

Automatic Braking System with Pneumatic Bumper for Vehicles

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Abstract: *Vehicle accidents are very high in recent years and the graph of accidents per day is constantly on rise. This is because of the increase in population of vehicles because of its high demand. There is serious threat to life and property because of these accidents. The use of computer assisted systems is a big step towards improving the safety and performance of the car. The main aim to study this project is, it helps design a device which can scan the surrounding and apply brakes automatically as it detects some hurdle in front of it. It helps prevent accidents due to drunken drive, rash driving, and loss of control.*

Keywords: Pneumatic controller, Optical sensor, Solenoid Valve

1. Introduction

Driving now a days is a compulsory activity for most of the people. With the increase in population, the number of vehicles has also started increasing. The recent development in this generation of sensor rich, distributed autonomous control, technology has had a profound effect on the design of modern automotive vehicles. The intelligence afforded by robust embedded microelectronics throughout the vehicle together with the communications network have resulted in control system which very well enhances the vehicle performances covering the aspects like passenger comfort, safety, and environmental effect. In addition to these it also helps improve the performance of the vehicle which can be gained from the development of the software simulation technique which employ a large range of system dynamic models, with the aim of achieving improved vehicle control strategies. Automatic Braking System is a technology for automobiles to sense an imminent collision with another vehicle, person or obstacle or a danger such as high brake or by applying the brakes to slow the vehicle without any driver input. Sensors like radar, video, infrared ultrasonic or other technologies can be used to detect the obstacles. GPS sensors can also be used which can detect fixed dangers such as approaching the stop signs through a location database. While the object is detected in front of the vehicle, the vehicle speed reduces and simultaneously the pneumatic bumper pops out in order to prevent the accident and the damage of the vehicle.

2. Is There a Need for Automatic Brakes in Vehicles?

All the process carried out in this process are without any driver input, so the vehicle with automatic brake isn't to be driven any differently. If the driver is perfectly vigilant, they would never notice that there is an automatic braking system in their vehicle. Automatic brakes can save the life of people travelling in that vehicle. This process is specifically designed as the safeguard against distracted driving, and the technology can also save lives if a driver happens to fall asleep behind the wheel. The number of such very common rear - end accidents can be cut in half by the latest automatic

braking system that first warn of an impending crash and then slam the brakes of the vehicles, according to the Insurance Institute for Highway Safety.

3. Working

The IR sensor is placed before the bumper to detect objects coming in the way of the moving vehicle. The system confirms the speed of the vehicle. The speed of the vehicle or object ahead is to be larger than the speed of the moving vehicle to avoid the collision. If the speed of the vehicle or the object ahead is lesser than the speed of the vehicle there are chances of a very massive collision taking place. In order to provide this collision form taking place, this automatic braking system comes into play. The signal of the IR detector which is connected to the stepper motor which drags the brakes that are connected at the front and rear end of the vehicle. Since the speed of vehicle is traced by the sensors the brakes are applied accordingly. The hardest brake will be applied when the distance between the vehicles is very less. Similarly, less brake will be applied on to the vehicle when the distance between the vehicle and the object or vehicle is more. The range of the brakes to be completely pressed and the vehicle to be completely stopped, the distance between the vehicles and the object that lies ahead can be varied. The program for this process is also set in the control unit. The pneumatic bumper attached ahead is used to save the vehicle from the damage. While the object is detected by the sensor, the pneumatic bumper pops out to save the vehicle. The distance at which the sensor identifies the object or obstacle is to be kept more than the total length of the bumper popping out.1

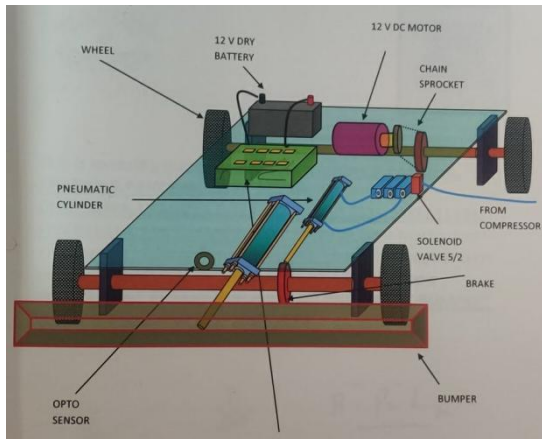


Figure 1: Schematic Diagram of Automatic Braking system with Pneumatic Control

4. Proposed System

The system proposed here consist of many components which includes

- Optical sensor
- Arduino 328 AVR Board
- Gear Motor

Optical sensor: This sensor is used to convert light rays into electronic signals. It will measure the physical quantity of light and then translate it into the form which is readable by the receiver. This sensor helps by reading the gap between two objects and sending the signals to the receiver.

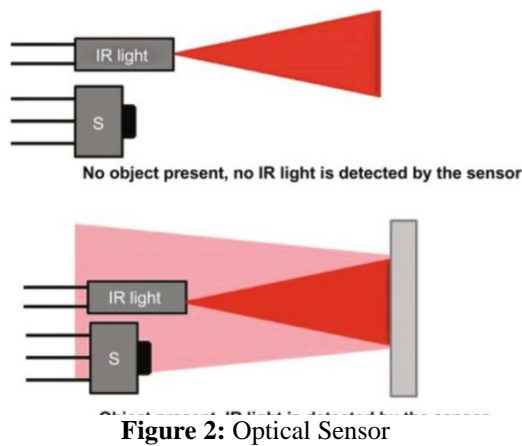


Figure 2: Optical Sensor

Arduino 328 AVR Board: This acts as the receiver. The signal sent by the optical sensor is converted into readable language and is forwarded to the Arduino. The output from this helps in giving the signal ahead to the motor which is basically used to reduce the speed of the vehicle.



Figure 3: Arduino 328 AVR Board

Gear Motor: The signal output from the Arduino is given to the motor. The motor reduces its speed gradually once the signal is received. The belt attached to the pulley fixed on motor shaft will pulled hence reducing the speed of the vehicle.



Figure 4: Gear Motor

Optical sensor plays an important role in this system as it's the part that senses the object appearing in front of the vehicle and helps to gradually stop the vehicle. The brake liner is connected to the pulley which is attached on the moving shaft. Whenever the optical sensor senses the object in front of the vehicle the signals are passed thus the brake liner gets tight and stops the rotating pulley thus stopping the vehicle. The range of the optical senso can be varied according to the need. Generally, it is kept high in order to avoid accidents. The optical sensor sends the signal to the receiver, which senses the signals and transmits it ahead. The autonomous braking system is used to sense the object in front and helps brake down the vehicle speed during object detection.

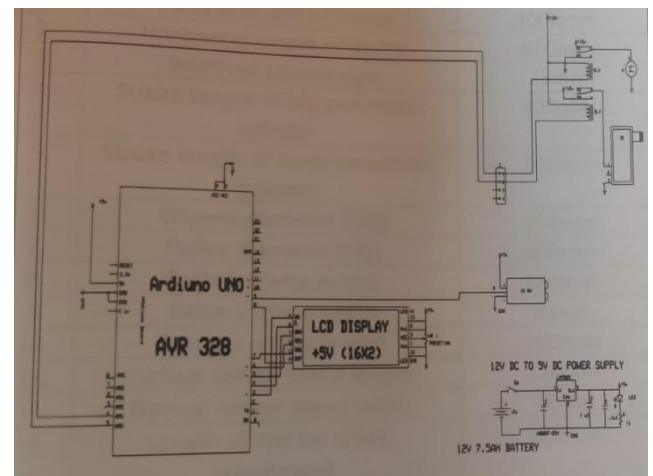


Figure 5: Layout of the control unit

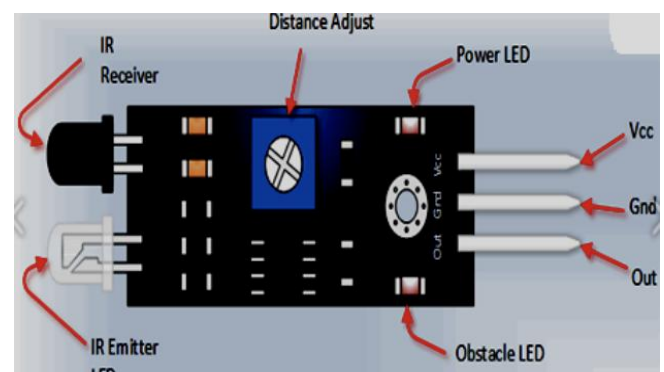


Figure 6: Schematic diagram of control unit

The figure above shows the object detection system which has receiver and transmitter which are used for receiving the signals from the optical sensor. The distance measured varies with the speed of the vehicle or object present in front.²

Pneumatic Bumper

Following are the main components of the pneumatic bumper system:

- Pneumatic Actuator
- Direction Control Valve
- Solenoid Valve
- Limit Switch
- Pneumatic Cylinder

Pneumatic Actuator: This device mainly consists of a piston or a diaphragm which is used to develop the motive power. It helps in keeping the air in the upper portion of the cylinder, allowing air pressure to force the diaphragm or piston to move the valve stem or rotate the valve control element.



Figure 7: Pneumatic Actuator

Direction Control Valve: These are one of the most fundamental parts of hydraulic and pneumatic systems. These allow fluid flow into different paths from one or more sources. It consists of a spool inside a cylinder which is mechanically or electrically actuated. The position of the spool restricts or permits flow; thus, it controls the fluid flow.



Figure 8: Direction Control Valve

Solenoid Valve: Solenoid Valve are the most frequently used control elements in fluids. Their tasks are to shut off, release, dose, distribute or mix fluids. They offer fast and safe switching, high - reliability, long service life, medium compatibility of the materials used, low control power and compact design.



Figure 9: Solenoid Valve

Limit Switch: Limit Switch is used to prevent the travel of an object in a mechanism past some predetermined point, it is mechanically operated by the motion of the object itself.



Figure 10: Limit Switch

Pneumatic Cylinder: Pneumatic Cylinder are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion.



Figure 11: Pneumatic Cylinder

As soon as the sensor senses the obstacle in front of it, the signal is sent to the receiver which will slow down the vehicle. While this process takes place, the signal is also sent to the pneumatic part which is responsible for popping of the pneumatic bumper. The connecting rod is attached to the bumper and the pneumatic cylinder. The force of the reciprocating of the bumper can be changed with this pneumatic bumper.³

Factors Considered while designing the System

1) Sensor range:

The sensor range is to be set such that when the pneumatic bumper completely comes out from its rest position. The minimum distance of the sensor will be the full length of the pneumatic bumper when it comes out from its rest position and the maximum length will be such that the vehicles should reduce its speed gradually and not suddenly.

2) Braking Distance:

The braking distance is considered as the main factor while designing this system since whole of this system is designed for the braking purpose. Braking distance for a particular speed is the distance between the point of application of the brakes and the point at which the vehicle comes to a complete stop from the present speed.

Braking distance = $V^2/2 \mu g m$

Where V - Velocity of vehicle (m/s)

μ - Coefficient of friction of the road = 0.8

g - Acceleration due to gravity = 9.81 m/s^2

In the above mentioned formula the condition of the brakes and the road conditions are not considered for coefficient of friction.4

Advantages of Automatic Braking System with Pneumatic Bumper

- 1) There is huge safety to the external and internal side of the vehicle
- 2) The proper braking of vehicle and proper distance of the vehicle from the obstacle ahead.
- 3) The safety of the car per accident and the safety of the passengers
- 4) Highly effective with simple design

Disadvantages of Automatic Braking System with Pneumatic Bumper

- 1) The system may breakdown if there is no proper programming done for it
- 2) There may be chances of low accuracy if there are any leakages
- 3) As there is pneumatic used, there may be low loading capacity

5. Future Scope

The introduced intelligent braking system is very cheap and affordable to anybody but the actual importance of safety increases the value of this system. Due to this the various changes, modification, new ideas are introduced. So, these automobile industries are about to launching the various intelligent systems to increase safety of customers. There can be many developments on the pneumatic bumper that opens to protect the vehicle from the damage. This pneumatic bumper may open only when the object coming forward would be with the speed greater than 100m/sec to protect the pedestrians from getting severely injured.5

6. Conclusion

This braking system if implemented can save a lot of accidents and will be able to save number of human lives. This system could be made compulsory in order to avoid accidents. The opening of the pneumatic bumper can also add values to the vehicle and can help save the vehicle and the human lives. The future of automotive safety will be much valuable and hence this system could help serve the purpose. The automatic braking system with pneumatic bumper represents a vast change from the traditional approach to safety, but at times could be considered as the fundamental system to achieving substantial benefits.

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