AUTOMATIC PNEUMATIC BUMPER AND BRAKING SYSTEM

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ABSTRACT:- *Now-a-days, accidents taking place are very frequent in India which occur mainly due to the inefficiency of driver to apply brakes at the right time. This is also because of rise in population of vehicles which if not handled properly may create difficulty in driving vehicles on road. A system must be designed to minimize accidents which may compensate for the inability of the drivers to apply brakes at the right time. Therefore our aim is to design and develop an electronically intelligent braking system which can automatically sense the objects ahead of the*

vehicle and applies brakes itself to avoid collision. If the collision still happens then we can add a new technology of retractable/extractable bumper which may extract in case of collision and avoids the damage to the vehicle's body. This bumper may extract or retract with the help of using Pneumatics technology which is much easier to implement and is readily available easily. Hence in this project we aim to design and develop "Automatic Pneumatic Bumper and Braking System".

Key Words- Automatic Bumper, Intelligent Braking System, Pneumatic Braking, Safety for 4-wheelers, Electronically controlled Braking.

1. INTRODUCTION

Population of vehicles in India is about one-third of population on India. Therefore the accidents taking place due to vehicle collision certainly contributes to the major portion of deaths. Though there are different causes for these accidents but a very common cause is inefficiency of the driver to apply brakes at the right time. So designing and implementing of an automatic bumper and braking system is must for vehicles to prevent the accidents. To achieve this system, we developed an Automatic Pneumatic Bumper and Braking System. Main components of this system are bumper, which is fully equipped by Infrared sensor and Pneumatic bumper control circuit. In this project, we have provided a collision control mechanism, called extractable and retractable bumper (E/R bumper). The E/R bumper is normally in the stowed position and when a high risk of frontal impact crash is detected, the bumper extracts to provide additional crush space. In this way the kinetic energy of a motor vehicle due to collision is rapidly converted into work by plastic deformation of bumper's structure. During this energy conversion process, the vehicle is decelerated in a relatively short time and distance. For vehicles involved in similar crash impact conditions, elementary physics ensures that those with less crush space and lower crush efficiency will have shorter stopping distances, higher average deceleration, and hence, more severe crash outcomes. The IR sensor on the E/R bumper senses the obstacle and If there is any obstacle closer to the vehicle (within 1-1.2 feets), the control signal is given to the bumper and break activation system. This bumper activation system is activated only when the vehicle speed is above 40-50 km/h, for sensing this speed we have proximity sensor installed in the system and hence the signal is transferred to the control unit and pneumatic bumper activation system respectively and therefore the bumper extracts, saving the vehicle's body from damage.

Bumper Retracted Bumper Extracted

Fig.1- Retracted & Extracted Bumper

1.1 Pneumatics

Pneumatic is a branch of engineering that makes use of gas or pressurized air. Pneumatic systems used in industry are commonly powered by compressed air or compressed inert gases. A centrally located and electrically powered compressor powers cylinders, air motors, and other pneumatic devices. When the pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.

1.2 IR Sensor

An infrared sensor is an electronic instrument that is used to sense certain characteristics of its surroundings. It does this by either emitting or detecting infrared radiation. Infrared sensors are also capable of measuring the heat being emitted by an object and detecting motion. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations.

Fig. 2 IR Sensor

The IR transmitting circuit is used in this project because it is readily available and also have the perfect sensing range as needed. These are the same sensors that are used in all TV remotes, AC remotes and other electronical devices. IR transmitter sends 42 kHz (frequency can be adjusted) carrier under 555 timer control. The transmitted signal gets reflected by the obstacle and the IR receiver circuit receives the signal which passes the control signal to the control unit. The control unit activates the pneumatic breaking system by which brakes are applied automatically and also the E/R bumper gets actuated.

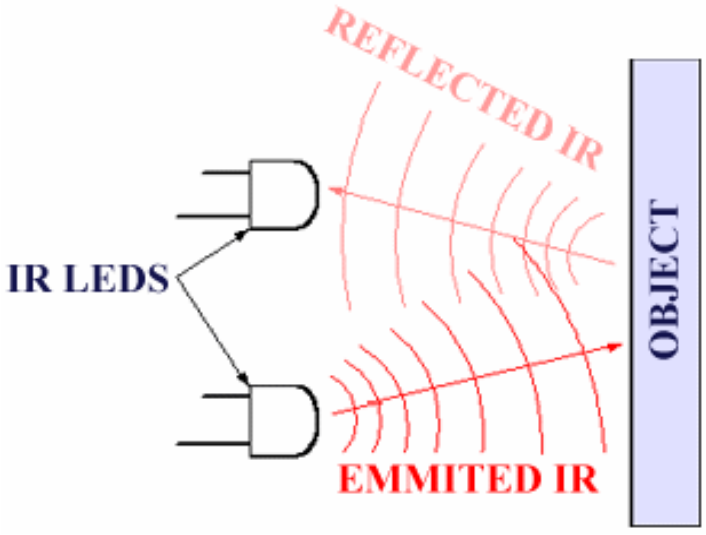

Fig.3 Working of IR Sensor

2. OBJECTIVES

The main objective of our project is to ensure safety to 4-wheelers and all the passengers it is carrying by the use of electronically operated intelligent braking system. Pneumatic Bumper System approach represents considerable shift from the use of traditional technology of safety to a the modern Pneumatics technology, by considering safety in terms of avoiding the possibility of accidents and protecting occupants when the collision is irresistible. With the help of this technology we can prevent more accidents, save more lives, reduce medical costs to society and decrease material damage to vehicles.

Following are the main objectives of Automatic System with Pneumatic Bumpers:

1) To increase the safety during pre-crash.

2) To increase the crashing distance during accident.

3) To decrease the level of passenger injury by use of external vehicle safety device.

4) To reduce the requirement of internal safety devices like air bags.

5) To increase external safety to vehicle body.

3. COMPONENTS

1) Pneumatic single acting cylinder

2) Solenoid valve

3) Flow control valve

4) IR sensor

5) Wheel and brake arrangement

6) PU connector

7) Reducer

8) Hose

9) Collar

10) Stand

11) Single phase induction motor.

4. EXPERIMENTAL PROCEDURE

The compressed air from the compressor at the pressure of 3 to 4bar is passed through a pipe connected to the Solenoid valve with one input and two outputs. The Solenoid Valve is actuated with Control Timing Unit. The air entering into the input goes out through the two outputs when the timing control unit is actuated. Due to the high air pressure at the bottom of the piston, the air pressure below the piston is more than the pressure above the piston. So this moves the piston rod upwards, which is pivoted by control unit. This force acting is passed on to punch/rivet which also moves downwards. The IR TRANSMITTER circuit is to transmit the Infra-Red rays. If any obstacle is there in the path, the Infra-Red rays gets reflected. This reflected Infra-Red rays are received by the receiver circuit, called “IR RECEIVER”. The IR receiver circuit receives the reflected IR rays and giving the control signal to the control circuit which is used to activate the solenoid valve. Once the solenoid valve is activated, the compressed air passes to the Single Acting Pneumatic Cylinder and hence activates the pneumatic cylinder and

moves the piston rod. If the piston moves forward, then the braking arrangement gets activated. The braking arrangement is used to break the wheel gradually or suddenly due to the piston movement. The breaking speed is varied by adjusting the valve is called "FLOW CONTROL VALVE". The compressed air flows through the Polyurethane tube to the flow control valve which is connected to the solenoid valve as shown in the block diagram.

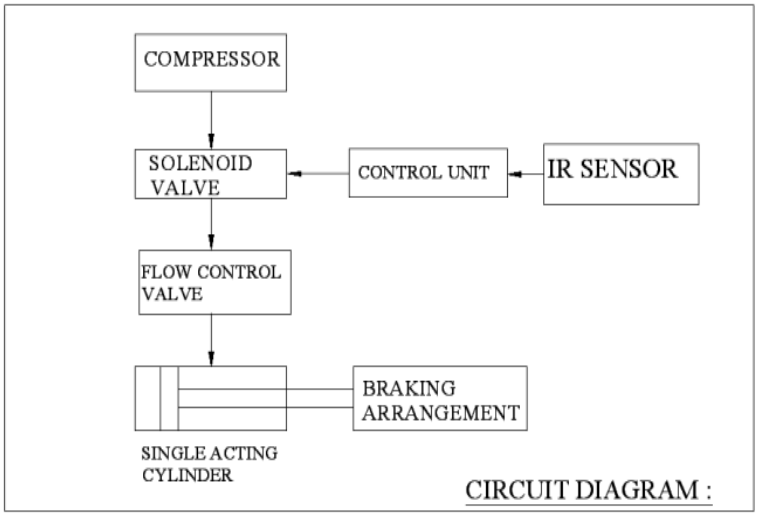

Fig. 4 Flow Diagram

5. EXPERIMENTAL WORK

For calculations, 'V. B. Bhandari and Design Data Book' were used as reference material and standard values in certain cases were taken directly from internet. Formulas used for calculations are as below:-

1) Calculation of pneumatic cylinder dimensions: Maximum force acting on bumper is assumed to be 90 N.

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

90 x 1.25 =112.5 N force

Also, pressure used is 4 bar = 0.4N/mm^2

For Bumper-

For Out-Stroke

$F_o = P \times A$

$112.5=0.4 \times \pi /4 (D^2)$

$112.5= 0.4 \times 0.7854 (D^2)$

$D^2 = 358.0978$ mm^2

So, D= 18.92mm

Selecting standard value of 20mm bore diameter, we calculate inner diameter.

Assuming In-stroke force to be equal to outstroke force, we assume in stroke force to be 90N.

For factor of safety of 1.25, in stroke force is 90x1.25=112.5N.

For in-stroke, Piston rod area = $\pi/4 \times d^2$

Effective area = $\pi/4 \times (D^2-d^2)$

= $0.7854 \times (202-d^2)$ mm^2

So, $F_i = 0.4 \times 0.7854 \times (202-d^2)$

$112.5 = 0.31416 \times (202-d^2)$

On solving, we get d= 6.47mm

Hence, selecting from standard values, inner diameter is 8 mm and bore diameter is 20mm.

To increase the crashing distance in case of accidents, we can increase the stroke length of cylinder used for extending the bumper.

So, for piston stroke of 110 mm is suitable.

2) Calculation of Braking distance

Braking distance, $D_b = [v^2/(2 \times \mu \times g)]$ m

Where, v = Velocity before applying brakes (App 10 km/hr = 2.78 m/s)

μ = coefficient of friction = 0.7 (for dry surfaces)

g = acceleration due to gravity ($9.81 m/sec^2$)

Braking distance, $D_b = [2.78^2/ (2 \times 0.7 \times 9.81)] = 0.5618$ m

3) Impact Force Calculation

Force, F = mass (m) x acceleration (a)

Mass of the vehicle m= 10kg (let)

By Equation of motions, $2as = v^2-u^2$

Where, v= Final velocity = 2.78 m/s

a= acceleration,

s = braking distance (D_b= 0.5618 m)

u= Initial velocity = 0

2*a* 0.5618 = 2.782 – 02

a = 6.87 m/s2

Force, F = m*a =10 x (6.87) = 68.7N

The Final impacting force value F = 68.7 N

6. ADVANTAGES

1) Increase in the safety during pre-crash.

2) Increased crashing distance during accident.

3) Decreased the level of passenger injury by use of external vehicle safety device.

4) Reduction in the requirement of internal safety devices like air bags.

5) Increased external safety to vehicle body.

7. LIMITATIONS

1. Stroke length is fixed.

2. Hard and thick materials cannot be riveted.

3. System has no provision to prevent and cure the accidents from rear side of vehicle.

4. Maintenance will be more due to the number of moving parts.

5. System has few limitations in densely traffic road.

6. Due to the linkages there will be frictional losses.

8. CONCLUSIONS AND FUTURE WORK

Working on this project has provided us an excellent opportunity and experience, to use our limited knowledge to develop altogether a new technology to ensure public safety. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while working on this project. We feel that the project work is a good solution to bridge the gates between institution and industries. We are able to understand the difficulties in maintaining the tolerances and also quality. We have done to our ability and skill making maximum use of available facilities. There is lot of scope for future development in vehicle. 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, air operated valves and accessories. The aim is to design and develop a control system based an intelligent electronically controlled automotive bumper activation system is called “Automatic Bumper System for Four Wheelers”. This system is consists of IR transmitter and Receiver circuit, Control Unit, Pneumatic bumper system. The IR sensor is used to detect the obstacle. There is any obstacle closer to the vehicle (within 4 feet) the control signal is given to the bumper activation system.

Fig. 5 Actual Model of Project

9. REFERENCES

[1] Pneumatic Control System----Stroll &Bernaud, Tata McGraw Hill Publications, 1999.

[2] Pneumatic System- Majumdhar, New Age India International (P) Ltd Publishers, 1997.

[3] "Automobile Engineering" William H. Crowse.

[4] Wang J.T. & Browne, A.L. ,"Extendable & Retractable Knee Bolser ," Paper No.323, the 2003 ESV Conference

[5] Wang J.T. 1999, "Bumper Energy Absorber." U.S. Patent No. 5,967,573.

[6] Wang J.T. & Jones G.L., 2001, "Self-Locking Telescoping Mechanism." U.S. Patent No. 6,30,258

[7] Dr..V.Singh, IJSRD -International Journal for Scientific Research Development Vol.3 Issue 06, 2015 pp.357-361.

[8] "Automobile Engineering", G.B.S. Narang, Khanna Publishers, Delhi, 1991, pp 671.