Sensor Assisted 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.**

1 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. 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 'Sensor Assisted Reverse Braking System".

Degrees of Automation:

Degrees of automation are of two types

1. Full automation.
2. 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.

- 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

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2. 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 maneuverability 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 electrohydraulic-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) $P_1V_1 = P1V2$ 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. [6] proposed a system, this fully automatic vehicle is equipped by micro controller, motor driving mechanism and battery. The power stored in the battery is used to drive the DC motor that causes the movement to AGV. The speed of rotation of DC motor i.e., velocity of AGV is controlled by the microprocessor controller.This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

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:

3. COMPONENTS AND 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

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- 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 Single acting 3/2 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 : 00c to 850c

Parts of Pneumatic Cylinder

1. Piston
2. Piston Rod
3. Cylinder Cover Plates
4. Cylinder Mounting Plates

1. 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 withstand the high compressor force developed in the cylinder and also the shock load during operation.

2. 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.

3. 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.

Parts of a Solenoid Valve

1. Coil
2. Frame
3. Solenoid Plunger

1. 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.

2. 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

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bolted or welded to the frame. The frame has provisions for receivers, the plunger.

3. 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 3/2 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 viscous process fluid. In this project we are supplying the signal to 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 / cm2
Media : Air

IR Sensor Units

The IR sensor unit mainly consists of

- IR transmitter unit
- IR receiver unit

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 to a higher desired pressure level. This is accomplished by reducing the volume of the gas. The compressed air was stored in air tank from which air flows to the cylinder through hoses

4. 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

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connected to the solenoid valve. The Polyurethane tube is connected to cylinder and solenoid valve by means of connectors.

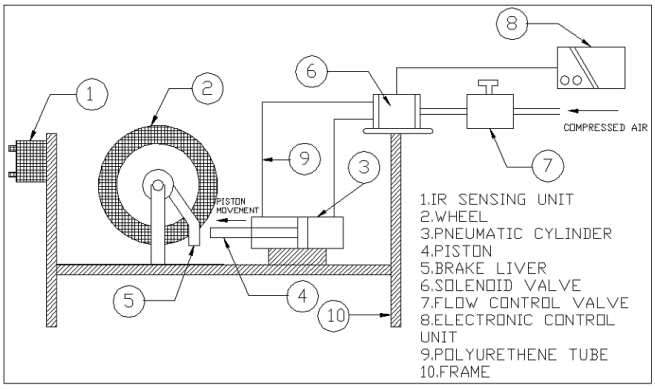

Fig .no: 4.1 CIRCUIT DIAGRAM OF SENSOR ASSISTED RVERSE BRAKING SYSTEM

Applications

- For automobile application
- Industrial application

Advantages

- Free from wear adjustment.
- Less power consumption
- Less skill technicians is sufficient to operate.
- It gives simplified operation.
- Simple in Installation.
- Less time and more profit.
- To avoid small accidents while parking or reversing the car.

5. 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 "SENSOR ASSISTED REVERSE BRAKING SYSTEM" which helps in understanding, how to achieve low cost automation. The application of pneumatics produces smooth operation.

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