Adaptive Braking System for E-BIKES Using Electromagnetic Brakes

Priyanka Mane[1], Viraj Tembe[2], Sourabh Salokhe[3], Vaibhav Powar[4], Avinash Khot[5]

[1](Assistant Professor, Electrical Engineering Department, Kolhapur Institute of Technology's College of Engineering, Kolhapur)

[2](Electrical Engineering Department, Kolhapur Institute of Technology's College of Engineering, Kolhapur)

[3](Electrical Engineering Department, Kolhapur Institute of Technology's College of Engineering, Kolhapur)

[4](Electrical Engineering Department, Kolhapur Institute of Technology's College of Engineering, Kolhapur)

[5](Electrical Engineering Department, Kolhapur Institute of Technology's College of Engineering, Kolhapur)

Abstract:

The braking system is always an important factor for any vehicle. Adaptive braking methods are recently developed braking methods in automobiles. It changes the whole braking system in a locomotive and deals with the concept of ABS. Electromagnetic brakes are the brakes employed on the electrical power & magnetic power.This project is designed with ultrasonic sensor, Inductive Proximity speed sensor, Arduino UNO microcontroller, DC gear motor and mechanical braking arrangement. The Ultrasonic Sensor is attached at front of vehicle. The ultrasonic transmitter and receiver is used to transmit the waves and collect the replicated waves present in forward-facing of the vehicle which calculates the distance and inductive proximity speed sensor calculates the speed, and this signal is given to microcontroller for calculation of speed and distance ratio. Also, IOT based Wi-Fi module is used for monitoring

1. Introduction

Numbers of automobiles are arriving into market with new updated technology for employment of social well-being and for other facilities [1]. The speed of vehicles is acting as dynamic part. However, one of the primary causes of traffic accidents is the speed. The communal braking is just not enough for avoid the accidents when owner is not aware of the road. Additional upgrading has to be made in braking method to stop a vehicle when driver is not awake. Means, it may require instinctive braking system. Thus, intelligent braking system stops the vehicle in

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emergency and in unawareness of the owner/driver [2]-[3]. Electromagnetic brake is one of the important components of this system and the breaking structure of security can be controlled by microprocessor [4]. It is generally recognized that the brakes use friction as change kinetic energy into heat. But the Electromagnetic brakes have been applied as added retardation apparatus in addition to the vehicle's standard friction brakes. Electromagnetism is main principle of their working [5].

The goal is to plan and upgrade a control method based on automation, smart and electronically controlled automotive braking system in vehicles [6]. Smart braking system contain an ultrasonic sensor which providing on the forward-facing side of the vehicle creating and discharging ultrasonic waves. On the front side of vehicle an ultrasonic receiver is place to receive the signal waves. To regulate the acceleration of the vehicle we used microprocessor based for finding of pulse data, for drive the electromagnet lever and apply brake to the vehicle rapid for protection reason. The sudden response time given by the electrical regulator is to be used for cut the braking distance by presenting upgraded control of system to brake. As EV has battery backup to control breaking the system adapt very well [7]-[10].

If any kind of obstruction in the way, Ultrasonic sensor detects the object or things and gives the control signal to the microprocessor and in response directs a signal to the motor drive to stop the wheel [11]. The DC gear motor is coupled to the wheels of the vehicle and power supply is given to it from Arduino UNO board. Then micro-controller is for controlling the gear motor the micro-processor based on recognition pulse data and the gear motor in return controls the braking of the vehicle adaptive way. Therefore, if the diver is not awake to brake the vehicle regularly or manually instinct at essential time so this upgraded system is to designed to resolve this problem, but by detecting the obstacles the vehicle can break automatically to stop an accident [12]-[13]. The outmoded/traditional methods used for braking system like oil now controlled by the speed and accurately accessible by current automate devices. ABS familiarized in vehicles providing fast break response and start for each slow wheel therefore confirming protection of vehicle and rider. The fastest response time given by the microprocessor is to be used for significantly minimizing the braking distance by presenting innovative control of braking method [14]-[16].

The use of electromagnetic braking may take it to the next level of vehicle safety and automation in Electrical vehicles [17]. The intelligent braking system is seemed to be more

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trustable as compared to other traditional braking systems. In addition, it develops that electromagnetic brake are make up around 80% of all of the power functional brake applications. Electromagnetic brakes have been used as additional retardation apparatus to overcome the general resistance or friction of the brakes [18]-[19]. This intelligent braking system not just help in efficient braking but also supports in avoiding the accidents and minimize the incidence of accidents to the lowest number. ABS usage can be neglected by simply using a micro controlled electromagnetic brake system [22]-[21].

2. Traditional braking system

Oil braking and disc braking are two different types of braking systems used in vehicles to slow down or stop the wheels.

1] Oil braking: - also known as drum braking, is a mechanical system that uses hydraulic pressure to activate brake shoes inside a drum attached to the wheel hub. When the driver applies pressure to the brake pedal, it activates a piston in the brake cylinder, which forces brake fluid through the brake lines and into the brake shoes. The brake shoes press against the drum, friction that slows down or stops the wheel. This system is simpler and less expensive than disc braking but may not perform as well under heavy use.

2] Disc braking: - on the other hand, is a more modern system that uses calipers to squeeze brake pads against a disc attached to the wheel hub. When the driver applies pressure to the brake pedal, it activates a piston in the brake caliper, which applies pressure to the brake pads, causing them to squeeze against the disc. The friction between the brake pads and the disc slows down or stops the wheel. Disc braking is generally more effective than oil braking because it provides more precise and consistent braking performance.

Oil and disc braking are mechanical systems that use friction to slow down or stop a vehicle, while electromagnet braking is an electrical system that uses magnetic force to achieve the same result.

In an electromagnet braking system, the brake pads are replaced with electromagnets that generate magnetic fields when an electric current flows through them. The strength directly related to the strength of the field's magnetism. The current supplied, allowing for precise control over the braking force. Electromagnet braking generates less heat than traditional

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1006-5911

braking systems, which can reduce wear and tear on the braking components and increase safety.

However, electromagnet braking does have some drawbacks. It requires a power source to operate, which may not always be available, and may not be as effective as traditional braking systems at high speeds or under heavy loads.

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3. Methodolgy

To assemble the project model, all of it initiates with an orderly plan where the production is of seven stages of solving method. The stages are as below:

Selection of the Idea of Electromagnetic Brakes:

Selection of the ABS is to minimalize the problems which usually occur in the conventional type of braking system where to overcome the problems like safety, maintaining parameters and efficiency. Hence, to overcome these problems the electromagnetic braking system is carefully chosen for the project.

Collecting the Research Paper:

Collect all the related information about the difficulties and the research programs which are happening around and the results of them and estimate them by comparison with the other research paper where to find out the drawbacks of the traditional methods types of braking systems in a more operative way.

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Study of the Electromagnetic Braking:

To learn and analyse the structure where by focusing to the working principle and the assembly resources and design needed for the project to be completed. And a study to the working of the braking structure depending to the project planned.

Estimation:

From the literature survey and market analysis the total tentative estimation of the proposed project is estimated.

Preparation of Project:

This step it is more focused on the design of part were observing on to numerous changes of designs of model according to the setting up specifications as planned in the earlier stages.

Assembly:

This stage involves of working on to the selected plan and approach to the realism. The project is then fabricated as per the stipulations given and checked if all the devices do work efficiently.

Block Diagram:

The block diagram is as shown in fig. 1 of model shows the automatic braking system using electromagnet in electric vehicles. In this diagram Arduino UNO is used as microcontroller, it is central part of project acts as brain which controls the braking system. It takes input signal from sensors and gives to the motor to control speed, there are the two sensors used, one is ultrasonic sensor and other is speed sensor. Micro-controller takes the input from these two sensors in which speed sensor gives the speed of the vehicle and ultrasonic sensor gives distance between the vehicle and upfront object or any obstacle. Micro-controller takes the input and according to speed upon distance ratio decides how much pressure is applied while braking. Then it also shows the speed and distance on LCD display which is connected to the microcontroller.

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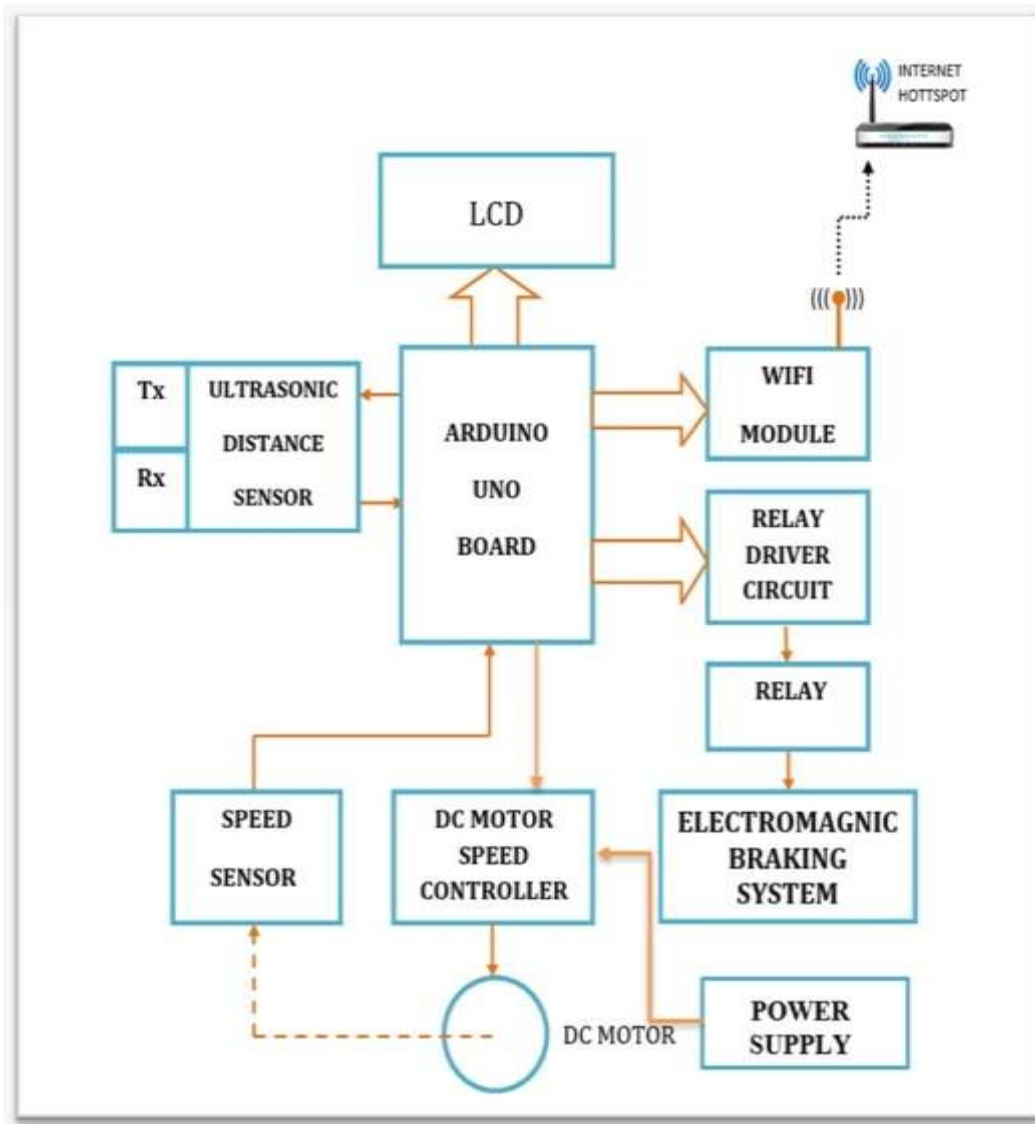
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Fig.1: Block diagram of an electromagnetic braking System

Here, the DC motor is used for rotating the disc. The power supply is given to dc motor through the 12 V adapter cable through the speed controller. DC motor is attached with speed controller for controlling the speed and speed sensor is attached to DC motor and microcontroller which calculates the speed and sends the data to the microcontroller. Then depending upon the speed and distance ratio it sends command to the relay driver circuit of the relay which is attached to electromagnet to control the braking where IOT is used. IOT is a wireless technology from we can monitor system data using a remote laptop or a smart phone. The Wi-Fi module will provide the wireless internet connection to the system which connects it to a local internet hotspot. Wi-Fi module is connected to the microcontroller. The sensor gives data of distance and speed was uploaded to the website or server using the Wi-Fi module.

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Working

The automatic braking system using an electromagnet in an electric vehicle is an IOT-based topology to ensure the safety of the vehicle by applying the brake automatically when an obstacle is detected in the path of the vehicle. The following steps show the working of this project:

An ultrasonic sensor at the vehicle's front identifies the distance between the vehicle and any object in its path. The Arduino UNO microcontroller takes input from the ultrasonic sensor and determines the distance of the object from the vehicle. If the distance is less than a certain threshold value, the microcontroller sends a signal to the 2-channel relay module, which switches on the electromagnet. The electromagnet generates a magnetic field that attracts a metal plate attached to the brake pedal, causing the brakes to be applied. And LCD display present the distance of the obstacle from the automobile and also displays a warning message indicating that the brakes have been applied. Once the obstacle is cleared, the microcontroller switches off the electromagnet, and the brake pedal is released, allowing the vehicle to continue its movement.

Overall, the project provides a reliable and efficient solution to enhance the safety of electric vehicles. By using IOT-based technology, the system can detect obstacles in real-time and apply the brakes automatically, helping to prevent accidents and ensure the safety of the vehicle and its occupants.

Circuit Diagram: In this project proteus is use for simulation & design suite. It is an
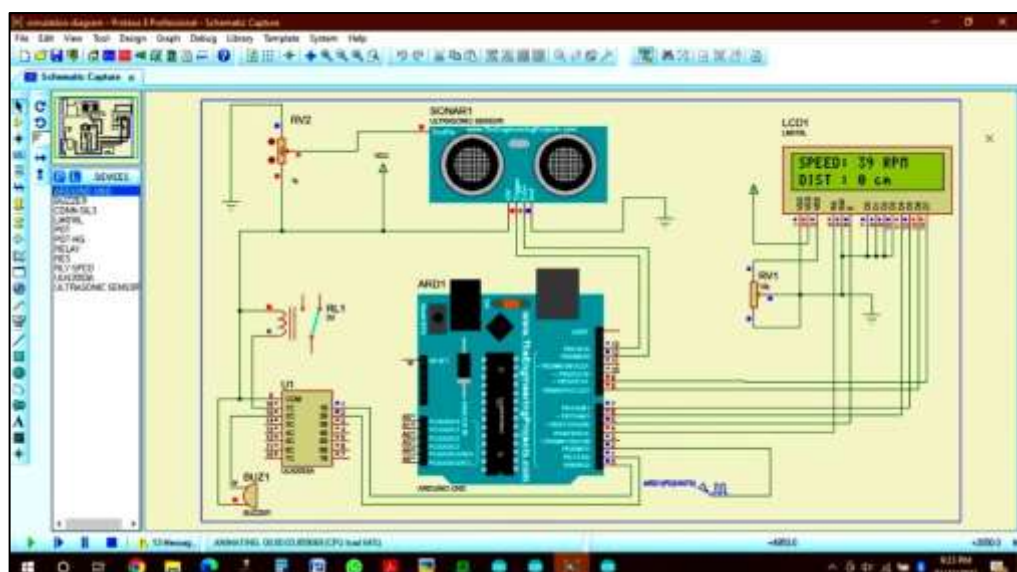
Fig2. Simulation of EM breaking in proteus software

exclusive software device used mainly for electrical design automation. It is an application of Windows for diagram capture and Simulation. Also, for Printed Circuit Board (PCB) outline project. It can be found in numerous configurations, It depends on the size of projects being construct and the required for microcontroller simulation. All PCB plane devices contain basic mixed-mode SPICE simulation capabilities as well as an auto-router. The software is used mostly by electrical project engineers and operators to produce schematics and automated designs for manufacturing PCB and as a quick prototyping instrument for R&D. It is used in training electronics, implanted design, and PCB design for students and Professor. It also has features which permit you to virtually simulate your projects. The circuit diagram is as shown in fig 2. Following are features of proteus

1] Schematic capture

2] PCB design

3] Virtual System Modelling (VSM)

LCD Connection:

– The RS pin of LCD is connecting to Pin4 of the Arduino UNO board.

– Enable pin of LCD is connecting to Pin5 of the Arduino UNO board.

– D4 Pin of LCD is connecting to Pin6 of the Arduino UNO Board.

– Connecting the D5 Pin of LCD to Pin7 of the Arduino UNO Board.

– D6 Pin of LCD is connecting to Pin8 of the Arduino Board.

– D7 Pin of LCD is connecting to Pin9 of the Arduino Board.

Software Used:

Proteus-

Components:

Microcontroller-

The Arduino UNO is a popular microcontroller board that can be used to create a wide range of electronic projects. The most important thing of the Arduino UNO is its flexibility. It contains of digital and analog input and output pins, which are used to interact with a diversity of sensors and other electronic equipment. The board can be programmed using the Arduino programming language, which is easy to learn and use, even for beginners.

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The Arduino UNO has a built-in USB connection, which can be used to program the board and power it from a computer or other USB power source. This makes it easy to use the board without needing additional hardware.

Ultrasonic Distance Sensor -

Ultrasonic sensor is a device which uses frequency of high values of sound waves to sense the presence of object within the range. It is small in size and it is very easy to use device. It works on the principle of echolocation. The time required for the sound waves to return back to the sensor is used to determine the distance between the sensor and object. It has Minimum range of 10 cm and Maximum range of 400 cm (4 Meters). Ultrasonic sensor has accuracy of -1 to +1 cm. Its resolution is 0.1 cm. For working of Ultrasonic sensor needs 5V DC Supply voltage. Ultrasonic sensors have 3 terminals; one is supply ground, second is Supply and third is Serial data (TTL 5V level) at 9600 baud rates.

Specifications:

Supply Current	15 mA
Supply Voltage	5 V
Output Data speed	9600 Bps
Minimum Range	10 cm
Maximum Range	400 cm (4 Meters)

Inductive Proximity Sensor-

Inductive proximity sensors are widely used in industrial automation and control systems to detect the position of machinery, monitor the movement of objects on a production line, and measure the flow of materials. They can detect objects at a distance without physical contact, which can help to prevent damage to sensitive equipment.

One of the main advantages of inductive proximity sensors is their ability to detect metallic objects without physical contact. This means that they are non-invasive and do not cause any damage or wear to the objects being detected. They are also highly accurate and reliable, with a long lifespan and minimal maintenance requirement.

Electromagnet -

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An electromagnet is a type of magnet that is created by passing an electrical current through a coil of wire. By adjusting the supply of current to electromagnet we can adjust the strength of electromagnetic power. As the current increases, the magnetic field becomes stronger, and as the current decreases, the magnetic field weakens. This makes electromagnets ideal for applications where variable strength is required.

One of the main advantages of electromagnets is their ability to turn on and off quickly and easily. This makes them suitable for applications where rapid switching is required. They are also highly versatile and can be made in a variety of sizes and shapes to suit different applications.

Buzzer-

In this project buzzer is used to notify us that certain object or vehicles are comes within the range of less than 1 meter (<1) then buzzer start buzzing and gives us signal that something is comes within the range.

Specifications

Rated voltage   6V DC

Operating voltage   4 to 8V DC

Rated current   less than or equal to 30mA

Tone   continuous

LCD Display –

An LCD display is also called as Liquid Crystal Display. It is a type of electronic visual show that by liquid crystals to creates images or text. It consists of a flat panel made up of numerous small pixels, with each pixel being made up of sub-pixels that are illuminated or darkened to create images. As we know that LCD is used to display their work and show the different parameters. The LCD used in this project is 16 X 2. Which means with this LCD we can show 16 characters to each line and there are two of such lines.16 X 2 means there are 2 rows and each row consists 16 characters.

Relay –

A 2-channel relay is an electronic device that allows you to control two separate circuits or devices using a single input signal. It consists of two independent electromechanical relays that are controlled by a common input signal. The relays are used to switch high voltage or high current circuits on and off using a low voltage signal.

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The input signal can be provided by a microcontroller, a sensor, or other electronic devices. When the input signal is applied, the relays are activated, and the circuit or device connected to the output terminals is energized or de-energized.

One of the main advantages of using a 2-channel relay is that it allows you to control multiple circuits or devices using a single input signal. This can simplify wiring and reduce the number of electronic components required for your project. Additionally, the relay provides electrical isolation between the input and output circuits, which can improve safety and protect sensitive electronic components from high voltage or high current circuits

Wi-Fi Module –

Wi-Fi modules or Wi-Fi microcontroller are used to send and receive the data over Wi-Fi. They can also accept the command over the Wi-Fi. Wi-Fi module is used for communications between the devices. They are most commonly used in the field of Internet of Things. A Wi-Fi module is an electronic component that provides wireless communication capabilities to devices. It allows devices to connect to a wireless network and communicate with other devices or the internet. Wi-Fi modules are widely used in a variety of applications, from home automation to industrial control systems.

A significant benefit of Wi-Fi modules is their capacity to deliver wireless connectivity to devices. This means that devices can communicate with each other without the need for cables or wires. They also provide high-speed data transfer rates, making them ideal for applications such as video streaming or large file transfers.

Hardware Design:

Hardware of the project is proto-type. We have used wooden board as base of project. The metal disc is mounted on the board along with the electronic parts and wire connection. The disc represents the wheel and connected to dc gear motor using steel frame. Disc is mounted on the dc gear motor. The proximity speed sensor is attached with motor for calculating the speed of the wheel. Disc has four bolt connections for speed sensing and further connected to the microcontroller for calculation. An electromagnet is attached on the steel frame. DC current is supplied to the coil and the magnetic field is produced through the armature since the current supplied across the coil and makes armature to get attracted in the direction of the coil. As an outcome, it produces a torque and ultimately the stop the vehicles.

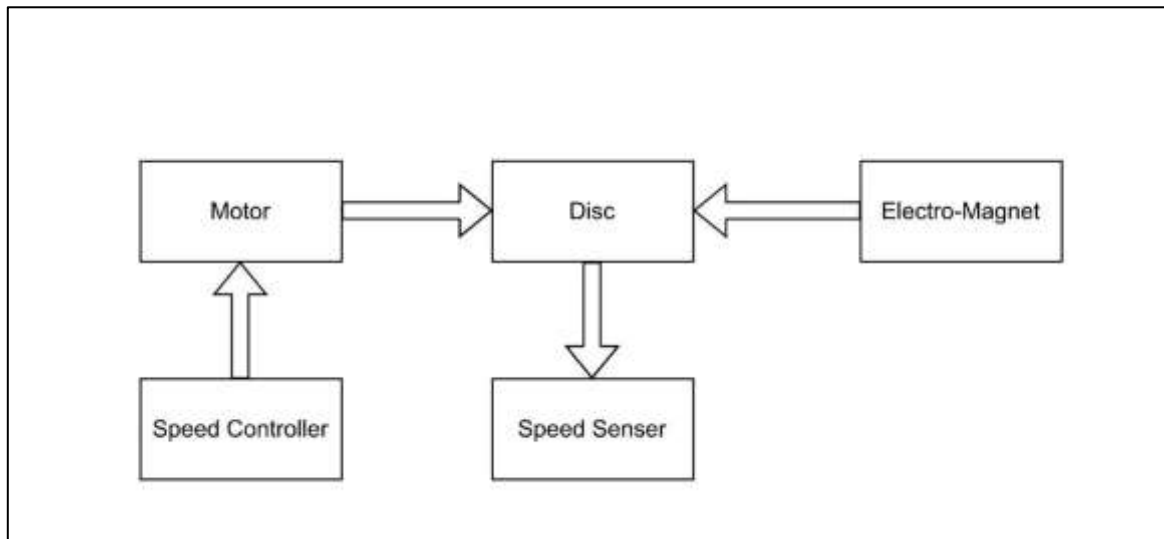The block diagram of hardware implementation is as shown in fig 3

Fig 3. Block Diagram of implementation

An ultrasonic sensor is a kind of the sensors which is based on computer visualization and radar. So, these sensors are used to count the distance between vehicle and the obstruction in the way of travelling. Using uninterrupted samples of the distance with respected obstacles or things the speed of vehicle is to be calculated. Proximity speed sensor is attached to the opposite side of the wheel of distance calculation and connected to the microcontroller.

The electronic part consists of Arduino UNO, display board, relays, controller, switches, resistor, wire and connections are all connected on circuit board. The proximity speed sensor and ultrasonic sensor are connected to Arduino port. The data in format of speed and distance send to microcontroller for further calculation through it. Ground is also provided here. Power supply is given to circuit through motor speed controller. The manual break switch is also connected to circuit for control of driver over EV- vehicle. Fig 4 illustrates the hardware implementation of the system.
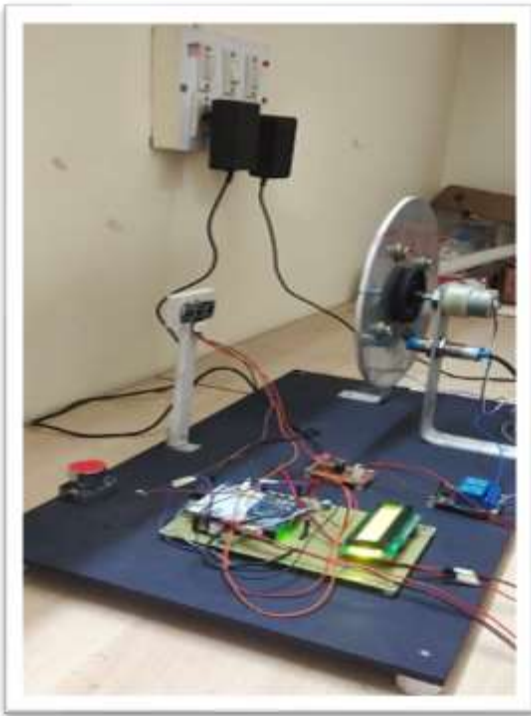
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Fig4.Hardware of Electromagnetic Breaking

4. Result and discussion:

The ABS or electromagnetic brakes are brilliant replacement for traditional automobile brakes system. Maintenance requirement of this brake would be last considerably longer, the electromagnetic brake eliminates dangers that may arise from using brakes in ways that exceed their ability to dissipate heat. The setting up of an electromagnetic brake is not tough or critical process. Any additional cooling arrangements were not needed. Efficiency of vehicle engine is not affected by these brakes. This brake also has the well control provide to diver over vehicle. The electromagnetic brakes have brilliant thermal dissolution efficiency. E-breaking system have the improved the heat dynamic performance than general disk/friction brakes in vehicles. The ultrasonic sensor measures the departure between the vehicle and obstruction and range applications that calculate the distance to an object using the, just like and active infrared systems. The distance accuracy of the ultrasonic distance sensor can be as accurate as 3mm and it provided a non-contact measurement function from 2cm to 400cm. The electromagnetic braking system offers over-all protection in the problems that could result from employing brakes in ways that go beyond their capacity to disperse heat are eliminated by the electromagnetic brake. Therefore, there is no doubt that this method develops the future breaking system for the E-vehicles. Fig 5-8 shown the results of the system implemented.

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Fig 5. Speed Status

Fig 6. Distance Status
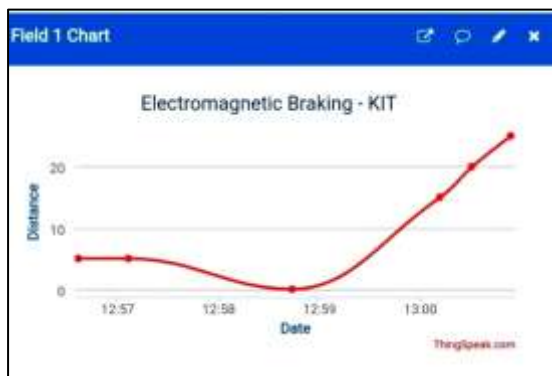
Fig 7.Field 1 output chart

Fig 8. Field 2 output chart

Fig 9. Field 3 output chart

5. Conclusion

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The intelligent braking technology appears to be more reliable than other conventional brake systems. ABS usage can be neglected by simply using a microcontroller electromagnetic brake system. It reduces the accidents and gives more control over the vehicle. It has less maintenance. It gives adjustable brake force, high brake force at high speed. It has cheap cost, compact size and light weight. It is more responsive an effective. It has no noise and smell of brake liquid dehydration and hardening problem are dispensed as no oil is used. The danger of thermal failure in braking system was avoided. The concept designed is just a prototype and needs to be developed more. So, the ABS can be a well industrial innovation in the upcoming future application.

6. Future Scope:

Depending on power of battery cell to start the brake system drains out the battery faster. Eddy current generation is small at slow speed thus low efficient at slow speed. By the additional budget provided for model and changes then there is a future for the E-Braking. If sensor of high accuracy and greater sense range are used then even quicker & accurate braking is applied. The slipping of the heavy weight automobile can be controlled more efficiently. In states where advanced roadway's structure exists then, this system is really helpful with additional things like regenerative braking and several more.

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