VEHICLE REAR END COLLISION AVOIDANCE USING VIRTUAL BUMPER AND AUTO BRAKING SYSTEM

Project Reference No.: 42S_BE_2124

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Keywords: Bumpers, brakes, Automatic Braking System, Proximity Sensor

Introduction:
The numbers of people who die during the vehicle accidents are also very large as compared to other causes of death. Though there are different causes for these accidents, a proper technology of braking system and technology is needed to reduce the damage during accident which reduces the accident rates. So the automatic braking system and pneumatic bumper systems is an attempt in this direction to prevent the accidents. To achieve this goal, we have made a prototype model of automatic braking with pneumatic bumper system in this present work.

The project work consists of IR transmitter and receiver circuit, electronic control unit, pneumatically actuated bumper system and braking system. The IR sensor senses the obstacles and the vehicles at the rear. If so the sensor gives the input to the control unit. The control unit actuates the pneumatic system through solenoid operated directional control valve and hence the brake is applied along with actuation of the virtual bumper.

Objectives:
The present work has the following objectives,
1. To improve rear end pre-crash safety.
2. To avoid the percentage of passenger injury by using external vehicle safety.
3. To increase the crashing distance during the accident.
4. To reduce the response time of braking system and to maintain accuracy in braking system.
5. To reduce the damage caused for rear end body and parts like Tail lamp, indicator, etc.,
6. To safeguard the pedestrians from collision during motion in reverse gear.

Methodology:
The virtual bumper and auto braking system which are used in this project work are a part of vehicle’s external safety. A prototype model has been used to avoid the collision and the damages caused for the rear end of the vehicle.

Different Components of the virtual bumper and auto braking system
Fabrication and assembly

Parts of Project Model

1. Air compressor
2. DC Gear motor
3. Solenoid operated directional control valve
4. Brake actuating double acting cylinder
5. Disc brake
6. Battery
7. Differential
8. Microcontroller and sensor
9. Bumper actuating double acting cylinder

All the above said components are accommodated over a chassis frame made of mild steel square pipe through flanges and bolts. For the transmission of power to the rear driving wheels, we have used differential of a 3 wheeler. An electric motor is used for driving the wheels which is power by 12V DC battery. The same battery also supplies power required for the operation of sensor, control unit and the solenoid of directional control valve.

Working Principle:

This system is actuated through a switch on the dash board while the driver decides to park the vehicle in reverse gear. The same system can also be actuated automatically to avoid rear end collision by other vehicle while travelling in forward direction.

The IR sensors are mounted at the front portion of the bumper. If there is any obstacle /a vehicle / a pedestrian situated in a path at the rear end, the Infra-Red rays sent from the IR transmitter get reflected. These reflected Infra-Red rays are received by the receiver circuit is called “IR RECEIVER”. The IR receiver gives the input signal to the control circuit. The control unit generates the output signal by executing the programme. The control unit activates the solenoid valve. When the solenoid valve is activated, the compressed air from the reservoir at high pressure is passed through a pipe connected to the directional control valve. The air under high pressure is made to pass through Double Acting pneumatic
cylinder. Both the bumper system and braking systems are activated. If the obstacle / a vehicle / a pedestrian move past the vicinity of the sensor then the control system actuates the pneumatic cylinder by reversing the flow direction of air by using directional control valves. The bumper is set back to its original position and the brakes are relieved.

**Results and Conclusion:**

Total response time of the system

Total time of response = Time taken by sensor + Time taken by control unit + Time taken by actuators

Total time of response = 1.3 + 0.2 + 0.5 = 2.0 Second

8.1 Stopping distance

The stopping distances at various speeds with different values of coefficient of friction are shown in table 8.1

The virtual bumper and auto braking system takes only 2 sec to get activated, which falls within the range of stopping distance at different speeds.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Co-efficient of friction</th>
<th>Stopping distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kmph</td>
<td>0.38</td>
<td>26 m</td>
</tr>
<tr>
<td>60 kmph</td>
<td>0.36</td>
<td>39 m</td>
</tr>
<tr>
<td>70 kmph</td>
<td>0.35</td>
<td>55 m</td>
</tr>
</tbody>
</table>

Table 8.2 Stopping Distance at Different Speeds

8.2. Deceleration Time

The deceleration time at various speeds are shown in table 4.2

The virtual bumper and auto braking system which falls within the range of deceleration time at different speeds.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Deceleration</th>
<th>Deceleration Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 kmph</td>
<td>3.704 m/s²</td>
<td>3.747 sec</td>
</tr>
<tr>
<td>60 kmph</td>
<td>3.558 m/s²</td>
<td>4.682 sec</td>
</tr>
<tr>
<td>70 kmph</td>
<td>3.435 m/s²</td>
<td>5.667 sec</td>
</tr>
<tr>
<td>80 kmph</td>
<td>3.577 m/s²</td>
<td>6.211 sec</td>
</tr>
<tr>
<td>90 kmph</td>
<td>3.765 m/s²</td>
<td>6.640 sec</td>
</tr>
</tbody>
</table>
Table 8.2 Deceleration Time at Different Speeds

CONCLUSION

The result of the project is, to avoid the percentage of passenger injury by using external vehicle safety. This increases the crashing distance during the accident. This system reduces the response time of braking system and maintains accuracy in braking. The damage caused for rear end body and parts like Tile lamp, indicator, etc is also avoided. This system safe guards the pedestrians from collision during motion in reverse gear.

After going through the results obtained we can conclude that

- The virtual bumper and auto braking system takes only 2 sec to get activated, which falls within the range of stopping distance at different speeds. Therefore it safe guards the vehicle rear end being hit by another vehicle when it is suddenly stopped at high speed.
- The virtual bumper and auto braking system which falls within the range of deceleration time at different speeds thus safe parking can be done without any damage for the rear end of the vehicle.

Scope for future work

As people are more cautious about safety during vehicle driving, the present work has got more opportunity for improvement through research and development.

The major work can be suggested as follows

- Different proximity sensor with less response time can be used.
- The output time of the control unit should be reduced by using advanced electronic control unit. The communication can be done via can controller area network (CAN) data bus which is more reliable.
- Advanced actuation system can be used for the bumper.
- The crash tests can be done by changing the materials of bumper. The crash depth can be identify to fix extract stroke of the bumper.