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Automated Reverse Braking System

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Abstract

In this world mechatronics and automation of various systems have been developed just to reduce the time and human error. The automated braking system is a part of mechatronics. Presently the vehicle has alarm system for maintaining the safe distance between moving vehicle. When the vehicle gets too close to the object, the alarm is triggered this warns the driver about an object. But this feature has many problems and is prone to human error. We have developed a model,by using the same sensor system but with the automated breaking pneumatic system which restricts the backward motion of the vehicle. Our aim is to design the system which can avoid the accident in reversing the heavy loaded vehicles like trucks, buses and all the vehicles consisting of pneumatic braking system. For this purpose we have developed a model which consists of pneumatic cylinder, solenoid valve, IR sensors, control unit etc. which serves as the complete mechanism of automated braking system while reversing the vehicles.

Keywords: Pneumatic Cylinder, Solenoid valve, IR Sensors, Control Unit, compressor etc.

Introduction

Stopping safely is one of the most important functions a motor vehicle can performed. Failure of the brake system will almost invariably result in property damage, personal injury, or even death. Consequently, a great deal of consideration has been given to improving the brake system in trucks and passenger cars over the last nine decades. According to *Mr. Willie D. Jones* in the *IEEE SPECTRUM* magazine (September 2001), a person dies in a car crash every second... Automation of the driving control of vehicles is one of the most vital needs of the hour. Various system or methods have been developed and the improvement is still continuous for the safety of Driver, Passengers as well as vehicle.

We are also come along with our new project *'Automated pneumatic Braking System'*. Our project is also for the safety of Driver, Passengers, and vehicle as well as for the obstacle if it is any human being or any important property. The whole body of our project consist of Pneumatic cylinder for the purpose of braking, solenoid valve and IR sensor. It is specially design for the heavy duty vehicle like Trucks, Busses etc. The purpose behind the use of pneumatic cylinder for braking is that pneumatic braking can stop the moving vehicle in 2 to 3 seconds moving at 30 KM. This braking system is fully automatic; hence we name it as 'Automatic pneumatic Braking System'.

Degrees of Automation*:*

Degrees of automation are of two types

I] Full automation.

II] Semi automation.

In semi automation a combination of manual effort and mechanical power is required whereas in full automation human participation is very negligible. Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity.

Need For Automation:

Automation plays an important role in mass production. For mass production of the product, the machining operations decide the sequence of machining. The machines designed for producing a particular product are called transfer machines. The components must be moved automatically from the bins to various machines sequentially and the final component can be placed separately for packaging. Materials can also be repeatedly transferred from the moving conveyors to the work place and vice versa. Nowadays almost all the manufacturing process is being atomized in order to deliver the products at a faster rate. The manufacturing operation is being atomized for the following reasons.

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- To achieve mass production
- To reduce man power
- To increase the efficiency of the plant
- To reduce the work load
- To reduce the production cost and time
- To achieve good product quality
- Less Maintenance.

Literature Review

Safety System

The aim is to design and develop a control system based on pneumatic braking system of an intelligent electronically controlled automotive pneumatic braking system. Based on this model, control strategies such as an 'antilock braking system' (ABS) and improved manoeuvrability via. Individual wheel braking are to be developed and evaluated. There have been considerable advances in modern vehicle braking systems in recent years. For example, electronically controlled ABS for emergency braking, electronically controlled hydraulically actuated individual brake-by-wire (BBW) systems for saloon cars and electronically controlled pneumatically actuated systems for heavy goods vehicles. The model is to be constructed in modular form thus allowing the replacement / interchange of the various blocks and their associated technologies. Upon completion of the full vehicle braking model, sensitivity analyses will be carried out. Once the preliminary simulation model has been thoroughly benchmarked and existing control system strategies evaluated, an audit of the technology used is to take place and this will provide a basis for comparison of iterative technologies / techniques.

The final phase of the new modern vehicle shall include:

- 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.

Pneumatics

The word ‘pneuma’ comes from Greek and means breather wind. The word pneumatics is the study of air movement and its phenomena is derived from the word pneuma. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially the driving and controlling of machines and equipment. Pneumatics has for some considerable time between used for carrying out the simplest mechanical tasks in more recent times has played a more important role in the development of pneumatic technology for automation. Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system supply of compressed air is by means using reciprocating compressor

. The compressibility of the air was first investigated by Robert Boyle in 1962 and that found that the product of pressure and volume of a particular quantity of gas. The equation is given bellow,

i.e., $PV = C$ (or) $P_1V_1 = P_1V_2$

Where, P-pressure

V-volume

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 but air is the mostly used system now a days..

Types of Braking

The brakes for automotive use may be classified according the following considerations.

1. With respect to application,
   a) Foot brake
   b) Hand brake
2. With respect to the method of braking contact,
   a) Internal expanding brakes
   b) External contracting brakes
3. With respect to the method of applying the braking force,
   a) Single acting brake
   b) Double acting brakes.
4. With respect to the brake gear,
   a) Mechanical brake
   b) Power brakes
5. With respect to the nature of power employed,
   a) Vacuum brake
   b) Air brake
   c) Hydraulic brake
   d) Electric brake
6. With respect to power unit,
   a) Cylinder brakes
   b) Diaphragm brake
7. With respect to the number of wheels,
   a) Two wheel brakes
   b) Four wheel brakes
8. With respect to power transmission,
   a) Direct acting brakes
   b) Geared brakes

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The foot brake or service brake is always applied by a pedal, while the parking brake is applied by a hand lever. The parking brake is intended chiefly to hold the car in position. The parking brake can be set in the "ON" position by means of a latch while the service brake remains on only as long as the driver presses down on the pedal. The hand brake is normally used only after the driver has stopped the car by using the foot brake. Its other use is as an emergency brake to stop the car if the foot brake system should fail. The hand or parking brakes operates on a pair of wheels, frequently the rear wheels. When drum type rear brakes are used, the same shoes can be used for both hand and foot control. The drum type of brake may either be a band brake or a shoe brake. Both band brakes and shoe brakes may be either external or internal. The band brakes generally are external and shoe brakes internal. In drum brakes the drum is attached to the wheel and revolves with it. Friction to slow the drum is applied from inside by the shoes which do not rotate but are mounted on a stationary metal back plate..

Disc brakes do the job more efficiently, for the cooling air can get to the rubbing between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates etc. Passages are drilled in the calliper for the fluid to enter or leave the each housing. These passages are also connected to another one for bleeding. Each cylinder contains a rubber selling ring between the cylinder and the piston. The brakes are applied, hydraulically actuated piston move the friction pads into contact with the disc, applying equal and opposite forces on the later. On releasing the brakes, the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc. Now let us see in detail about different braking systems in automobiles.

Mechanical Brake:

In a motor vehicle, the wheel is attached to an auxiliary wheel called drum. The brake shoes are made to contact this drum. In most designs, two shoes are used with each drum to form a complete brake mechanism at each wheel. The brake shoes have brake linings on their outer surfaces. Each brake shoe is hinged at one end by on anchor pin; the other end is operated by some means so that the brake shoe expands outwards. The brake linings come into contact with the drum. Retracting spring keeps the brake shoe into position when the brakes are not applied.

Hydraulic Brakes:

The hydraulic brakes are applied by the liquid pressure. The pedal force is transmitted to the brake shoe by means of a confined liquid through a system of force transmission. The force applied to the pedal is multiplied and transmitted to brake shoes by a force transmission system. This system is based upon Pascal's principle, which states that "The confined liquids transmit pressure without loss equally in all directions". It essentially consists of two main components – master cylinder and wheel cylinder the master cylinder is connected by the wheel cylinders at each of the four wheels. The system is filled with the liquid under light pressure when the brakes are not in operation. The liquid is known as brake fluid, and is usually a mixture of glycerine and alcohol or caster-oil, denatured alcohol and some additives

Air Brake

Air brakes are widely used in heavy vehicle like buses and trucks which require a heavier braking effort that can be applied by the driver's foot. Air brakes are applied by the pressure of compressed air, instead of foot pressure, acting against flexible diaphragms in brake chamber. The diaphragms are connected to the wheel brakes. These diaphragms are controlled through a hand or foot operated valve. The brake valve controls brake operation by directing the flow of air from a reservoir against diaphragms in the brake chamber when the brakes are applied and from brake chambers to tube atmosphere when the brakes are released. The air compressor, driven by the engine furnishes compressed air to the reservoir fall below a set valve.

Electric Brake

Electric Brakes are also used in some motor vehicles, although these are not very popular. Warner electric brake is one of the examples of such brakes. An electric brake essentially consists of an electromagnet within the brake drum. The current from the battery is utilized to energize the electromagnet, which actuates the mechanism to expand the brake shoe against the brake drum, thus applying the brakes. The severity of braking is controlled by means of a rheostat, which is operated by the driver through the foot pedal. Electric brakes are simpler.

Vacuum Brakes / Servo Brakes

A serve mechanism fitted to the braking system reduces the physical effort the driver has to use on the brake pedal most servo mechanisms are of the vacuum assistance type. A pressure differential can be established by subjecting one side of the piston to atmospheric pressure and the other side to a pressure below atmospheric pressure by exhausting air from the corresponding end of the servo cylinder.

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Sensor

A sensor is a device that responds to physical stimulus (heat, light, sound, pressure, motion, and flow) and generate electrical signal that can be measured or interpreted. It 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. The active element of a sensor is referred to as a transducer. Sensors works by converting some physical parameter into an electrical signal

- Sensor - to measure the quantity
- Transducer - to convert signals from one form to another form

Care should be taken in the choice of sensory devices for particular tasks. The operating characteristics of each device should be closely matched to the task for which it is being utilized. Different sensors can be used in different ways to sense same conditions and the same sensors can be used in different ways to sense different conditions.

Choosing a sensor:

A sensor is choose on the basis of following properties

- Accuracy
- Calibration
- Environmental range
- Repeatability
- Resolution
- Cost

Types of Sensor

I] Active and Passive Sensors
II] Solid State Sensors
III] Laser sensors
IV] Optical sensor
V] IR Sensors

Components aqnd Description

The SYSTEM consists of the following components to fulfil the requirements of complete operation of the machine.

- PNEUMATIC DOUBLE ACTING CYCLINDER
- SOLENOID VALVE
- FLOW CONTROL VALVE
- IR SENSOR UNIT
- WHEEL AND BRAKE ARRANGEMENT
- STAND
- AIR TANK (COMPRESSOR)

Pneumatic Double Acting Cylinder

The cylinder is a DOUBLE acting cylinder one, which means that the air pressure operates forward and s backward. The air from the compressor is passed through the regulator which controls the pressure to required amount by adjusting its knob. A pressure gauge is attached to the regulator for showing the line pressure. Then the compressed air is passed through the Double acting 5/2 solenoid valve for supplying the air to one side of the cylinder. One hose take the output of the directional Control (Solenoid) valve and they are attached to one end of the cylinder by means of connectors. One of the outputs from the directional control valve is taken to the flow control valve from taken to the cylinder. The hose is attached to each component of pneumatic system only by connectors.

Technical details of pneumatic cylinder are as follows:

Piston Rod	: M.S. hard Chrome plated
Seals	: Nit rile (Buna – N) Elastomer
End Covers	: Cast iron graded fine grained
	from 25mm to 300mm
Piston	: Aluminium
Media	: Air
Temperature	: 0^0c to 85^0c

Parts of Pneumatic Cylinder

I] Piston
II] Piston Rod
III] Cylinder Cover Plates
IV] Cylinder Mounting Plates

I] Piston

The piston is a cylindrical member of certain length which reciprocates inside the cylinder. The diameter of the piston is slightly less than that of the cylinder bore diameter and it is fitted to the top of the piston rod. It is one of the important parts which convert the pressure energy into mechanical power. The piston is equipped with a ring suitably proportioned and it is relatively soft rubber which is capable of providing good sealing with low friction at the operating pressure. The purpose of piston is to provide means of conveying the pressure of air inside the cylinder to the piston of the oil cylinder. Generally piston is made up of **Aluminium alloy**-light and medium work **Brass** or **bronze** or **CI-Heavy duty** the piston is double acting type. The piston moves forward when the high pressure air is turned from the right side of cylinder. The piston moves backward when the solenoid valve is in OFF condition. The piston should be as strong and rigid as possible. The efficiency and economy of the machine primarily depends on the working of the piston. It must operate in the cylinder with a minimum of friction and should be able to

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withstand the high compressor force developed in the cylinder and also the shock load during operation.
The piston should posses the following qualities:

- The movement of the piston should not create much noise.
- It should be frictionless.
- It should withstand high pressure.

II] Piston Rod

The piston rod is circular in cross section. It connects piston with piston of other cylinder. The piston rod is made of mild steel ground and polished. A high finish is essential on the outer rod surface to minimize wear on the rod seals. The piston rod is connected to the piston by mechanical fastening. The piston and the piston rod can be separated if necessary. One end of the piston rod is connected to the bottom of the piston. The other end of the piston rod is connected to the other piston rod by means of coupling. The piston transmits the working force to the oil cylinder through the piston rod. The piston rod is designed to withstand the high compressive force. It should avoid bending and withstand shock loads caused by the cutting force. The piston moves inside the rod seal fixed in the bottom cover plate of the cylinder. The sealing arrangements prevent the leakage of air from the bottom of the cylinder while the rod reciprocates through it.

Solenoid Valve with Control Unit:

The directional valve is one of the important parts of a pneumatic system. Commonly known as DCV, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its internal movable parts. This valve was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve. A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one in which the plunger is pulled when the solenoid is energized.
Technical details of the solenoid valve as follows:

Pressure	:	0 to 7 kg / cm^2
Media	:	Air
Type	:	5/2
Applied Voltage	:	24 V D.C
Frequency	:	50 Hz

Parts of a Solenoid Valve

I] Coil
II] Frame
III] Solenoid Plunger

I] Coil

The solenoid coil is made of copper wire. The layers of wire are separated by insulating layer. The entire solenoid coil is covered with a varnish that is not affected by solvents, moisture, cutting oil or often fluids. Coils are rated in various voltages such as 115 volts AC, 230 volts AC, 460 volts AC, 575 Volts AC, 6 Volts DC, 12 Volts DC, 24 Volts DC, 115 Volts DC & 230 Volts DC. They are designed for such frequencies as 50 Hz to 60 Hz.

II] Frame

The solenoid frame serves several purposes. Since it is made of laminated sheets, it is magnetized when the current passes through the coil. The magnetized coil attracts the metal plunger to move. The frame has provisions for attaching the mounting. They are usually bolted or welded to the frame. The frame has provisions for receivers, the plunger.

III] Solenoid Plunger

The Solenoid plunger is the mover mechanism of the solenoid. The plunger is made of steel laminations which are riveted together under high pressure, so that there will be no movement of the lamination with respect to one another. At the top of the plunger a pin hole is placed for making a connection to some device. The solenoid plunger is moved by a magnetic force in one direction and is usually returned by spring action. Solenoid operated valves are usually provided with cover over either the solenoid or the entire valve. This protects the solenoid from dirt and other foreign matter, and protects the actuator. In many applications it is necessary to use explosion proof solenoids.

Working of 5/2 Single Acting Solenoid Valve

The control valve is used to control the flow direction is called cut off valve or solenoid valve. This solenoid cut off valve is controlled by the emergency push button. The solenoid valve consists of electromagnetic coil, stem and spring. The air enters to the pneumatic solenoid valve when the push button is in ON position. A stem connects the closure device to the control element of the actuator. The spring acting on the control element forces the closure device down into the closed position on the valve seat. The pilot supply overcomes the spring force to lift the control element into the open position. These valves are mainly suitable for contaminated or extremely

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viscous process fluid. In this project we are supplying the signal to solenoid valve.

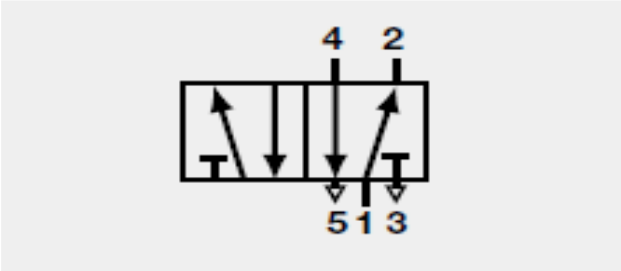

Figure 3.4: Circuit diagram of 5/2 Single Acting Solenoid Valve

Flow Control Valve

This valve is used to speed up the piston movement and also it acts as a 1- way restriction valve which means that the air can pass through only one way and it can't return back. By using this valve the time consumption is reduced because of the faster movement of the piston.

Technical details of flow control valve as follows:

Size : ¼"
Pressure : 0 to 10 kg / cm^2
Media : Air

IR Sensor Units

The IR sensor unit mainly consists of

- IR transmitter unit
- IR receiver unit
- Step down transformer

The IR transmitter and IR receiver circuit is used to sense the obstacle. It is fixed to the back side of the frame stand with a suitable arrangement. The pneumatic cylinder is controlled by the flow control valve, single acting solenoid valve and control unit. The step down transformer is used to reduce the input voltage.

IR transmitter:

When AC voltage is supplied to the IC 555 timer it generates pulse and send to BD140 transistor where it amplifies and produces IR rays through LED.

IR receiver:

If there is any obstacle then rays are reflected which is received by the receiver unit and it send the signal to solenoid valve through relay RL1.

Wheel and Braking Arrangement

The simple wheel and braking arrangement is fixed to the frame stand. Near the brake drum, the pneumatic cylinder piston is fixed. In our project we are using a scooty wheel with internal expanding type brake shoe.

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.

Compressor (Air Tank)

A compressor is a machine that compresses air or another type of gas from a low inlet pressure (usually atmospheric) to a higher desired pressure level. This is accomplished by reducing the volume of the gas. Air compressors are generally positive displacement units and are either of the reciprocating piston type or the rotary screw or rotary vane types. The compressed air was stored in air tank from which air flows to the cylinder through hoses.

Working Principle

The whole system operates only when the car is moving in reverse direction. So when we shift the reverse gear, power supply is given to the sensor unit. In the sensor unit, **IR TRANSMITTER** circuit will transmit the Infra-Red rays. If any obstacle is there in a path, the Infra-Red rays reflected. This reflected Infra-Red rays are received by the receiver circuit is called "**IR RECEIVER".** If there is no obstacle in a path, the receiver circuit will not receive any signal and the whole system remains as it is. The IR receiver circuit receives the reflected IR rays and giving the control signal to the control circuit. The control circuit is used to activate the solenoid valve. The operating principle of solenoid valve is already explained in the above chapter. If the solenoid valve is activated, the compressed air passes to the double acting pneumatic cylinder. The compressed air activates the pneumatic cylinder and moves the piston rod. If the piston moves forward, then the braking arrangement activated. The braking arrangement is used to brake the wheel gradually or suddenly due to the piston movement. The braking speed is varied by adjusting the valve is called **"FLOW CONTROL VALVE".** In our project, we have to apply this braking arrangement in one wheel as a model. The compressed air drawn from the compressor in our project.The compressed air flow through the Polyurethane tube to the flow control valve. The flow control valve is connected to the solenoid valve. The Polyurethane tube is connected to cylinder and solenoid valve by means of connectors. This system is mentioned in the diagram

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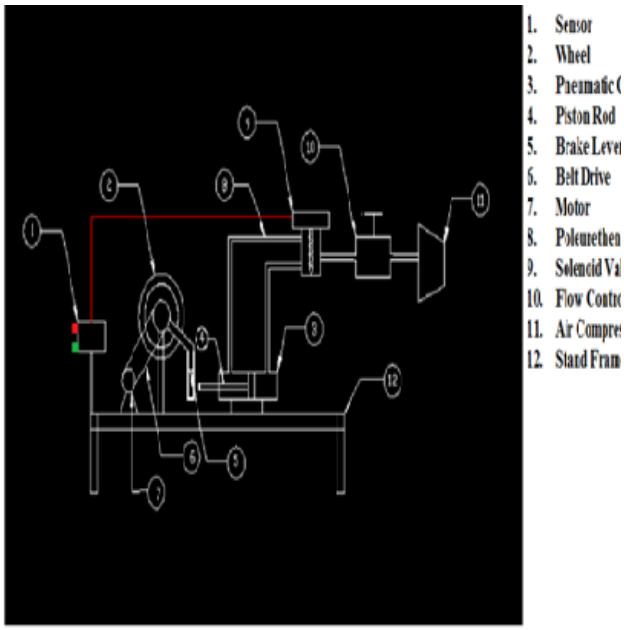

Figure 4.1 : Automated Braking System

Applications

- For automobile application
- Industrial application

Advantages

- Brake cost will be less.
- Free from wear adjustment.
- Less power consumption
- Less skill technicians is sufficient to operate.
- It gives simplified operation.
- Simple in Installation
- To avoid other burnable interactions viz.… (Diaphragm) is not used.
- Less time and more profit.
- To avoid small accidents while parking or reversing the car.

Conclusion

The whole system works only while reversing the vehicle. When the sensor senses any obstacle behind the vehicle, it sends signal to the control unit (solenoid valve and flow control valve) which allows the passage of air from the compressor to the pneumatic cylinder which push the piston forward and results in stopping the running wheel. Thus we have developed an **"AUTOMATED PNEUMATIC BRAKING SYSTEM"** which helps in understanding, how to achieve low cost automation. The application of pneumatics produces smooth operation.

Collision detection and avoidance systems should become more commonplace with the passage of time. People are living in a networked world and constantly feel that they have less time on their hands. To perfect this technique, it might take several years, but this project is surely a step in the right direction. Prevention is better than cure. So instead of treating patients after an accident, accidents should be prevented by incorporating this system. This project is very feasible as very less expensive parts are used. This project can be improved upon in many ways.

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