Journal of Applied Technology and Innovation (eISSN: 2600-7304)
vol. 1, no. 2, (2017), pp. 58-66

Alternative Emergency Braking System for Vehicles

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Abstract **-** The main aim of this project is to develop an alternative emergency braking system and brake failure identifier for vehicles. In this proposed method, an eddy current braking is used for alternative emergency braking system and the brake failure is identified by placing the ultrasonic sensor opposite to brake pads of the vehicles, that detects the thickness of the brake pad and notifies the driver with a visual and audible alert if there is a tear or brake pads are detached. The performance of the alternative emergency braking system is evaluated with different tests the first test is using aluminium and copper disk; and second test is of different magnets that is neodymium and ferrite magnet. The time taken for the speed of the motor to reduce the speed is up to 65% in 5 seconds using the aluminium disk and neodymium magnet. However, the speed reduction of the motor is only 50% in 5 seconds of time using the copper disk and ferrite magnet. Overall, the system proved to be very accurate in terms of braking efficiency and braking force generated by the eddy currents when the aluminium disk and neodymium magnet is used.

Index Terms **–** Emergency braking system, Eddy current braking, Brake failure identification

1. Introduction

Due to the rapid advance of technology our society and environment has been influenced greatly. In this era of time, one of the most crucial areas that consist of the advancement of technology is the automobile industry which has made travelling easier than ever with such short span of time. Even with such an advanced technology in Automobile industry there is still certain things that need to be improved to make the travelling much safer and reliable.

Over the years in an automobile industry there are many incidents reported of vehicle accidents due to the main brake failure of the car. One of the scariest things that can happen while driving is the brake failure, we apply the brake pedal and it goes all the way down as nothing is there (Smit et al., 2015). The brake failure can occur without any warning to the driver and can lead to anxiety, a feeling of worry and losing the control on steering wheel due to the highly panic situation (Oduro, 2012).

Improvements to road designs continue to reduce the number and sovereignty of vehicle accidents on our roads, improvements are made through the use of new active safety technologies design to help prevent accidents. Many good vehicles are fitted with lane departure warning system, to alert driver if they stray out of their lanes, an advanced emergency braking system that warns the driver if their truck is on a collision course with a slow moving or stationary vehicle ahead, and if necessary the advanced emergency braking system will automatically apply the brakes (Smit et al., 2015).

Despite having these advanced systems in an automobile industry there are no alternative emergency braking systems which can be used to stop the car in case of main car brake failure, which can be due to the worn out of the brake shoe or cut in the brake liner of the car.

This paper focus on developing an alternative braking system for vehicles which will stop the vehicle when there is a failure in the main braking system of the vehicle. This system will have the ability to identify the brake failure using different sensors. The system is designed to give the driver a visual and audible alert of the brake failure so that the driver can be ready to use the alternative system when required or can avoid speeding more and limiting the chances of malfunction.

2. Materials and Methods

To develop and construct the brake failure identifying and activating the alternative brake system, certain analysis of the development and construction requirements of the system must be emphasized. The system to be developed and constructed following are the mandatory requirements.

- Ultrasonic Sensor
- Aluminum Disk sheets
- Neodymium Magnets

- Bearings attached to the rotating steel rods.
- Arduino IDE software
- DC motor
- Buzzer
- Arduino Uno Board
- New Brake pads
- Old brake pads (torn)
- LED

The software part of the system has been done for the construction of the brake failure identifier. Whereas, for the alternative braking system there is no software part and it only comprises of hardware components, however, for the brake failure identifier has both the software and hardware.

2.1 Methodology for Brake Failure Identifier

The software used to program the brake failure identifier is Arduino IDE. For the hardware part, it comprises of Arduino UNO, 220 ohm resistor, breadboard, Ultrasonic sensor, LED and a buzzer. The software Arduino IDE helps programming for many applications (Venkatachalapathi & Mallikarjuna, 2016). The programming done for this project is to identify and notify the drivers in case of brake failure chances.

The ultrasonic sensor is connected to breadboard which measures the distance and alerts the user if brake pad thickness is lesser than normal defined length. For notifying the user LED and buzzer is connected which gives an audible and visual alert to the driver in case of brake failure.

2.3 Methodology of Alternative Emergency Braking System

The construction of the alternative braking system has the gears, bearings rotating rod, neodymium magnet, aluminum sheets, 24V dc motor and external voltage supply for dc motor. The dc motor is connected to one of the gear and the other gear is connected to the rotating rod this provides the rotational movement.

The bearing has been connected to allow the smooth rotation of the rod, the placing of the bearing was in the center of the two wood blocks which allows the passing of the rod from the center. The tightening nuts were connected to the bearing that gives stability to the high speed rotation of the rod.

The braking pads has been placed in the same base as the alternative brake system. There are two braking pads that are used one is completely torn and other is the new braking pad. Both the braking pads are placed and checked if the system identifies and notify the user with audible and visual alert.

3. Results and Discussion

The objectives of the project are achieved successfully, the results obtained for both the systems alternative emergency braking and brake failure identifier will be discussed in detail.

3.1 Results of Brake Failure Identifier

Figure 1 shows the brake fail identifier system, when there are new brake pads placed the LED is off. Hence, there is no need for activating the alternative brake system.

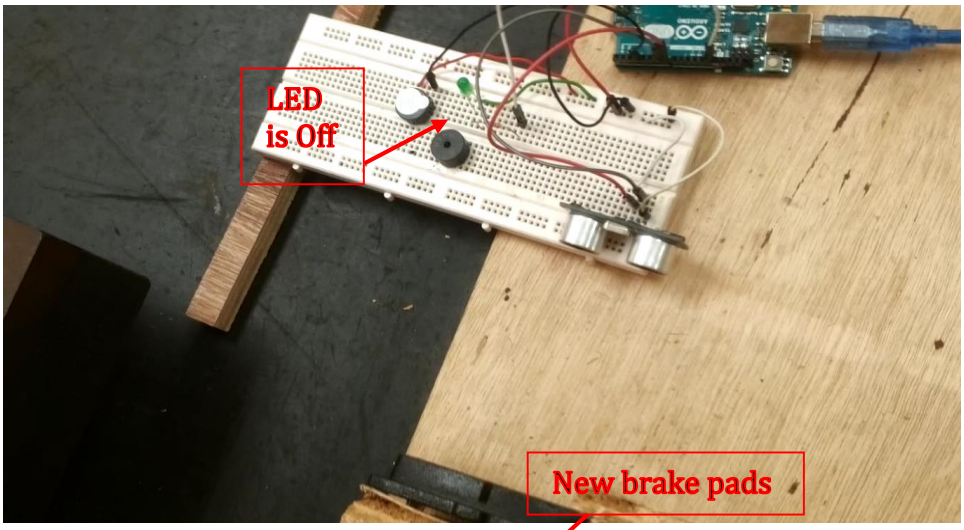

Figure 1: LED off with new brake pads

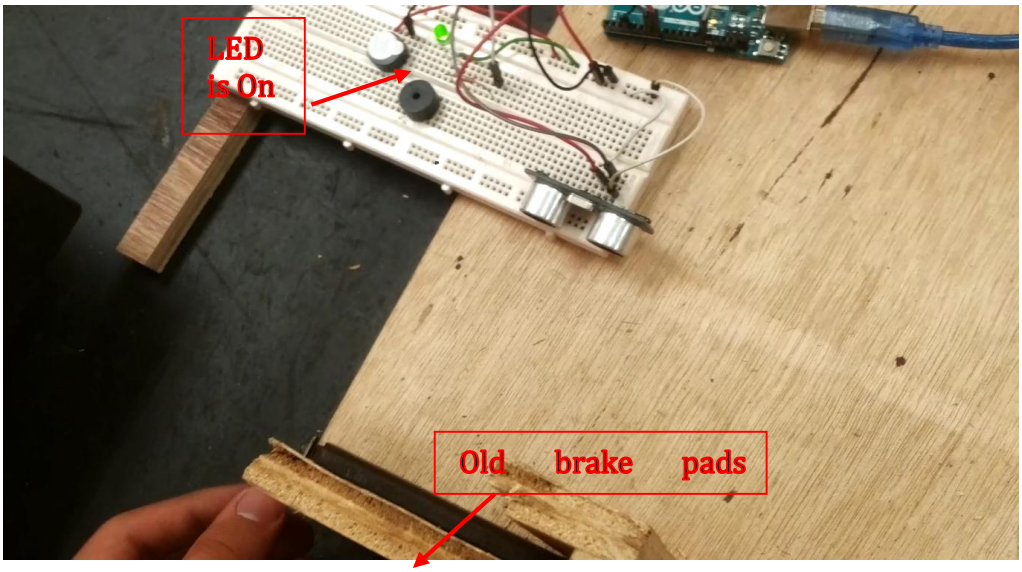

Figure 2: LED on with torn brake pads

Figure 2 shows the system has detected the danger and LED is on because the brake pads placed are the old ones with completely torn brake pad. This gives the user a visual and audible alert, since, this is just the picture the buzzer sound cannot be proved to be in working condition but a demonstration video has been recorded and will be demonstrated during the presentation.

3.2 Results of Alternative Emergency Braking System

The alternative brake system hardware is shown in the Figure 3, and it can be said that the higher the speed of the motor the higher the braking force is applied by the eddy currents.

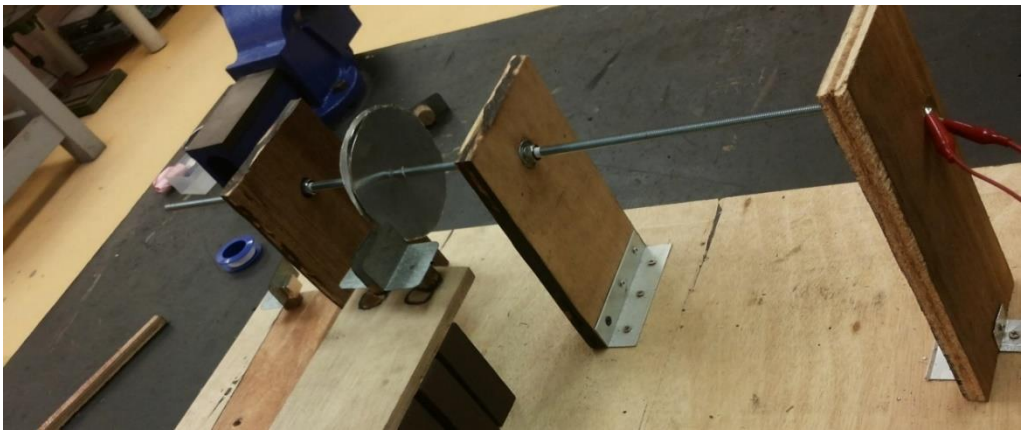

Figure 3: Hardware of alternative braking system

4. Testing of the System

To test the efficiency and effectiveness of the system five different tests are done with collected data. The data analysis of the results obtained are done with the help of graphs and experiment explanation is also given below of the two tests (Kumar, Ibraheem & Sharma, 2014).

4.1 Different non-conductive materials used for disk

The copper disk was attached to the steel rod and neodymium magnets were placed aligned at 2 cm apart and when the 24V dc motor was turned on the neodymium magnet was brought almost 0.5 cm closer to the copper disk, which is to determine the deceleration speed of the motor.

a) Data Collection

For the proposed method, the data collection is shown in Table 1.

Table 1: Braking force Copper versus Aluminum disk

Time (sec)	Copper (km/h)	Aluminum (km/h)
1	80	80
2	75	71
3	65	56
4	55	43
5	50	30

b) Data Analysis

As it can be seen in Figure 4 that the speed of the DC motor is reduced more than 50% that is 80km/h to 28 km/h in 5 seconds when aluminum is used and when copper disk is used the deceleration taken in 5 seconds is from 80 km/h to 48 km/h.

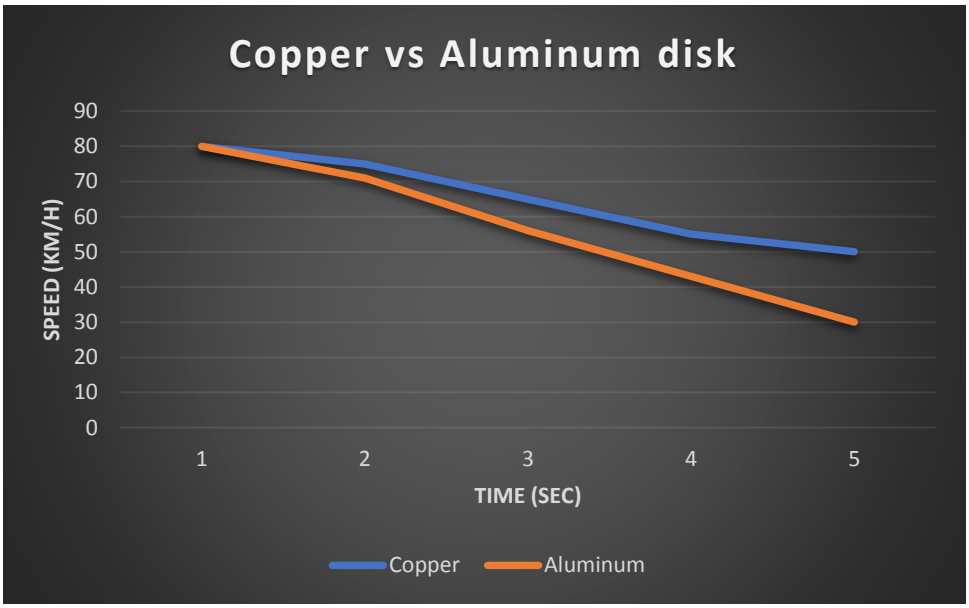

Figure 4: Speed variation with time (for Copper & Aluminum)

4.2 Distance between magnet and aluminum disk

The aluminum disk was attached to the steel rod and neodymium magnets were placed aligned and tested with three different distances apart. Then the 24V dc motor was switched on to determine the deceleration speed of the motor at different distances between disk and magnet

a) Data Collection

For the proposed method, the data collection is shown in Table 2.

Table 2: Distance between magnet and disk

Time (sec)	Distance 1.5 cm (km/h)	Distance 1 cm (km/h)	Distance 0.5 cm (km/h)
1	60	60	60
2	59	58	50
3	58	55	40
4	57	52	32
5	55	48	25

b) Data Analysis

Figure 5 shows the deceleration speed of the dc motor; the speed of the dc motor is monitored with three different distances between the disk and a magnet. The test with the closest distance that is 0.5cm gives the most efficient results in terms of braking torque generated. The result with 1.5cm distance shows only reduction of 10% speed within 5 seconds. Therefore, the closest the distance is between the disk and magnet, the higher the braking force will be generated to reduce the speed up to 60% within 5-6 seconds of time.

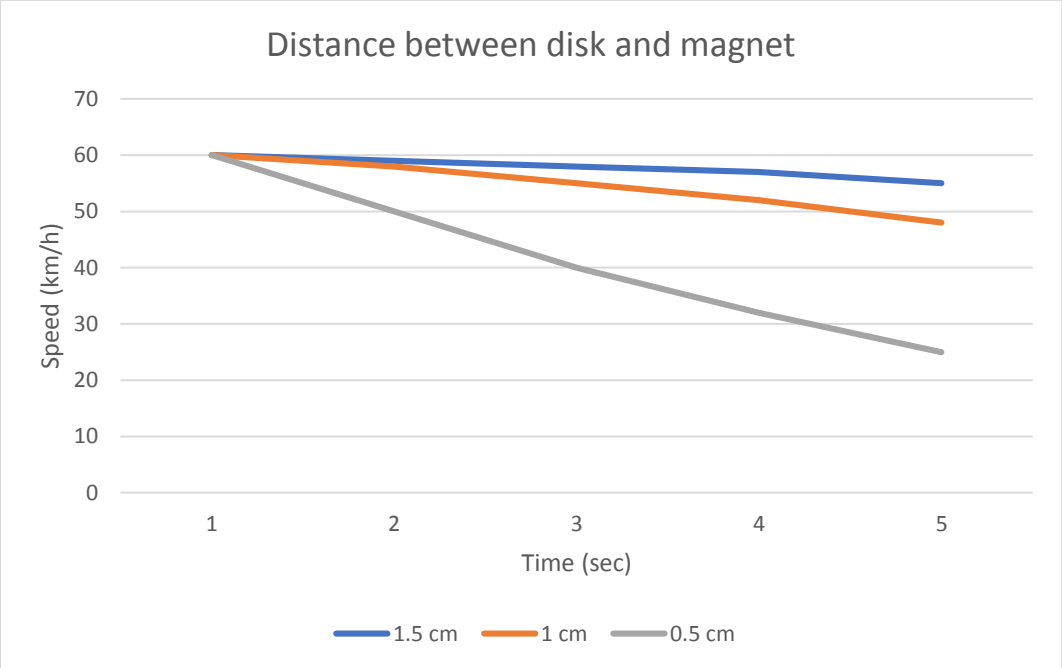

Figure 5: Distance between disk and magnet

4.3 Limitations of the Project

The magnetic brake method, which works on the principle of producing eddy currents is restricted to its magnetic braking force based on the speed of the motor, the lower the speed of the motor, the lower the braking force; and higher the speed of the motor, the higher the braking force will be applied. Therefore, the vehicle that is moving at low speed the less braking force will be applied and hence more chances of collision at lower speeds.

4.4 Recommendation to the Project

The auto-tire locking system can be installed to the tires as the magnetic brake reduce the speed of the car up to certain limit and then the auto-tire lock system will be activated (Christoph, Frank & Horst, 2015). Therefore, following and adhering the recommendations will have a positive impact to the overall braking system.

5. Conclusions

In conclusion, the alternative emergency braking system is being implemented to overcome the accidents caused due to the primary brake failure of the vehicles. However, the main reason of failure is due to the mechanical friction tear of the brake pads or cut in the brake liner. The system being implemented in this project is using the eddy current braking system that does not involve the mechanical friction, hence, the chances of accidents will be reduced.

For the driver to know the brake failure a program is developed in such a way that detects the torn of brake pads or cut in brake liner and notifies the driver with audible and visual alert. Statistical results show that the speed of the car is reduced up to 65% as soon as the alternative braking system is activated, however, further research and contribution from various researchers can improve the efficiency for generating the higher braking force and provide more reliability to the automobile sector.

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