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Design and Fabrication of Electromagnetic Automatic Braking System

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Abstract: The idea of electric brakes is novel and adaptable. Magnetic field and electric force are used to operate electromagnetic brakes. The Electromagnetic Braking system transmits the force necessary for braking automatically while using magnetic force to hold the brakes in place. It is obvious that the electromagnetic brake plays a significant role in the secure stopping of large vehicles. It seeks to lessen brake failure to prevent traffic collisions. Additionally, it lessens the need for brake system maintenance. This system's benefit is that it may be applied to any car with only minor transmission and electrical system modifications. The Electromagnetic Braking system transmits the force necessary for braking automatically while using magnetic force to hold the brakes in place. The shaft should be joined to the disc, and a frame-mounted electromagnet should be used. The magnetic field is increased everywhere when electricity is fed into a coil because of the flowing force that passes through the coil and draws weapons to the coil. As a result, the torque will increase and the car will finally become more relaxed. These brakes, which function as supplemental brakes, can be used on heavy trucks. Commercial cars that have magnetic fluctuations produced by current controllers can employ electric brakes. Future automobiles may use brakes that have undergone certain upgrades.

Frequent collision brakes prevent the car's movement by converting the car's kinetic energy into heat. Removing the friction between the brake material and the brake area means that the life of these components will be greatly improved, which will reduce the cost to the consumer throughout the lifetime of his car and will reduce emissions. It can be proved in this study that the electromagnetic automatic brake is an effective delay device. The use and control of electric brakes may be combined with the design of vehicles and their brake collision system to obtain the appropriate matching of both operating systems in order to maximize safety while minimizing operating costs. This paper discusses the development of Automatic Braking System bases on sensor technology.

***Index Terms* – Automatic braking System, Electromagnetic. Sensor.**

I.INTRODUCTION

Electromagnetic disc brake system will replace conventional braking methods in the future. Eddy currents and resistance are produced by electromagnetic induction as part of the electromagnetic disc braking system's deceleration of an object. By adjusting the electromagnet's magnetic field's strength, the braking effect can be changed when employing an electromagnet. As a result, the disc develops an eddy current. Due to the opposite magnetic field created by these eddy currents (Lenz's law), the disc is unable to rotate and can be stopped. The rotor's movement is ultimately converted into heat inside the rotor. When a magneto resistive force is created, the conductive material slows down as it moves through a quiescent magnetic field, causing the eddy current brake to happen. Eddy currents are generated in the conductor as a result of the changing magnetic flux, which waste energy and produce drag. A force that resists changes in magnetic flux is produced by the interaction of the two magnetic fields. Due to the eddy currents that the moving magnetic field induces on the surface, the neighboring conductive surface drags and resists the movement of the moving magnet.

The goal of this braking system is to create a new automatic braking system that can address the issue of a vehicle stopping on its own if the driver does not manually apply the brakes when a sensor identifies an obstruction. The underlying idea behind how this ultrasonic sensor works is that when ultrasonic waves are emitted from the transmitter, the obstacles that the sensor detects reflect the waves, which are then picked up by the receiver. The primary objective of this project is to enable autonomous braking when an impediment is detected by the sensor. Consequently, there are several drawbacks to employing this electromagnetic braking technology. Therefore, when using this electromagnetic braking system, there is no contact element, which reduces brake pad wear.

The majority of braking systems use frictional forces to transform the kinetic energy of a moving item into heat, which is then dissipated by the brake pads. Overusing a friction-type brake system will raise the brake pads' temperature and decrease the system's efficiency. A review of previous studies on electromagnetic brakes provided insights into understanding the various factors involved in their implementation. We could conclude that the material used for the stator and rotor is nylon. It yields when the load reaches critical levels. The stator can be replaced with steel and the rotating disk can be replaced with aluminum. It takes time for the brake shoes to return to their original positions. A spring mechanism may be provided to encourage the brake shoe to return to position quickly. The ultrasonic sensor detects obstacles and automatically brakes

II. Design of Robot parts

The goal of this project is to create an effective electromagnetic automatic braking system that can help vehicles automatically brake when a sensor detects an object, lowering the danger of collisions.

The components used in this project are:

- DC motor (as a motor)
- DC electromagnetism
- Cable drive
- Relay
- Transformer
- Ultrasonic sensor

A series of eddy currents are produced when a disc enters a magnetic field, as explained by Lenz's law. By doing so, a magnetic field is generated, cancelling out any changes brought on by the revolving disc. The induced magnetic field enters the side as the horseshoe magnet's magnetic field leaves from the side. This field is produced by the induced current, which moves clockwise. As a result, the disc shuts down very quickly and some heat is produced by the eddy currents. The arrangement is shown in fig 2.1& 2.2

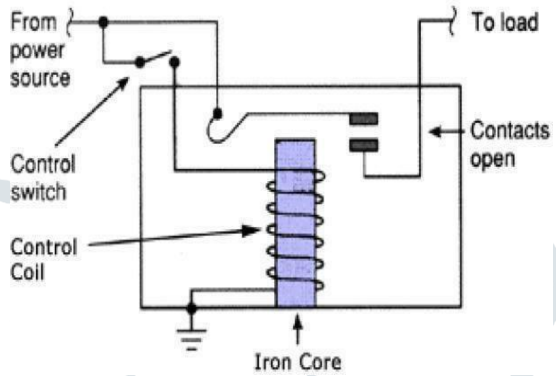


Fig 2.1 Circuit diagram for electromagnetic brake

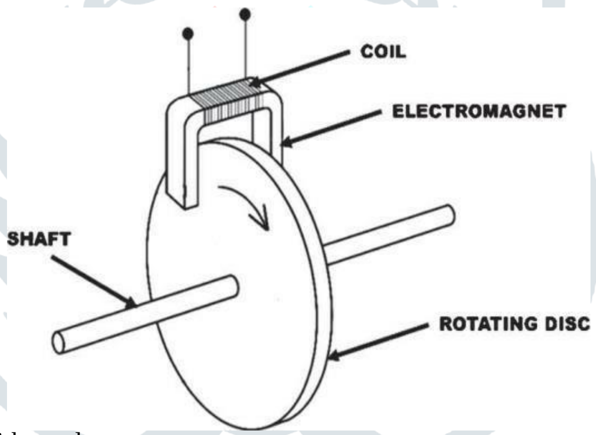


Fig 2.2 Pictorial representation of disc with an electromagnet

III. DESIGN & CAD MODELING

Drawings or solid models are the primary tools and products used in concept design, which is the first stage of the design process. A set of interconnected ideas and concepts about what the system should accomplish, how it should function, and how it should look are presented during the conceptual design phase to provide a description of the proposed system. Designing interactions, experiences, procedures, and strategies falls under this category.

The diagram given below shows the 3d model of the Electromagnetic Automatic braking system.

1. Diameter of disc = 179mm.
2. Length of stand = 450mm.
3. Breadth of stand = 500mm.
4. Height of stand = 340mm.
5. Diameter of wheel = 300mm.
6. Diameter of pulley = 30mm

After studying about various aspects of design and construction of the project, the following calculations were drawn for selection of various parts of the project.

Design Calculations

Center distance between pulleys = 0.38m

Drive pulley C diameter = 0.03m = d

Drive pulley diameter = 0.06m = D

Drive pulley speed = 1800rpm = N1 Belt material = Fabric

Pulley material = Plastic A.
Calculating the driven pulley's speed is as follows:
I = n1/n2 = D/ d
N2 = (0.06/0.03)*1800 N2 = 3600 rpm

Design of Electromagnet

A 40 mm x 40 mm outer core.
25 mm x 25 mm for the inner core.
Electromagnet (N) has 800 spins (24 gauge wire)
The supplied current and voltage are 7 amps and 230 volts.
The electromagnet's length (L) is 25 mm.
Let the plate, shaft & wheel assembly maximum weight is to be consider approx. 5kg. i.e. 49.05 N,
so we know that,
f= b ^{2}/2 x permeability of free space
The force in Newton is F.
B is the Tesla's magnetic field.
A represents the square metres of the pole faces.
The permeability of empty space is o.
Total glamorous flow in the core: 0.0109 wb = 0.0112 wb + 0.0112 wb + 0.975 wb.
H = B/ = 0.0112/ 4 10- 7 = 8912.67 AT/m is the beguiling force.
The attractive force between the attraction and the plate is provided for an air gap of 0.5 mm (assume).
H L = 8912.67 25 10 3 AT = 222.816 AT
For each magnet, determine the strength of the electromagnet F = 38.423 N.

Choosing a motor

AC motor with a single phase.
Speed = 0- 8600 rpm. • Power = 1/ 15 hp = 50 watt (variable).
Motor Torque P = 2 N T 60 T = 60 x 50 2 x 8600 T = 0.055 N- m,
meaning that an electromagnet with a force of 38.423 N would be able to overpower this necklace and stop the slice.
Note that all calculations are performed at full motor speed.

Structure of Shaft (ASME Code).

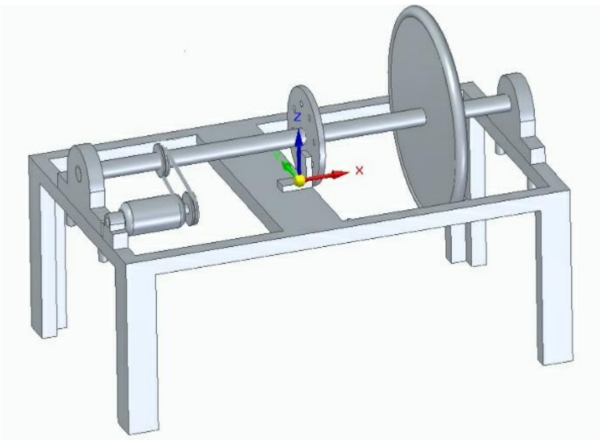
According to code, the genuine shear stress for a marketable material shaft is act = 55N/mm T = $^3\sqrt{}$ 16 x act x d3 =
d = 2.17
Therefore, 2.17mm diameter would be sufficient for shaft to bear the load of the assembly.
For safe to purpose and for disc and wheel to fit on shaft, selected shaft diameter is 5cm.

Shaft ball bearing.

The drive system design is the primary consideration while selecting ball bearings. H. The ball bearings' dimensions are crucial. Therefore, choose the right ball bearing first. It considers how convenient it is to mount ball bearings. I selected a pillow block ball bearing with a 20mm diameter to support the shaft because it has a 20mm shaft diameter.

Calculation of Braking Distance for different velocities

Distance to Brake = V / 2 g (meter)
where V = the vehicle's speed (in m/s)
Road coefficient of friction = 0.8 g
Gravitational acceleration = 9.81(m/s2)
Now for the 10 km/hr velocity.
Braking Distance is equal to (10*1000/3600)/(2*0.8*9.81) or 0.18 metres.
for a speed of 20 km/h.
Braking distance is equal to (20*1000/3600)/(2*0.8*9.81) or 0.35 metres



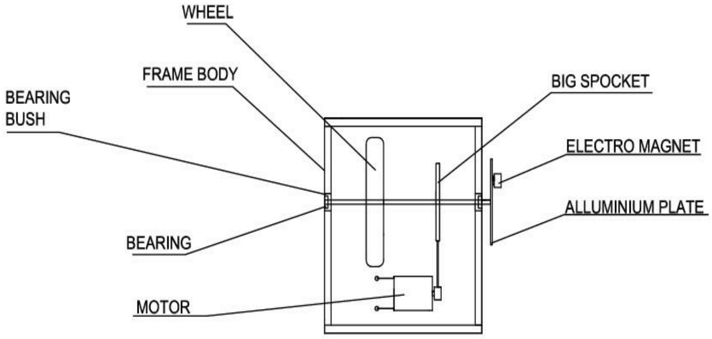


Fig 3.1 CAD Model and 2-D view of the Braking System

IV. FABRICATION OF MAGNETIC BRAKING SYSTEM

The structure is made up of vertical columns. The vertical column's top is where the pulley is installed. This apparatus is fixed to a metal base that serves as a base. The motor is screwed into place at the base's other end. Typically, a driven wheel pulley and a motor pulley are wrapped by a V-belt. The driven pulley's front shaft is connected to a metal pulley. The powered pulley is connected to the front of the metal disc by an electromagnet. The electromagnet must be fastened to the metal disc with the least amount of play possible. The electromagnet and motor are connected to the ON/OFF switch and controller, respectively, by electric wires, which control the power supply

A belt drives the pulley when the motor is running. Now, the pulley will spin continually. due to the fact that the shaft's associated steel plate (disc) rotates before the electromagnet. If an obstacle is encountered when the sensor is sending a signal through the transmitter, the signal is reflected and is then picked up by the receiver. In this case, braking is necessary. It is switched on. So, the electromagnet receives current or voltage. As a result, the excitation coil applies a voltage or current to produce a magnetic field. This coil draws the armature to the metal discs' surface by generating magnetic flux lines between the metal discs.

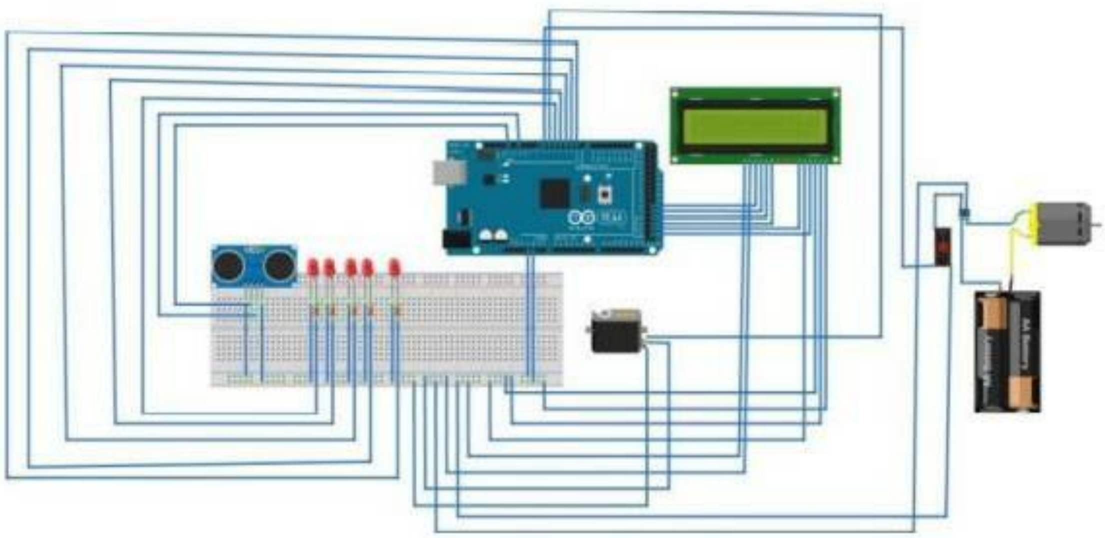


Fig 4.1 Circuit diagram for automation part using Arduino

The Arduino board is made up of an 8, 16, or 32-bit Atmel AVR microcontroller, as well as auxiliary parts that help with programming and circuit integration. The Arduino's common connector, which enables users to attach the CPU board to a number of detachable add-on modules known as shields, is a crucial component. Most boards come with a 5 volt linear regulator and a 16 MHz crystal oscillator, although due to form factor restrictions, certain designs, like the Lily Pad, operate at 8 MHz and have inbuilt voltage regulators. is left out. Unlike other devices that normally require an external programmer, the Arduino microcontroller comes pre-programmed with a boot loader, which makes it simpler to upload programmes to on-chip flash memory.

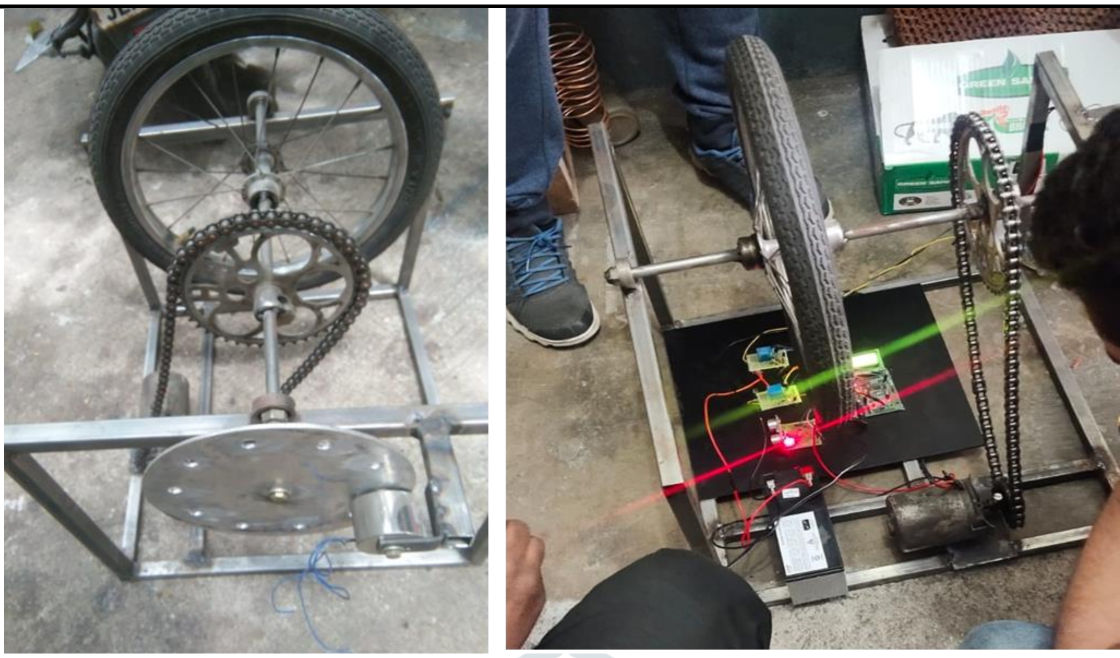


Fig 4.2 Developed Electromagnetic Automatic braking System

The electromagnetic switch automatically shuts off and cuts off current or voltage to the brake when an obstruction passes outside of its sensing range. The metal disc can freely revolve. Here, a spring is utilised as a barrier to keep the electromagnet's armature winding from touching the disc. The control of the supply to the coil is switched to rotate the wheel. Only when slowing down and when applying the brakes does slip happen. When the brakes are entirely applied, there is no slip.

V. TESTING OF ELECTROMAGNETIC AUTOMATIC BRAKING SYSTEM

The idea of using an electromagnetic automatic braking system is to reduce the possibility of road accidents by introducing this braking system into the vehicle. Here, an electromagnet is used to create a friction-free braking system.

This braking system uses bicycle wheels powered by a DC motor with a battery. This system is connected to a steel stand. In addition, we use pulleys, drive chains, metal discs, Arduino UNO 360, HC-SR04 ultrasonic sensors, brake electromagnets that act as solenoids, connecting wires and more. When the motor is on, it will torque the wheel and the wheel will start spinning.

The wheels are mounted on a cylindrical shaft, and the discs are mounted on the same shaft. When an object is brought in front of (within) the sensor, it receives the transmitted signal and forwards it to the Arduino UNO360. The Arduino is programmed accordingly and energizes the electromagnet when activated. Next, the electromagnet creates a magnetic field. As a result, a magnetic field is induced in the disc, causing the disc to stop and the wheel to stop.

VI. RESULTS AND DISCUSSION

An ultrasonic sensor measures the separation between the car and the obstruction. Ultrasound can be utilised in detection and range applications that calculate the distance to an object using the notion of flight time, just like radar, lidar, and active infrared systems. Ultrasonic radiation is a sound wave that is audible to humans but has a frequency higher than that, making it ideal for short- to medium-range, low-speed applications. The distance accuracy of the HC-SR04 ultrasonic distance module can be as accurate as 3mm and it offers a non-contact measurement function from 2cm to 400cm.

Fundamentals of work:

(1) IO triggers are used for high-level signals lasting at least 10us.

(2) Module automatically sends eight 40 kHzs to detect if a pulse signal is coming back.

CONCLUSION

It has been discovered that the electromagnetic braking system is more dependable than other braking methods. Even a small leak in an oil or air braking system might result in a full brake failure. The coils and ignition circuits are individually attached to each wheel in an electromagnetic braking system, such as the four disc plates, but even if one coil does not totally fail the brake, the other three do. It works. Additionally, this system requires less upkeep. Additionally, it has been discovered that 80 percent of all electric braking applications use electromagnetic brakes. On large vehicles, electromagnetic brakes were utilised as an additional speed limiter in addition to the standard friction brakes. As a result of their limited use, friction brakes hardly ever become hot. Brake.

This upgraded brake system aids in efficient braking as well as accident prevention and accident frequency reduction. Electromagnetic brakes also guard against risks that can result from continued usage of the brake after its capacity to disperse heat has been reached. We were able to successfully build a vehicle detection system using two ultrasonic sensors. To improve measurement accuracy or to meet user needs, the space between the ultrasonic sensors can be altered.

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