Design, Manufacturing And Analysis Of Accident Avoiding System

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Abstract

Many fatal vehicle accidents take place due to overs-speeding every year causing damages to vehicle and life of passengers. The main purpose and the objective of this research paper is to develop a system to keep the lower front end of vehicle secured and protect it from getting damaged and to protect passengers by reducing the certain impact of an accident. The main aim of the project is to develop an " Automatic speed control and accident avoiding system" for the vehicle using ultrasonic sensor whenever any obstacle is detected with a certain range. The aim is to design and develop a control system based on intelligent electronically controlled automotive bumper actuation and automatic braking system for a four-wheeler vehicle. This project of ultrasonic transmitter has a receiver circuit, control unit, pneumatic bumper system and braking system.

Introduction

As per The Economic Times, every year more than 1,50,000 fatal accidents take place in the country due to over speeding. Thus, there is an urgent need to develop an automated system that can help us reduce these accidents, if not completely avoid them. The sheer loss that is incurred in road accidents due to either carelessness of the driver or pedestrians is increasing at an alarming pace. As there are limitations to the use and effectiveness of seat belts and air bags, we have made an effort to develop a system that can help us achieve our aim. The technology of pneumatics has gained tremendous importance in the field of workplace rationalization and automation. We've chosen pneumatics to our advantage in this mechanism as pneumatics take advantage of the low friction and compressible nature of air. A lot of air can be moved rapidly, and although compressibility needs to be factored in, it can provide an advantage with unmatched response and cycle times. Most pneumatic applications are low inertia, so they tend to accelerate and decelerate quickly.

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The aim is to design and develop a control system based on an intelligent, electronically controlled Automotive Pneumatic Bumper Activation System & an Automatic Braking System. This system consists of an ultrasonic transmitter and receiver, control unit, pneumatic cylinders and solenoid valves. The ultrasonic sensor is used to detect the obstacle. If there is any obstacle closer to the vehicle (within 8 feet), the control signal activates the Pneumatic Bumper system.

The Pneumatic Bumper system is used to protect the passengers and the vehicles by reducing the sudden impact that one experience when a vehicle crash into another one. The material of this pneumatic bumper will be chosen according to its capacity to absorb as much impact force as it can. This system can bring about a considerable change in the outcome of an accident.

Problem Statement

In conventional vehicles there are different mechanisms which are operated manually. When the driver sees the obstacle or any vehicle in front of his vehicle, driver may fail to give the proper input to braking system. Currently, there are no provisions to minimize the damages to the vehicles. Currently bumpers are a part of the vehicle body which have a specific capacity and when the range of the accidental force is very high then the bumpers fail and these forces are transferred towards the passengers. To overcome these unwanted effects, we have to design the Automatic Braking System with Pneumatic bumpers which have following objectives.

Objective of the project:

- To increase the sureness of Braking Application.
- To reduce the response time of Braking system.
- To improve pre-crash safety.
- To reduce the intensity of passenger injury by using external vehicle safety equipment.
- To reduce the dependence on internal safety devices like air bags, seat belts etc.

Literature Review

- **A Characterization of Dynamic Human Braking Behavior with Implications for ACC Design**

  Skilled driving behavior can be characterized as tracking, control, and regulation of appropriate perceptual cues. From experiments and supporting literature, we identify time head-way and time-to-collision as plausible perceptual cues, and characterize skilled braking behavior as a trajectory through the resulting perceptual state space [1].

- **A Deceleration Control Method of Automobile for Collision Avoidance**

  In the view point of preventive safety, deceleration assistance control is effective when collision risk is high and it is difficult for the driver to avoid it. On the other hand, driver can feel anxiety or nuisance against the system if the initiation timing of automatic brake and/or deceleration profile is not appropriate and it may make the system inefficient. Thus, in order to realize an acceptable and efficient system, it is important to know characteristics of comfortable deceleration behavior and apply them to deceleration assistance system [4].

- **Safety System: -**

. The final phase of the new modern vehicle shall include:

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- Development of improved ABS control systems
- Development and assessment of an electro-hydraulic-BBW(EH-BBW) system
- Individual wheel braking combined with traction control
- Assessing sensor failure and fault tolerant control system design
- Preliminary studies into an electrically actuated system
- Re-engineering using simplified models.

Construction and Working:

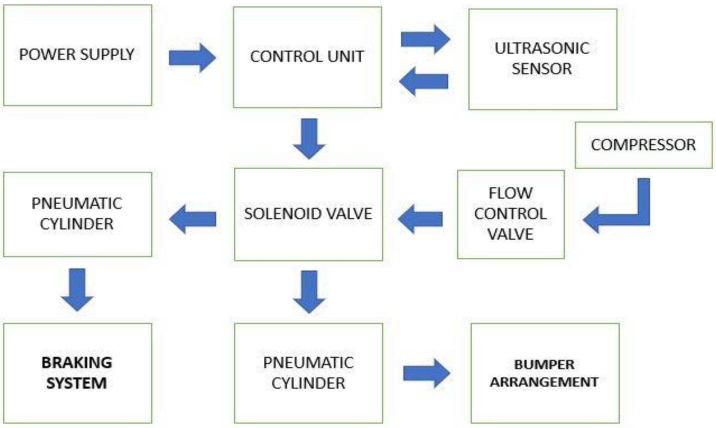

Fig-1: Constructional block diagram

This system is designed mainly to be used at the time of an emergency; when an obstacle, human, animal or vehicle is in front of the vehicle and in close proximity, it is detected by the ultrasonic sensors installed at the front end of the chassis. The range of the ultrasonic sensor to detect an obstacle can be defined in Arduino program. The signal received by ultrasonic sensor is sent to the control unit. This control unit commands the relay according to the input signal. There are two relays used in this system; one responsible for the activation of the bumper mechanism and another for the operation of brakes. Hence, when an obstacle is detected within the specified range, the control unit activates the bumper extension and automatic braking system simultaneously.

Constructional Features

1. Relay

It is a control unit having specification 3P 240A. This control unit acts according to sensor signal to activate bumper system and to apply breaking through solenoid valve.

A **relay** is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal.

2. Compressed Air Tank

Compressed air tank is used to store the compressed air having pressure 1.5 bar.

3. 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 center. 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 center of the coil so that the orifice opens.

Applications: -

For Automobile applications: -

- It works effectively on heavy vehicles, which tend to roll back in slopey regions.

System Elements

Ultrasonic Sensor

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

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.

Pneumatic Cylinder

Pneumatic cylinders are mechanical devices which use the power of compressed air to produce a force in a reciprocating linear motion.

Stand

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.

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.

DC Motor:

A **DC motor** is of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

Specifications of motor:

- RPM: 30 at 12V
- Voltage: 4V to 12V
- Stall torque: 28 Kg-cm at stall current of 1.3 Amp.

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- Shaft diameter: 6mm
- Shaft length: 22mm
- Gear assembly: Spur
- Brush type: Carbon
- Motor weight: 143gms

Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts.

Design

The CAD design in an integral step in the formulation of the entire system. Every minute part needs to be either designed or imported to form a perfect assembly. This step is further divided into two:

(i) System design
(ii) Mechanical design
System Design:

System design is mainly concerned with the various physical constraints and ergonomics, space requirements, arrangement of various components on frame at system, man-machine interaction, number of controls, position of controls, working environment, maintenance, scope of improvement, weight if machine from ground level, total weight of machine, etc.

Mechanical Design:

In mechanical design, the components are listed down and stored on the basis design and procurement i.e.
(i) Designed parts
(ii) Parts to be purchased

Mechanical design phase is significant from the designer's view as the success of the project depends entirely on the correct design analysis of the problem.
Many preliminary alternatives are eliminated during this phase. The designer should possess adequate knowledge of the physical properties of material, load stresses and failure. He should be capable of identifying all internal and external forces acting on machine parts. These forces may be classified as,
(a) Dead weight forces
(b) Friction forces
(c) Inertia forces
(d) Centrifugal forces
(e) Forces generated during power transmission, etc.

Following is the assembly of the system generated in CATIA V5.

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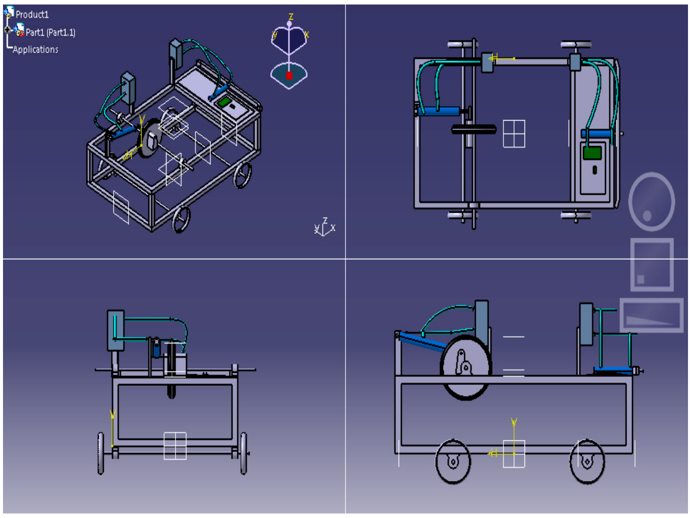

Calculations

1. Design of Frame

Frame design for safety FOR 25*25*3 L angle mild steel channel

b = 25 mm, d= 25 mm, t = 3 mm.

Consider the maximum load on the frame to be 50 kg.

Max. Bending moment = force*perpendicular distance

= 50*9.81*450

M = 220725 N-mm

We know,

$M / I = \sigma_b / y$

M = Bending moment

I = Moment of Inertia about axis of bending that is; I_{xx}

y = Distance of the layer at which the bending stress is consider

E = Modulus of elasticity of beam material.

$I = bd^3 / 12$

$= 25*25^3 / 12$

$I = 32552.08 \text{ mm}^4$

$\sigma_b = My / I$

= 220725*12.5 / 32552.08

$\sigma_b = 84.76 \text{ N/mm}^2$

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The allowable shear stress for material is $\sigma_{allow} = S_{yt}$ / fos

Where S_{yt} = yield stress = 210 MPa = 210 N/mm^2

fos is factor of safety = 2

So σ_{allow}= 210/2 = 105 MPa = 105 N/mm^2

Comparing above we get,

$\sigma_b < \sigma_{allow}$ i.e. 84.76 <105 N/mm^2

Hence, design is safe.

2. Welded Joint:

Check the strength of the welded joints for safety.

The transverse fillet weld is used to weld the side plate and the edge stiffness plate.

The maximum load which the plate can carry for transverse fillet weld is

P = 0.707 x S x L x ft

Where, S = factor of safety,

L = contact length = 25mm

The load of shear along with the friction is 50 kg = 500N

Hence, 500 = 0.707 x 3 x 25 x ft

Now, let us find the safe value of 'ft'

Therefore, ft = $\frac{500}{0.707\ x\ 3\ x\ 25}$

ft = 9.4295 N/mm^2

Since the calculated value of the tensile load is smaller than the permissible value i.e. ft=56 N/mm^2. Hence, welded joint is safe.

3. Design of Shaft:

For a main shaft which is a power generator, power is given as,

P = F x V-- (1)

Also, force acting on shaft is given by,

F = m x g-- (2)

Assuming load on the shaft = m=50kg

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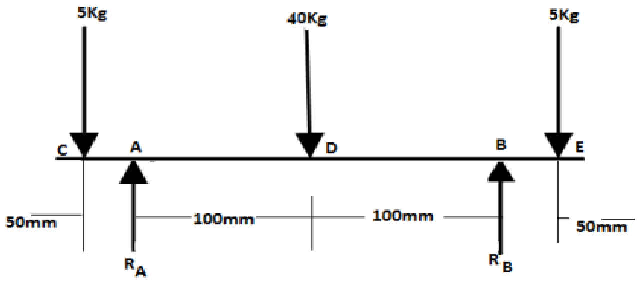

Fig. 8 Free body diagram

g = 9.81
Thus, F = 50 × 9.81 = 490.5 N

Velocity is found out to be 10 cm/s i.e. V = 0.10 m/s

Power, P = 490.5 x 0.10 = 40.05 watts

We know that torque is given as, T = P x 60/(2πn)

Assuming no. of revolutions, n= 50 rpm

Thus, we have Torque, T = 49.05 x 60/(2πx50)

$= 9.36 \times 10^3$ N-mm

For a given shaft, we have, from diagram,
Vertical reactions at wheels i.e. fixed supports,
RA = RB = (5+40+5)/2

= 25 kg
= 25 x 9.81 = 245.25 N

From bending moment diagram, maximum bending moment is found to be M = 1750 Kg-mm = 17.167×10^3 N-mm

The resultant moment on a given shaft is given as
$MR= (M + T)^{1/2}$
= ((17.167x103)2+ (9.36 x 103)2) ½
$= 19.552 \times 10^3$N-mm

Also, we know that shaft diameter is given as,
$d =[(MR \times 16)/ (\pi \times \tau)]^{1/3}$

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SHEAR STRESS VALUES

Service Condition	τ_s (MPa)
Heavily loaded short shafts carrying no axial load	48-106
Multiple bearing long shafts carrying no axial load	13-22
Axially loaded shafts (bevel gear drive or helical gear drive)	8-10
Shafts working under heavy overloads (stone crushers, etc.)	4.5-5.3

Consider shear stress, τ = 50Mpa
d = $[((19.552x103)\ x16)/\ (\pi x50)]^{1/3}$
d = 12.581 mm

This is ideal diameter of shaft which is needed. Since a shaft may be subjected to extra load as it has to work in rough conditions and from availability point of view, we chose a safe diameter from DDHB (Table 3.5a) of standard shaft diameter of 15 mm.

Thus, diameter of shaft, d = 15 mm

4. Motor

Specification and calculation

Speed = 30rpm

Voltage = 12 V

Power = 18 watt

torque of motor = τ = p * 60/2 * 3.14588 N

τ = 18 * 60/(3 * 3.14 * 30)

τ = 5.294 N/m^2

τ = 5.2910^3 N/mm^2

Motor shaft is made of MS and its allowable shear stress F_d = 42 MPa

Torque = τ = (3.14 * F_d* d^3) / 16

5.294 * 10^3 = (3.14 * 42 * d^3)/16

d= 6mm

Results:

1)When the distance is set between maximum and minimum, i.e., is 0-40 cm then the bumper is activated and simultaneously braking takes place.

2)When the distance is set beyond 40cm then the bumper does not extend and braking does not occur.

Conclusion

By conducting tests on the model, we can conclude that during a head on collision, this system significantly reduces the impact on the front end of the vehicle hence reducing the damages caused to the vehicle. It also reduces the probability of occurrence of an accident as much as it possibly can.

References

[1] A.Arunkuma , T. Muthumani , V. Balasubramani "DESIGN AND FABRICATION OF ANTI ROLL BACK SYSTEM IN VEHICLES USING DRUM & SHOE MECHANISM" ISSN: 0976-1353 Volume 12 Issue 3 –JANUARY 2015.

[2] Knorr-Bremse systems for Commercial Vehicle systems India Pvt. Ltd. (KBI-CVs)" ANTIROLL BACK SYSTEM FOR COMMERCIAL VEHICLES"

[3] V. P. Bondaletov, "Pawl Motion in Free-Running Ratchet Gear at High Drum Speeds", ISSN 1068-798X, Russian Engineering Research, 2008, Vol. 28, No. 9, pp. 845–848.

[4] J. A. Kennedy, L. L. Howell, "The Drum & Shoe Ring (RaPR) Mechanism", 12th IFToMM World Congress, Besançon (France), June18-21, 2007.

[5] Transport Research Wing, "Road Accidents in India", Ministry of Road Transport and Highways, India, 2011.

[6] The New In-Depth, At-the-Scene, Accident Investigation Database in India by N.Rameshkrishnan, A. Sathyakumar, S.Balakumar, A. M. Hassan, R. Rajaraman, J. Padmanaban.

[7] Erik Coelingh, etal, "Collision Warning with Auto Brake", Sweden, ppn: 07-0450.

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