

Development of Automatic Pneumatic Bumper with Advanced Bumper-Cylinder Assembly

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ABSTRACT: As the vehicles are incising day by day it is required that technological advancement solve the problems of the transportation system. Accident caused by a lot of reasons but the most common reason is invisibility during the right angle turn or at curvy road. So, to reduces the impact at such situation the Automatic Pneumatic Bumper is used as it is very effective technique which allows industries and institutions to understand the difficulties in maintaining the standard and forbearance of vehicles. And Implementation of this passive safety system is going to reduce the damage during the accident. So, This research paper is about the advancement in conventional Automatic Bumperto improve the shock absorption during accident.

KEYWORDS: Automatic Bumper system, IR transmitter and receiver, Solenoid valve, Proximity sensor, Electropneumatic system, Ultrasonic sensor

I. INTRODUCTION

The increment in world population causes the increment in transportation weather it is of people or of goods. The Commercial or Special Purpose vehicles encounters accident due to various reasons but one of the most common is During the sharp turn when driver has no ability to see what is coming. Developed country like USA, Dubai, China, India etc has a great demand of various good and raw material every day causes the increment in use of special purpose or commercial vehicle and this traffic causes the more accident. According to survey carried out by The National Highway Traffic Safety Administration (NHTSA) around 40% of car accident causes at the road corner. And that also causes the increment in traffic. In India around 88,755 accidents are reported as "Hit from Back", 97,816 as a "Head on Collision" and 58,774 reported as "Hit from the Side" in 2018 according to survey carried out by

Ministry of Road Transport and Highways. In which 56% of people died due to 'Hit from Back', 36% due to 'Hit from Back' and 37.7% due to 'Hit from Side'.

So, the aim is to design a vehicle containing the solution of the existing problem.

II. PROBLEM STATEMENT

In conventional Automatic Pneumatic Bumper when sensor detects any object with in the range it gives signal to Controller and the whole Bumper moves forward regardless the position of the object. This causes the Bumper damage because when object is on the left side only left portion of the bumper is compressed at the right side there is a tension on the mechanism and same for the other side. That why in conventional method retractable bumper is used. Use of the retractable bumper obviously increases the running cost of vehicle as it is required to change every time. So, by implanting three cylinders with three IR sensors we can reduce the impact on other side of bumper. When object is at the left most side of the vehicle the bumper will move forward at the maximum distance at left side in order to absorb the most impact and the distance of piston to move forward is decreases with the direction at right side. Same for the other side also. But when the Sensor placed at the centre detects the object the whole bumper will move forward at the maximum distance possible.

III. OBJECTIVES

1. Reduces the impact during the accident.
2. It distributes the force Uniformly so the damage of the Bumper is very less.
3. It will causes the less injury to the other vehicle or pedestrian or and animal.
4. It increases the durability of system.
5. It is cost effective.

IV. COMPONENTS OF THE SYSTEM

The components that are mentioned is for prototype of smaller scale.

A. Single Acting Pneumatic Cylinder:

The cylinder used is single acting Pneumatic cylinder. Single acting stands for the operation of the air pressure at the forward direction and spring effect at the backward direction. The air from the compressor is dragged into the cylinder by solenoid valve and flow control valve which regulates the pressure.



(ACTUAL IMAGE OF THE PRODUCT)

The connection between the cylinder Solenoid valve and compressor is via hoses.

Specifications:

- Material: Cast iron
- Bore: 40 mm
- Length of stroke: 160mm
- Working pressure: 0-8 bar
- Working Temperature: 0-80 °c

B. Solenoid Valve:

The solenoid valve is electromechanical valve which operates according to signals. It directs the from compressor to cylinder.



(ACTUAL IMAGE OF THE PRODUCT)

Specifications:

- Type: 3/2
- Voltage: 220V
- Power: 6VA
- Flowrate value : 0.67 Nm³/h
- Working pressure: 1.5-8 bar

- Current: 23A AC
- Response time : 0.035 s

C. Air Compressor :

Air Compressor is the device which compresses the air which is in side the tank. The compressed air is then passed to cylinder by flow control valve and solenoid valve.



(ACTUAL IMAGE OF THE PRODUCT)

Specifications:

- Type: Single Phase
- Speed: 1440 RPM
- Rated power: 0.25 HP
- AC Voltage: 240V
- Pole: 4
- Mounting: Foot

D. IR Sensor :

IR Sensor detects the object with in the specified range. The Infrared sensor detects the object by heat produced by object so it is also able to detect animals and humans.



(ACTUAL IMAGE OF THE PRODUCT)

Specifications:

- Detection Method : on-beam
- Detection Distance : 5 m ± 10%
- Voltage : 12 ~ 240 V (AC and DC universal)
- Housing Material : ABS housing
- Weight : 0.4 kg

E. Controller :

The Arduino UNO is an open source microcontroller board based on the Microchip ATmega328P. The board is equipped with 14 digital Input/Output pins. It is programmed to generate the specific type of output when the sensors detect the object in front of them.



(ACTUAL IMAGE OF PRODUCT)

Specifications:

- Operating Voltage : 5V
- Input Voltage : 7-12 V
- Number of memory stick : 3
- Product Dimension : 15 * 14 * 3 cm

V. CALCULATION

For standard SUV,

- Pneumatic cylinder dimensions:

Maximum force exerted on bumper is assumed to be 10kN.

Considering factor of safety as 1.25, we design bumper for,

10000 x 1.25 = 12500 N force
 Also, pressure used is 40 bar = 4N/mm²

For Bumper Out-Stroke

$$F_o = P \times A$$

$$12500 = 4 \times \frac{\pi}{4} \times D^2$$

$$12500 = 4 \times 0.7854 \times D^2$$

$$D^2 = 3978.87 \text{ mm}^2$$

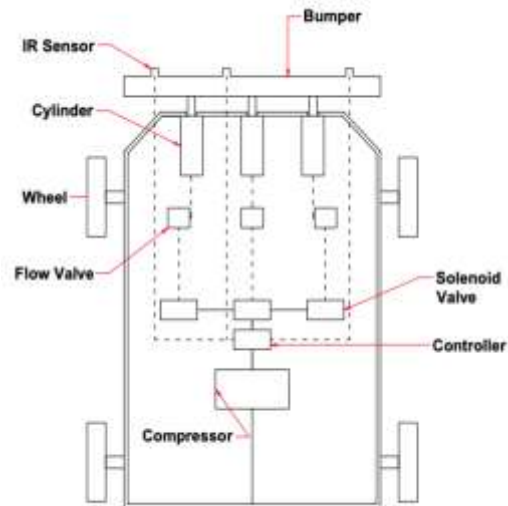
So, D = 63.08 mm

Selecting standard value of 65 mm bore diameter. Hence for standard SUV we need to use 3 Cylinder with 65 mm diameter.

VI. WORKING

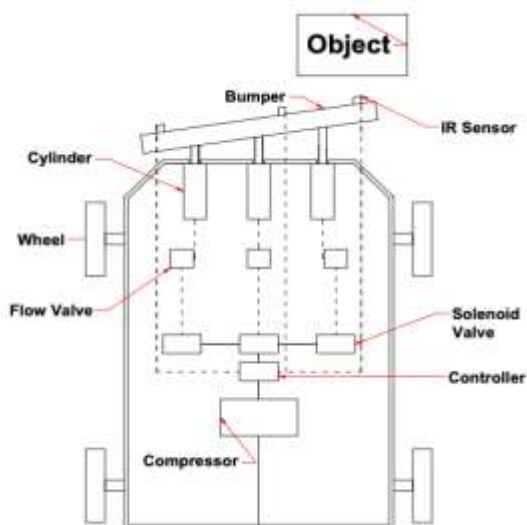
- 1) When Object is exactly at the Front of Vehicle :

When Object (other car, human or animal) is at the exact front of the vehicle then all three sensors are going to detect the object or most importantly the central sensor will detect the object and this causes the whole bumper moves forward at the same distance in other word the all three cylinder has same length of outward stroke.



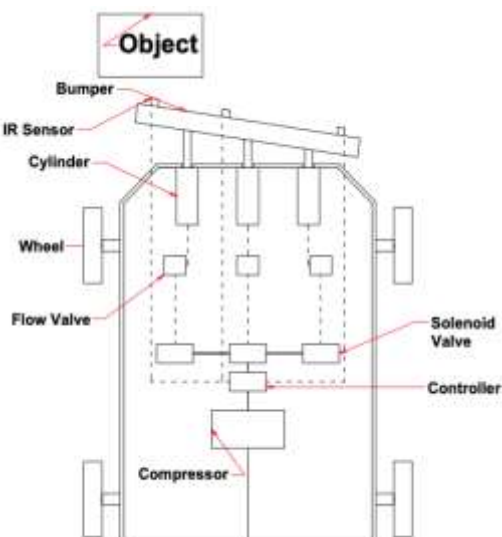
When Central Sensor or all three sensors detects any object they give signal to the Controller. Then Controller operates Compressor which compress the air which was in the airtight tank at the certain pressure. Then the air is allowed to move forward by the Solenoid Valves which are also controlled by the controller. Then air is passed through the Flow valve to vary the pressure of air if it is needed. And then to the cylinder which causes the piston to move forward. When piston reaches its maximum length of stroke then flow valve releases certain amount of pressure so that the cautioning effect can be archived as during the collision time bumper is at the maximum distance but after collision the cautioning effect is needed to reduce the impact.

1. When object is at the Rightmost of the Vehicle :



When object is at the Rightmost of the vehicle Only right sensor will detect it as exactly at the front. So, in this situation the Right Cylinder has a maximum outward stroke and then the distance of outward stroke is gradually decreases when moving to left. So that the load exerted is distributed uniformly.

2. When object is at the Leftmost of the Vehicle :



When object is at the Leftmost of the vehicle Only Left sensor will detect it as exactly at the front. So, in this situation the Left Cylinder has a maximum outward stroke and then the distance of outward stroke is gradually decreases when moving

to Right. So that the load exerted is distributed uniformly. And this will eliminate the compression on the right side hence there will be no fracture at the right.

VII. FUTURE SCOPE AND CONCLUSION

As it is very well known that Automotive industries has a vary wide range in technical advancement. And it is the basic necessity that one can get the comfort and safe transportation system. This Improvement in Automatic Pneumatic Bumper will provide a smart system. Which will increase the reliability, Safety and at the same time it will reduce the running cost. There are still plethora improvements which can improve the Bumper system. By working on this project we really feel that this system will surely helpful for Industrial as well as General purpose.

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