BRAKE FAILURE DETECTION WITH AUXILARY BRAKING SYSTEM IN CARS

JAVED AHMED.K, SHRI RAM.K.S, AKSHAY KUMAR.B, SANTOSH.J

Department of Mechanical & Electrical Engineering Jeppiaar Engineering College
E-mail: javedmech94@gmail.com, shriram0904@gmail.com, kumarakshay121@yahoo.com, santhu291shankar@gmail.com

Abstract- Brakes are implemented in cars to stop the vehicle. The increase in number of deaths and accidents is due to brake failure. Brake failures mainly occur due to brake lining failures and results in pressure loss. The aim of our paper is to diagnose faulty braking system and application of an auxiliary secondary braking system in case of brake failures. We can achieve it by using sensors and dual braking units. A pressure transducer sensor monitors the pressure in brake lining. When the primary hydraulic disc brake fails, the sensor detects the pressure loss and gives warning signal to the driver and also activates power supply to the secondary braking unit which is a hub motors in rear wheels. This functions as a secondary braking unit and helps the driver to stop the vehicle and thus ensures safety of the passengers.

I. INTRODUCTION:
The main purpose of this paper is to ensure drivers safety by using a dual braking system. A brake is a mechanical device that inhibits motion by slowing down a body or by slowing it. Brakes retard the motion of a body creating friction between two working surfaces and converts the kinetic energy of the moving body into heat. Brakes are generally applied to moving as well as tyers. Sometimes brake failure may occur when the brake lining is cutoff. And the brake fluid leaks out causing pressure loss and hence the brake shoes does not apply the required pressure on the discs.

The pressure loss can be detected by a pressure sensor. Pressure sensor functions as a transducer. Transducers produce electric signals as output. The output from the pressure transducer goes to the comparator. The comparator has a reference value of the pressure.

The electric signals generated by the pressure transducer is a function of the pressure. The comparator compares the pressure value with the reference value. If the value is different from the reference value, the value is sent to relay.

A relay is an electrically operated switch. Relays are used to control a circuit by a low power unit with isolation from control circuit as well as the controlled circuit. The relay receives the electric signals from the comparator. The relay is connected to battery at one end and auxiliary braking unit at the other end. The relay connects the power source to the auxiliary braking unit.

II. AUXILARY BRAKING UNIT:
The auxiliary braking unit is used as secondary braking unit when the primary hydraulic disc brake of the vehicle fails. The secondary brakes receive power from battery. The secondary braking unit is a hub motor unit present at both the wheels of the rear axle.

The hub motor also called as wheel hub drive is an electric motor incorporated into the wheels of the vehicle. Hub motors have their highest torque when they start.

When the relay receives positive value from comparator, it connects the power source to the hub motor. The hub motor rotates in a direction opposite to the direction of rotation of the wheels.

Therefore the hub motor provides negative torque to the wheels and retards the output power of the wheels. Thus the wheels are slowed down and the vehicle is stopped. Figure 1 represents the creo model of primary and auxiliary braking system.

III. LIST OF COMPONENTS:
- Differential Pressure transducer
- IC 741
- JK flipflop IC 7474
- Electrostatic relay
- 12V Battery
- ½ HP Hub motor

Figure 1
IV. WORKING OF THE SETUP

Figure 2 represents logical and control system for the Auxiliary braking system. A hydraulic disc brake uses hydraulic brake fluid to apply pressure on the brake disc and stops the vehicle. In case a brake failure occurs, due to pressure loss, the brake will fail. But here the pressure loss is detected by the differential type transducer. The transducer sends a voltage signal to the analog comparator. The analog comparator used here is IC741.

The voltage signal is a function of the existing pressure at the brake lines. The comparator has a reference value. The comparator compares the reference value with the measured value. If there is no difference in the values the comparator sends no value. But if the measured pressure value is less than the reference value, a pulse is sent to the JK Flipflop. The Flipflop stores the current value and sends a continuous current to the relay. The relay triggers the parking light, indication light and supplies to the field winding DC shunt motor. The indication light informs the driver that the brake failure has occurred. The indicator lights inform the outsiders that brake failure has occurred in the vehicle so that they take necessary steps to help the driver to maneuver the vehicle to a safe spot with the help of the auxiliary braking system preventing any damage to life and property. The auxiliary brake is activated by a push button and it is activated by the driver.

The current generated by the shunt motor is isolated from the control system by the relay. Figure 4 represents the symbolic diagram for electromagnetic relay. Shunt motor is a DC motor which consist of field winding and armature winding. This motor can be used in regenerative mode. In this mode motor acts as generator and power is supplied from the motor. To When the relay is switched the field winding is excited and a braking effect is produced. The kinetic energy is converted into electrical energy and can be stored in the battery. Power electronics controller is employed to condition the output of the motor and to charge the battery.

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The Auxiliary Braking system was implemented in the formula race car designed and fabricated for SUPRA SAE 2014 event. Figure 5 shows the pressure transducer arrangement in the master cylinder of the car.

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Figure 6 represents the primary braking system and the hub motor arrangement for the auxiliary braking system.
V. CALCULATIONS:

Force calculation for braking system:

\[ T = \frac{P \times 60}{2 \pi N} \text{ in N/m} \]

\[ \text{Force} = \frac{T}{R} \]

Where

- \( P \): power in W
- \( N \): Speed in rpm
- \( T \): Torque in N/m
- \( R \): radius in m

The rated power of the hub motor is 745.68 W.
The rated speed is 1500 rpm.

\[ T = \frac{745.68 \times 60}{2 \times \pi \times 1500} = 4.749 \text{ N/m} \]

\[ F = 25 \text{ N} \]

The force of 25 N is applied on each of the rear wheels. Hence the net braking force is 50 N.

This force is sufficient to maneuver the vehicle and safely stop the vehicle and prevent accidents.

MERITS:

- The safety of driver is ensured
- The regenerative braking recovers energy and stores it in battery.
- Brake failure is notified to the surrounding traffic via parking lights.
- The cost is low

CONCLUSION:

This setup reduces the accidents and prevents loss of life. Auxiliary braking gives additional capability to the driver and to ensure prevention of damage to life and property.

REFERENCES:

[1] www.engineersedge.com

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