Automatic Hydraulic Bumper and Speed Limiting System
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Abstract—The loss of human as well as financial loss due to repaired of the damaged vehicles is alarming. In recent years the numbers of vehicles have increased drastically leading to further increase in accidents and repair costs. Automobile manufacturing companies are developing upgraded vehicles in respect of technology and fuel efficiency. Manufacturers are also continuously working on improvement of safety measures in modern vehicles. Present work involves design and simulation of “Automatic hydraulic bumper and speed control system” to enhance safety measures. This system consists of IR transmitter, receiver circuit, control unit and hydraulic bumper system. As and when vehicle is close to obstacle the IR transmitted signal from the vehicle is reflected back from obstacle and received by detector and processed in the control unit. The control unit activates the breaking system. Simultaneously the solenoid valve is activated to move the bumper forward. In case of collision from front side impact force on the vehicle gets absorbed which prevents any unexpected extent of damage or injury during the accident. The bumper system has been designed to satisfy the safety norms ECE 26 using CATIA V5 software.

Key words: Hydraulic Bumper, Speed Control, ECE-26 Norms

I. INTRODUCTION

I have introducing new project idea “Automatic hydraulic bumper & speed limiting system”, which is fully equipped by IR sensors circuit and Hydraulic bumper activation circuit.

The hydraulic bumper system is used to protect the man and vehicle. This bumper activation system is only activated at the vehicle speed above 40-50 km per hour. This vehicle speed is sensed by the proximity sensor which gives a signal to control unit and hydraulic bumper activation system. This is fully equipped by IR sensors circuit and hydraulic bumper activation circuit.

A. Problem Statements:
- During accident vehicles get heavily damaged.
- Impact on vehicle during accident damages the front parts like bumper, radiator grill, headlamp, fog lamp.
- Instead of all above part can we minimizes the damages parts during accident?
- Another thing can we reduce the impact of accident?

B. Function of bumper:
- Safety
- Most Prominent fascia of a vehicle
- Exterior trim component
- Most important aesthetic parts
- Designed to specific shapes

- Absorbs some of the impacts
- Acts as a barrier to any object coming in contact with the vehicle

C. Introductions to FPB:
- When an object comes near the vehicle, the sensors get actuated and provide the actuating signal to the hydraulic actuators.
- Hydraulic cylinder supplies the fluid to the expandable bumpers which subsequently move outward providing resisting force against an impact force caused by an object on the vehicle.

D. IR Sensor:

1) Basic Operating Principle:
- The infrared proximity sensor consists of two components: Emitter and Detector.
- Infrared light is emitted by the emitter in the direction to be tested.
- Any object in the path of the emitted light will reflect some amount of light back toward the sensor.
- The detector collects the reflected light and determines the distance of the object from the sensor.
- A sensor is a transducer used to make a measurement of a physical variable. Any sensor
requires calibration in order to be useful as a measuring device.

- Optical sensors are characterized specified by spectral, radiometric and geometric performance.
- The transmitted signal reflected by the obstacle and the IR receiver circuit receives the signal which further gives control signal to the control unit. The control unit activates the pneumatic breaking system, so that break will be applied.
- If the solenoid valve is activated, the oil passes to the Double Acting Hydraulic Cylinder. Which further moves the piston rod.

2) Types of the sensor for distance calculate:
- Reflected IR strength
- Modulated IR signal
- Triangulation

E. Selection of Hydraulics:

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Hydraulics is an attractive medium for low cost mechanization particularly for sequential or repetitive operations. Many factories and plants already have this system, which is capable of providing both the power or energy requirements and the control system.

The main advantages of an all-hydraulic systems are usually robust and its high power to weight ratio, the latter reducing maintenance to a low level. It can also have outstanding advantages in terms of safety

1) Hydraulic System Components

- Hydraulic double acting cylinder
- Solenoid valve
- Flow control valve
- IR sensor unit
- Wheel and speed limiting system arrangement
- Single phase induction motor & gear pump

Fig. 3: Block Diagram

II. LITERATURE SURVEY

Saad jawad university of hertfordshire [1], Smart structures for frontal collision mitigation, SAE 2002 world congress detroit, michigan march 4-7, 2002 the ideal structure for frontal collisions needs to maximize the deformation zone, and adapt to impact conditions by stiffening at severe impacts and softening otherwise. Smart hydraulic structures are proposed to meet these ideal requirements. Sample “Hydraulic smart structures” were designed and tested for feasibility of crash under high pressure and high impact speed conditions.

Adrian k. Lund and joseph m. Nolan insurance institute for highway safety [2] changes in vehicle designs from frontal offset and side impact crash testing, 2003 sae world congress detroit, michigan march 3-6, 2003, the insurance institute for highway safety (IIHS) has been conducting frontal offset crash tests of new passenger vehicles & providing comparative crashworthiness information to the public. This program has resulted in large improvements in frontal crashworthiness largely because vehicle structures have been redesigned to prevent significant collapse of the occupant compartment.

James A. neptune neptune engineering, inc [3] a comparison of crush stiffness characteristics from partial-overlap and full-overlap frontal crash tests, international congress and exposition detroit, michigan march 1-4, 1999, recently partial-overlap crash tests have been performed and the test data has been made available to the public. A comparison of crush stiffness characteristics from partial-overlap, and full-overlap, frontal crash tests is presented in this paper.

G. Benet , f. Blanes, J.E. Simó, P. Pérez[4], using infrared sensors for distance measurement in mobile robots, universidad politecnica de valencia,spain 27march2002, the amplitude response of infrared (IR) sensors based on reflected amplitude of the surrounding objects is non-linear and depends on the reflectance characteristics of the object surface. As a result, the main use of IR sensors in robotics is for obstacle avoidance.

Jae-Wan Lee Kyong-Han Yoon Korea, Automobile test and research institute korea, Youn-Soo Kang The Korea Transport Institute korea Gyung-Jin Park hanyang university[5],vehicle hood and bumper structure design to mitigate casualties of pedestrian accidents ,hanyang university korea paper no 05-0105,In this research, a method, which uses an experiment and simulation simultaneously, is developed. Orthogonal arrays are employed to link the two methods. The minimum number of experiments is allocated to some rows of an orthogonal array and the simulations are allocated to the rest of the rows. Experiments should be allocated to have the cases of the experiments orthogonal. Mathematical error analysis is conducted.

Peter J. Schuster[6],Current trends in bumper design for pedestrian impact, california polytechnic state university 2006-01-0464,The most common method proposed for cushioning the lower limb in an impact uses an energy absorber (plastic foam or 'egg-crate') in front of a semi-rigid (steel or aluminum) beam. There are also proposals for 'spring steel', steel-foil composites, crush-cans, and plastic beams. The most common method proposed for supporting the lower limb in an impact is a secondary lower beam, known as a 'stiffener' or 'spoiler'. Most proposed lower stiffeners are plastic plates or metal beams supported by the engine under tray, the radiator support, or the front-end module. In addition to these concepts, there are a number of design proposals involving a deploying bumper or lower stiffener.
III. ECONOMIC COMMISSION FOR EUROPE ECE – 26

Fig. 4: ECE 26

A. Scope:
This Regulation applies to external projections. It does not apply to exterior rear-view mirrors or to the ball of towing devices

B. Purpose:
The purpose of this Regulation is to reduce the risk or seriousness of bodily injury to a person hit by the bodywork or brushing against it in the event of a collision. This is valid both when the vehicle is stationary and in motion.

C. Consideration for Bumper
   - The ends of the bumpers shall be turned in towards the external surface in order to minimize the risk of fouling. This requirement is considered to be satisfied if either the bumper is recessed or integrated within the bodywork or the end of the bumper is turned in so that it is not contactable by a 100 mm sphere and the gap between the bumper end and the surrounding bodywork does not exceed 20 mm.
   - If the line of the bumper which corresponds to the outline contour of the car vertical projection is on a rigid surface, that surface shall have a minimum radius of curvature of 5 mm at all its points lying from the contour line to 20 mm inward, and a minimum radius of curvature of 2.5 mm in all other cases. This provision applies to that part of the zone lying from the contour line to 20 mm inward which is situated between and in front (or rear in case of the rear bumper) of tangential points with the contour line of two vertical planes each forming with the longitudinal plane of symmetry of the vehicle an angle of 15°.
   - Shall not apply to parts on or of the bumper or to bumper insets which have a projection of less than 5 mm, with special reference to joint covers and jets for headlamp washers; but the outward facing angles of such parts shall be blunted, save where such parts protrude less than 1.5 mm.

Fig. 5: Section of Bumper Assembly

Fig. 6: ECE 26 for Bumper assembly
IV. Conclusion

In conclusion remarks of our project work; we will provide benefit of automated movable bumpers to avoid accidents. It is shown that "Smart Structures" employing two hydraulic cylinders integrated within the front longitudinal members is capable of absorbing more impact energy for the same crush distance and for the same maximum load level compared with passive structures. The bumper system has been designed to satisfy the safety norms ECE 26.

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