IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 18, Issue 1 Ser. I (Jan. – Feb. 2021), PP 54-58
www.iosrjournals.org

Automatic Pre-Emptive Safety Measures for Collision and Dents Using Pneumatic System

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Abstract:
The aim is to design a fully functional automatic pneumatic bumper system which will be equipped with sensor .I t will be designed for automobile vehicle with an aim to reduce the pre collision impact as much as possible the primary aim to facilitate the parking of vehicle with ease using our system, especially for amateur drivers who are prone to committing errors while parking or even driving the vehicle. But the main objective is minimization of pre collision impact during mishaps and save precious human life .In a nutshell , the plan to build a robust system that can be used irrespective of the frequency of the traffic and facilitate its use in the daytime as well as in the night.

Keyword: *pneumatic bumper, automation ,sensor ,pre collision impact ,safety system*

Date of Submission: 03-01-2021 Date of Acceptance: 16-01-2021

I. Introduction:

It is with pleasure that we introduce you to the project which basically is to design a fully functional automatic pneumatic bumper system which will be equipped with sensors it will be designed for automobile vehicles with an aim to reduce the pre-collision impact as much as possible.

Our country, with its overwhelming population, no wonder falls into the category of an accident prone country as a matter of fact, we top the list of the most number of road accidents as per the world road statistics .

The automobiles that we use in our day-to-day lives are equipped with a safety system which comprises of a bumper. The bumper is used to minimize the pre-collision impact. This bumper is actuated with the help of a pneumatic system. It also simultaneously comprises of a sensor which detects any obstacle in a pre-determined range and notifies the system accordingly. This system comprises of the bumper employed on the front side of the vehicle and it uses infrared sensors .

With automation being a part and parcel of today s production industry, it is only fitting that automation is employed in this venture as well. So, in order to prevent loss of human life due to accidents, we have tried to develop a system which can be called 'smart enough' to reduce the casualties due to road mishaps! As we know, automation can be achieved through various sources like hydraulics, robotics, etc. but due to its low cost, the pneumatic system forms a lucrative option its simplicity also aids its selection .long story short, it is basically an intelligent and electronically controlled automated pneumatic bumper system.

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.

Compressor capacity is the actual quantity of pressure compressed and delivered and the volume expressed is that of the pressure at intake conditions namely at atmosphere pressure and normal ambient temperature. The compressibility of the pressure was investigated by Robert Boyle in 1962 and found that the product of pressure and volume of a particular quantity of gas.

The usual written as

$PV = C$ (or) $P_1V_1 = P2V2$

In this equation the pressure is the absolute pressure which for free is about 14.7 Psi and is capable of maintaining a column of mercury, nearly 30 inches high in an ordinary barometer. Any gas can be used in pneumatic system.

Components employed and their specification

1.Ultrasonic sensor :

Model name : HCSR04

Reason : Ultrasonic sensor provide more reliable and accurate data than IR sensor .Also , IR sensor won't work if the intensity of light is greater ,rendering the system ineffective.
2. Single acting pneumatic cylinder :
Type : spring return type
Reason : In this design, the piston rod extends when compressed air is supplied to the cylinder. As soon as the air supply is cut off, the piston rod retracts by spring force.Thus, it is a perfect fit for our system.

3. Solenoid valve :
Type : 3/2 way 2 position normally closed
Model name: 2P025
Reason : When a normally closed solenoid valve is not powered, the plunger is down, effectively sealing the valve and preventing the flow of liquid or gas. Once the normally closed solenoid valve is powered or energized, the magnetic field causes the plunger to rise. This unseals the valve and allows the flow of liquid or fluid to pass through.

4. Flow control valve :
Reason : This valve speed up piston movement and act as one way restriction valve. By using this valve time consumption is reduced because of faster piston movement.

5. Bumper material :

AISI 1018 mild/low carbon steel has excellent weld ability and produces a uniform and harder case and it is considered as the best steel for carburized parts. AISI 1018 mild/low carbon steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties, AISI 1018 hot rolled steel also includes improved machining characteristics and Brinell hardness.

Chemical Composition:

Element Content:
Carbon, C 0.14 - 0.20 %
Iron, Fe 98.81 - 99.26 % (as remainder)
Manganese, Mn 0.60 - 0.90 %
Phosphorous, P $\leq$ 0.040 %
Sulfur, S $\leq$ 0.050

6. Controller : Arduino atmega 328

Design Calculation

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

Design of piston rod :
Diameter of piston = 15 mm

Area of cylinder = (pi*d*d)/4
= (pi*0.015*0.015)/4
= 0.0001767 m^2

Force acting on the rod (p) = pressure * area
= 500000 * 0.0001767 (assume pressure =5 bar)
= 88.35N

Length of piston rod :
Approach stroke = 140 mm

Length of thread = 2*20 = 40mm

Extra length due to front cover = 12mm

Extra length of accumulated head = 20mm

Total length of the piston rod = 140+40+12+2
= 212mm

Stopping distance calculation:

The total stopping distance of vehicle is calculated as follows :-

The braking distance (which is commonly measured as the skid length) given an initial driving speed v is

Braking distance , $Db = v^2/2*\mu*g$

Where v=velocity before applying brakes (approx. 25km/hr = 6.94m/s)
μ= coefficient of friction = 0.7 (for dry surfaces)
g =acceleration due to gravity =9.81 m/sec²
Db = (6.94*6.94) / (2*0.7*9.81)
Db = 3.51m

The total stopping distance is the sum of the perception-reaction distance and the braking distance

D total = (D) p-r + Db = v (t)p-r + $v^2/2*\mu*g$

A common baseline value t p-r = 1.5 second, μ= 0.7 is used in stopping distance charts. These values incorporate the ability of the vast majority of drivers under normal road conditions. However, a keen and alert driver may have perception-reaction times well below 1 second and a modern car with computerized anti-skid brakes may have a friction coefficient of 0.9--or even far exceed 1.0 with sticky tires.

Total stopping distance = 6.94*1 + 3.51 = 10.45m

Then, The total braking distance = Total stopping distance + Bumper actuation length
= 10.45 + 0.212
= 10.662
~ 11m
Hence the sensor sensing range is set at 11m

Impact force calculation:

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

Mass of the vehicle m= 20kg

By motion Equation, $2as = v^2-u^2$

Where, v= Final velocity = 6.94m/s

a= acceleration,

s = braking distance (Db=3.51m)

u= Initial velocity = 0

$2*a*3.51 = 6.94^2 – 0^2 = 6.86 m/sec^2$

Force, F = m*a =20 * (6.86)=137.2N

The Final impacting force value F = 137.2N

Working principle:

The ultrasonic circuit is employed in the system to transmit the ultrasonic rays in the presence of any kind of obstacle in its path ,the ultrasonic rays are reflected . These ultrasonic rays are then received by the receiver when this receiver circuit receives the reflected rays ,it gives the signal to the control circuit ,which then in turn activates the solenoid valve . When the solenoid valve is activated ,the compressed air is then passed to the single acting pneumatic cylinder . Due to this process the pneumatic cylinder is activated and the piston rod is pushed in the forward direction thus ,it can be said that the bumper is actuated .Meanwhile ,the compressed air also actuates the small single acting pneumatic cylinder as the piston rod moves in the forward direction, this rod which is connected to the lever of the braking system ,brake is also pushed thus ,the brake is applied .Depending upon braking system arrangement used ,the brakes will either be applied gradually or suddenly due to the piston movement . The braking speed can also be altered or varied by using flow control valve .In this system is actuated .

Advantages:

We broadly identified the following advantages in the existing
System

1. The system increases the pre-crash safety.
2.The system facilitates to provide more safety to the passenger.
3. The system plays a pivotal role to save human life in road accidents.
4. Due to the automation used ,the braking system is able to give a quicker response . This increases the surety in braking system .
5. The system can be widely used to park the vehicles safely and securely.

Limitations:

We observed the following lacunas in the existing system

1. System has its limitations in dense traffic.
2. The bumper system is employed only at the front end , leaving the vehicle vulnerable to collision from rear end.
3. Due to the linkages there are ought to be frictional losses.
4 . As the number of moving parts are more, the maintenance will be increased as well.
5. Hard and thick materials cannot be riveted.
6 .The stroke length is fixed.

Application :

This system can be successfully employed in all types of light vehicle like cars , rickshaws , tempos , etc.
This system is also perfectly applicable the heavy vehicle like buses ,trucks, trailers ,etc.

II. Conclusion

The thought process behind the designing and fabrication of this particular system is to facilitate the enhancement of the technique for prevention of accidents .Apart from this , it also reduces the hazard due to mishaps like damages to the vehicle, injury to the one the one sitting inside the vehicle, etc.

The deployment of pneumatics ensures smooth functioning and operations of the whole system . There is room for modification and usage of various technique to suit different applications. Implementation of this system can help reduce the cost of high end automobiles by ensuring similar kind of safety measures. In conclusion the automatic pneumatic bumper system can help to achieve low cost automation.

Future scope :

The future work deals with incorporating this system with various features to provide enhanced protection by the intelligent braking system in real time application. For that, some of the possible changes are: 1) Regular bumpers can be replaced by hydraulic bumpers. 2) Limit switch can be used to limit the minimum speed above which the system gets triggered. 3) Bumper design can further be enhanced to act as external air bags. 4) With some modifications, the project can be used with timer circuits so as to apply brakes and extend the bumper after a delay of few milliseconds so that the bumper does not extend unless the vehicle just reaches the crashing distance.

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Atharva Bhajne, et. al. "Automatic Pre-Emptive Safety Measures for Collision and Dents Using Pneumatic System." *IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)*, 18(1), 2021, pp. 54-58.