacle and vehicle.

The microcontroller signals for the actuation of pneumatic braking circuit and pneumatic bumper circuit simultaneously. Combination of these circuits effectively avoids collision and reduces the damage to be incurred by the vehicle.

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I. OBJECTIVES

Following are the main objectives of Automatic Pneumatic Bumper with Braking system:

- To prevent accidents.
- To provide safety to driver
- To avoid damage of vehicle
- To increase the sureness of braking Application.
- To increase the response time of braking system.
- To avoid the percentage of passenger injury by using external vehicle safety.
- To reduce the requirement of internal safety devices like air bags.

II. PROBLEM STATEMENT

All the conventional vehicles are equipped with brakes that are operated manually. The consequence of collision depends on driver's reflex to vary the driving environment. Vehicle accidents might be a consequence of rash driving, driving under influence, fatigue etc. Most of these can be mapped down to a single cause, driver's inability to hit the brakes at right time. If this work is replaced by automatic means, most of the collision can be controlled.

III. SYSTEM ELEMENTS

A. ULTRASONIC SENSORS

Ultrasonic ranging and detecting devices use high frequency sound waves called ultrasonic waves to detect presence of an object and its range.

Figure 1:Ultrasonic Sensor

B. PNEUMATIC CYLINDER

Pneumatic cylinder (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion.Operating with a range of 3 bar to 6 bar pressure.

Figure 2:Pneumatic Cylinder

C. RELAY

It is a control unit having specification 3P 240A. This control unit is act according to sensor signal to stop the engine and to apply breaking through solenoid valve

Figure 3:Relay

D. CONTROL UNIT

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). 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.

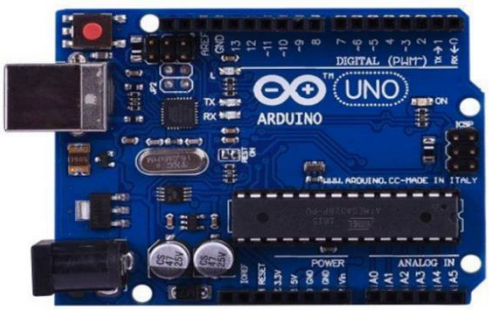

Figure 4:Arduino Uno Microcontroller

E. COMPRESSED AIR TANK

A compressor is a machine that compresses air or another type of gas from a low inlet pressure (usually atmospheric) to a higher desired pressure level. This is accomplished by reducing the volume of the gas. Air compressors are generally positive displacement units and are either of the reciprocating piston type or the rotary screw or rotary vane types. The compressed air was stored in air tank from which air flows to the cylinder through hoses.

Figure 5:Compressed Air Tank

F. SOLENOID VALVE

A solenoid valve is an electromechanical controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core in its centre. This core is called the plunger. In rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts a force on the plunger. As a result, the plunger is pulled toward the centre of the coil so that the orifice opens. This is the basic principle that is used to open and close solenoid valves.

Figure 6:Solenoid Valve

G. MECHANICAL BRAKE

In a motor vehicle, the wheel is attached to an auxiliary wheel called drum. The brake shoes are made to contact this drum. In most designs, two shoes are used with each drum to form a complete brake mechanism at each wheel. The brake shoes have brake linings on the outer surfaces. Each brake shoe is hinged at one end by on anchor pin; the other end is operated by some means so that the brake shoe expands outwards.The drum type of brake may either be a band brake or a shoe brake. Both band brakes and shoe brakes may be either external or internal. The band brakes generally are external and shoe brakes internal.

Figure 7:Mechanical Brake

H. FRAME

This is a supporting frame and made up of mild steel. It is used to support the whole setup rigidly. The frame was made by means of welding steel rods.

Figure 8:Steel Frame

I. POWER

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-DC adapter (wall-wart) or battery.

J. MOTOR

A 12 watt DC motor is used as the prime mover to rotate the wheel powered by a DC battery.

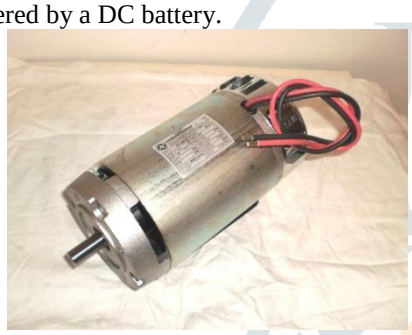

Figure 9:DC Motor

IV. METHODOLOGY

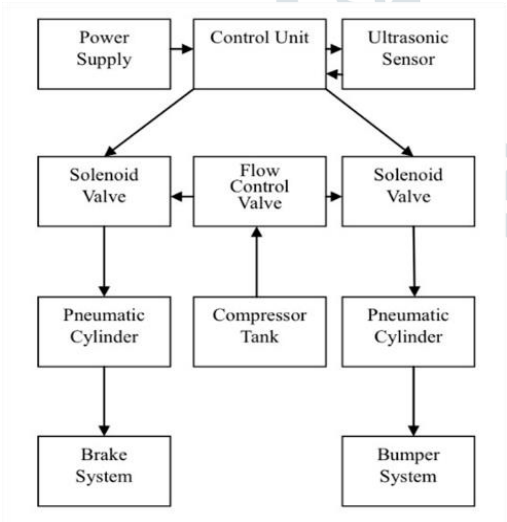

Figure 10:Block Diagram of the System

When a vehicle equipped with Automatic Pneumatic Bumper with Breaking system detects an obstacle in its path, the Ultrasonic sensor placed on the vehicle detects the obstacle and sends the signal to the control unit. Therefore, the distance between the vehicle and the obstacle is measured through the control unit.

The control unit also operates the relay according to the input signals provided to the control unit. The relay is used to cut off the electric power supply provided to the IC engine during and emergency situation resulting in switching off of the engine.

When the obstacle is within the specified range of the system, the control unit signals the solenoid valve. The solenoid valve opens the port which actuates the pneumatic cylinder. This results in extension of the bumper installed in front of the vehicle.

The breaking system also works simultaneously to the pneumatic bumper system. In breaking we have two scenarios. In the first scenario the driver is attentive and applies the brakes using the brake pedal. In this system limiting switch which is placed below the break pedal gets activated by the foot force of the driver. This actuation of limiting switch provides the signal to the solenoid valve. The solenoid valve opens the port resulting in actuation of the braking system.

In the second scenario, if the driver is distracted the braking system is activated automatically. The controlled unit calculates the breaking distance required for the vehicle to come to rest. Accordingly the control unit signals the solenoid valve. The solenoid valve opens the port which actuates the brakes, hence avoiding the collision.

V. RESULT

A. SHAFT

The shaft is supported on bearings and it rotates on a set of gears or pulleys for the purpose of power transmission. As we know that shaft diameter is given as:

$d=[(mr*16/\pi* \tau)]*1/3$

By calculating we get the diameter as 12.581mm.

We chose a safe diameter from DDHB(Table 3.5a) of standard shafts. Thus the diameter of the shaft is selected as 15mm**.**

B. BEARING

From calculations we have selected SKF 6202-2Z with a rated dynamic capacity of 12KN. As calculated from equation $L=(C/P)^p$, the required dynamic capacity of the bearing is 8.725kN.

C. SINGLE ACTING CYLINDER

The force exerted by the pneumatic cylinder on outstroke is given as: $Force(F)=P\prod*(d_1^2-d_2^2)/4$

Where, d_1=diameter of piston.

d_2=diameter of piston rod.

With minimum pressure of 3 bar and maximum pressure of 6 bar,we get F_{min}=519.305N and F_{max}=1038.61N.

Hence we have selected a single acting cylinder with a minimum pressure of 3bar to the maximum pressure of 6bar.

D. MOTOR

For determining the motor of required speed the following equation is considered.

$P=2\Pi nt/16$

Taking a 12Watt power motor we have selected the speed of motor as 10rpm.

VI. ADVANTAGES

- Simple in operation.
- Less power consumption
- Less skilled driver is sufficient to operate.
- Installation is simple.
- System able to increase the pre-crash safety.
- To avoid accidents while driving the car.

VII. DISADVANTAGES

- Additional cost required for doing modification.
- System have few limitations in densely traffic road.
- System has no provision to prevent accidents from rear side of vehicle.

VIII. COST ESTIMATION

The approximate cost required for the completion of this project is noted in the table below:

Table 1:Cost Estimation of the Project.

Part Name	Quantity	Total Cost(Rs)
Wheel	1	1750
Solenoid Cylinder	2	2400
Solenoid Valve	2	1600
Small Wheel	4	800
Bearing	6	330
Shaft(m)	3	285
Clamp	6	360
Battery(12V)	1	850
Electronic Circuit	1	1200
Pneumatic Pipe(m)	2.5	300
Square Pipe(ft)	2	1100
Total		10,975

IX. CONCLUSION

Our main aim behind designing and manufacturing of this project was to reduce the number of accidents on the road,thus ensuring the safety of the passengers.Our project also reduces the damage caused to the vehicle during a collision with the help of the pneumatic bumper. Compensating for the shortcomings of other already available systems, our work is not only of good feasibility and high reliability but also cost effective.

Our work on this project has provided us with great experience, planning and making use of our practical and theoretical knowledge.We are proud that we have completed the work with the limited time successfully.

The prototype we designed and manufactured is working with satisfactory conditions and is able to achieve all the objectiveswhichwe hoped to achieve.

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