Electromagnetic Actuator In Anti lock Braking System (Bikes)

A PROJECT REPORT

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BONAFIDE

CERTIFICATE

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ABSTRACT

Our main aim of this project is to replace the modulator in anti lock braking system (ABS) for bikes with the help of electronic control unit associated with solenoid valve (2/2), arduino microcontroller and a speed sensor. The speed of the motor is sensed by an inductive proximity sensor and is fed to the controller. The disc is attached with a motor for applying brake. The calliper is made to hold the disc for providing brake. A 2/2 solenoid valve is connected to the brake calliper, which allows the brake fluid flow to the calliper, based on the signal from the controller. When the brake lever is pressed, the controller sends signal to the solenoid valve in the form of pulse, which rapidly opens and closes the valve and the brake fluid is supplied to the calliper. Thus the brake is applied by the calliper. The power supply to the motor is disconnected using a relay switch at the time when the brake lever is pressed.

Keywords: Anti lock braking system (ABS), Solenoid valve (2/2), Arduino microcontroller, Speed sensor, Brake calliper, Brake lever, Battery

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CHAPTER 1

INTRODUCTION

1.1 TRADITIONAL BRAKING SYSTEM:

The traditional braking system may have disc type or drum type brakes. They use a simple principle of hydraulics. A hydraulic brake circuit uses a master and slave cylinder connected by pipes with brake fluids. When the brake pedal is pushed, the piston in the master cylinder moves and forces the fluid in the pipe. The fluid pressure is distributed evenly around the system. The fluid thus moves the slave cylinders at each wheel and forces the pistons out to apply the brakes. When subjected to heavy braking, more weight may be exerted at the rear wheels so that they lock and thus the vehicle may skid. Using friction, the brakes transmit the force to the tires and the tire also transmits that force to the road using friction. The main problem with this system is that, the force exerted on the wheel by the brakes cannot exceed the force of friction between the road and the wheel. This braking system also wastes energy that has been built up by the engine in the form of heat. If it exceeds then the vehicle will start to slide. This problem is rectified by the implementation of ABS in automobiles.

1.1.1 FRICTIONAL BRAKES:

Frictional brakes are most commonly used type of brakes and they use shoe or pad for application of brake. The friction shoe or pad consists of rotating device that contract and rub on the outside of a rotating drum. This type is used in hand brake or drum brake.

They are most commonly used brakes and they can be divided into:

- Disc brake
- Drum brake

1.1.1.1 DISC BRAKE:

It has a disc that turns as the wheel rotates. A calliper is attached to the disc which has small hydraulic pistons which work under the pressure exerted by the master cylinder. The pads are pressed by the piston which clamp against the disc from both the side to slow or stop the vehicle. The distance moved by the piston is small and they have low clearance when the brake is released. They do not have return springs.

1.1.1.2 DRUM BRAKE:

A drum brake consists of a hollow drum which is used to turn the wheel. A stationary back plate which has two curved shoes with friction linings is placed at the back of the drum. The brake shoes have a pivot at one end and a piston at the other end. Due to hydraulic pressure, the shoes are moved outwards by the pistons in the brake wheel cylinders, which press against the friction linings inside the drum to slow or stop the wheel. The leading shoe is pulled by the rotation of the drum and it makes contact, improving the braking effect.

1.2 ANTI-LOCK BRAKING SYSTEM (ABS):

Anti-lock Braking System (ABS) is a safety system used in automobiles which allows the vehicle to maintain traction with the road surface according to the braking and thus preventing the wheels from locking up and thus can avoid skidding. The ABS comprises of two discs mounted on both the wheels of the motor cycle which are connected to magnetic sensors that continuously monitor wheel speed. The sensors send wheel speed data within a specified interval of time to the control unit. ABS detects any sudden change in the wheel speeds and when a sudden deceleration is detected, the ABS will reduce the hydraulic pressure supplied to the braking system until the wheel starts to accelerate again. The braking pressure is increased again when a sudden deceleration is detected. Until the user removes their foot from the brake pedal or when the vehicle stops, this process is repeated. ABS offers improved control of the vehicle and also decreases stopping distances on wet and slippery surfaces [1].

1.2.1 TYPES OF ABS:

1.2.1.1 PISTON SYSTEMS:

The movement of a spring tensioned piston is used in this system. The pressure is released by a linear motor which pulls the plunger and gives more space for the fluid. Displacement sensors are used for recording the distance travelled by the piston and allow a more precise control.

1.2.1.2 VALVE AND PUMP SYSTEMS:

This system uses inlet and outlet valves, pump, motor, accumulator and reservoirs for its operation. Based on the requirement, the number of valves differs due to the additional functions and number of brake channels used in the system. The inlet and outlet valve are operated by the solenoid based on the input from the control unit. When the pressure is released, the brake fluid is stored in the accumulators, which can be used back in the circuit using the motor which can be felt by the driver by a pulsation on the brake lever.

1.3 PROBLEM STATEMENT:

- In the traditional method, when the brake is applied, the wheel tends to stop rotating and thus lockup which may result in vehicle skid.
- Current method employs hydraulic modulator, so accuracy may change after some time.
- Whenever brake is applied harder, rider could feel more vibrations on brake lever.

1.4 OBJECTIVE:

Our aim of this project is to replace the hydraulic control unit (modulator) by electronic control unit in ABS for Bikes with the help of electronic actuator associated with Solenoid valve (2/2), Arduino controller, a speed sensor and caliper with brake pads. In hydraulic controlled ABS, the oil pressure is controlled and sending it to the brake pad by the use of piston but in our project the oil pressure is controlled by the use of solenoid valve.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW-I:

ANTI-LOCK BRAKING SYSTEM WITH ELECTROMAGNETIC BRAKE[2].

- **Naila Mikhaeil-Boules;**

  Paul D. Wilkey; James J. Kowalik;

In this project, the ABS is provided by a master cylinder and a wheel brake. When the wheel condition is within the preset parameters, the ABS controller provides a signal based on the rotation condition of the wheel. The fluid flow is prevented between master cylinder and the wheel brake based on the activation signal given by the controller. The pressure is modulated by a piston mounted within the actuator frame and for communication with the brake. The motor has a rotor connected with a disc. The position of the piston is locked by the friction surface engaged with the disc. The braking is done by an electromagnetic core which responds to a signal from the controller. It moves a plunger to a position and disengages the friction surface and the disc allowing the rotation of the motor and piston movement.

We use brake calliper in place of the electromagnet in this project and the brake fluid flow is controlled by a 2/2 solenoid valve, based on the signal from the Arduino controller.

2.2 LITERATURE REVIEW-II:

AN ANTI-LOCK BRAKING CONTROL SYSTEM FOR A HYBRID ELECTRO MAGNETIC/ELECTRO HYDRAULIC BRAKE-BY-WIRE SYSTEM[3].

- **Sohel Anwar,** ***Member, IEEE***

In this project, the slip regulation for a hybrid electromagnetic – electro hydraulic braking using a nonlinear sliding mode type controller is given. The brake torque signal generated by a supervisory controller based on the signal from brake pedal sensor is modified by the ABS controller. Using a closed loop actuator control algorithms, the brake torque signal is given to control the electro hydraulic brake (EHB) and eddy current brake (ECB). The control algorithm presented in this project, shows good slip regulation while braking on low friction coefficient surfaces than non ABS braking. In this paper they have designed hybrid brake by wire system architecture, modelled the wheel slip dynamics and they have implemented the controller for hybrid actuation system. The braking done by using ECB is smooth and has no noise, vibration and harshness than in the hydraulic ABS systems.

2.3 LITERATURE REVIEW-III:

DESIGN OF AN ANTILOCK BRAKING SYSTEM CONTROLLER[4].

J. O. Pedro; O. T. Nyandoro; C. G. Bigg

K. Gross; J. T. Nelson

In this paper, the antilock braking system (ABS) controller is designed which is used for minimizing the braking distance by adjusting the braking torque corresponding to the wheel slip. It is developed and experimentally tested for a quarter car model. Based on the rotational gains of the driving wheel, the controller gains are calculated. Different control approaches for designing ABS controller has been suggested by researchers. The current most widely used ABS controllers uses PI and PID control. The non linear PID controller has better braking performance than conventional PID controller. The algorithm used for the wheel slip is a real time proportional- integral (PI) controller algorithm and is implemented through a controller. In this paper, the ABS schemes proposed are focused in extending and implementing the current schemes for a special class braking systems. They have also described the mathematical model of the quarter car, stability analysis of the plant, controller design and the numerical simulation of the plant in simulink.

CHAPTER 3

METHODOLOGY

3.1 BLOCK DIAGRAM:

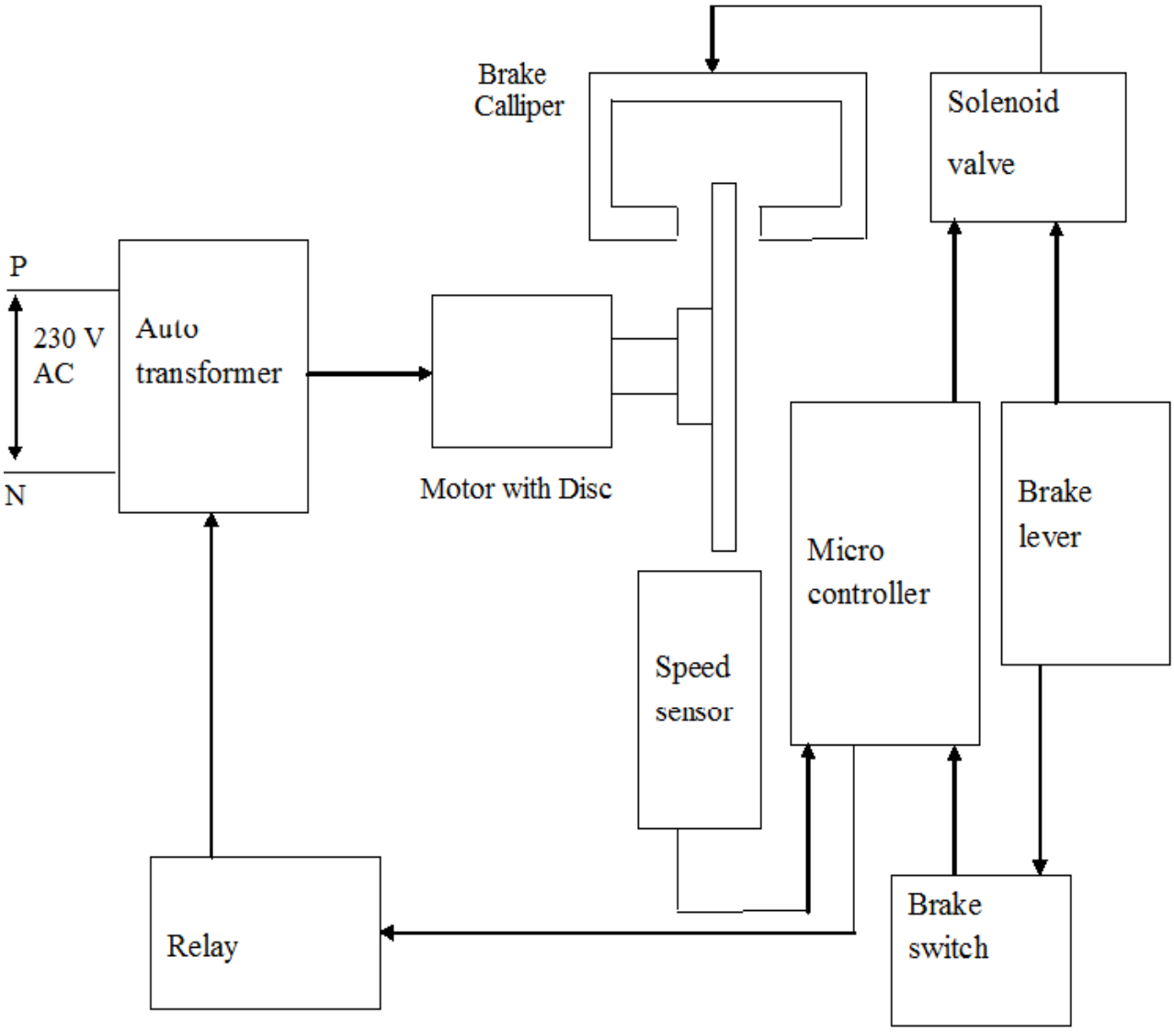

Figure 1.Block Diagram

3.2 WORKING:

The supply to the autotransformer 230V is given to the motor. The autotransformer voltage is varied such that the, motor rotates at 800 to 1000 rpm. The speed sensor measures the speed of the motor continuously and delivers it to the controller. When brake lever is pressed, the brake switch send the signal to the microcontroller, and according to the current speed, the controller sends signal to the solenoid. When the brake switch send the signal to the microcontroller, the controller sends signal to the relay and it disconnects the power supply from the transformer, then the motor gets deceleration. The signal is send in the form of pulse, based on the motor speed. During deceleration, the motor speed is decreasing to lower rpm. Thus the brake fluid is passed to the caliper at this frequency by rapid opening and closing of the solenoid valves. The solenoid thus allows the brake fluid to the caliper according to the signal. Thus the brake pad closes and opens continuously and presses against the disc. Thus the brake is applied. [5].

CHAPTER 4

COMPONENTS DISCRIPTION

4.1 ARDUINO MICROCONTROLLER:

Arduino is an open-source platform which is being used widely for building large variety electronics projects. It consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on your computer. This is used to write and upload computer code to the physical board.

The Arduino platform has become very popular among those people just starting out with electronics projects, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not require a separate piece of hardware (called a programmer) which is used to load new code onto the board – you can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Arduino can easily interact with the buttons, LEDs, motors, speakers, cameras, the internet, and even your smart-phone or your TV. This flexibility combined with the fact that the Arduino software is free, the hardware boards are pretty cheap, and both the software and hardware are easy to learn has now led to a large community of users who have contributed code and released instructions for a huge variety of Arduino-based projects.

The Arduino Uno is a microcontroller board based on the ATmega8L-8PU (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support

the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

4.1.1 MICROCONTROLLER SPECIFICATION:

Table 1 .Controller specification

Microcontroller	ATmega8L-8PU
Operating Voltage	5V
Input Voltage	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	23
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	8 KB (ATmega8L-8PU)
SRAM	1 KB (ATmega8L-8PU)
EEPROMDATA MEMORY	512KB (ATmega8L-8PU)

Figure 2.Microcontroller

ADVANTAGES:

- Inexpensive
- Cross platform
- Simple, clear programming environment
- Open source and extensible software

4.2 SOLENOID VALVE:

A solenoid is an electromagnetic device which is used to convert electrical energy into mechanical motion but it has a short stroke length. The solenoid valve used in this project is 2/2 NC solenoid valve. It consists of a coil of wire which has an iron plunger which moves through the center of the coil. The plunger is usually held halfway out of the coil by using a spring. When the coil is energized, the magnetic field attracts the plunger to the middle of the coil. The plunger returns to its original position by the help of a spring when the coil is not energized[6].

The solenoid valve has a basic electric solenoid and a mechanical valve. The mechanical energy produced by the solenoid is used to operate a mechanical valve to open, close or to adjust it in a position.

Figure 3.Solenoid Valve

4.2.1 TYPES:

Based on the position of the valve, it can be divided into two types namely:

- Normally Closed (NC)
- Normally Open (NO)

NORMALLY CLOSED:

A solenoid valve is known as normally closed, when there is no flow in the valve in its resting position.

NORMALLY OPEN:

A solenoid valve is known as normally open, when the valve allows fluid flow in its resting position.

Based on the number of ports available in the solenoid, it can be divided as:

- Two Ways
- Three ways

TWO WAY VALVE:

Two way solenoid valve, it has two ports. One port is for inlet and the other is for outlet of the fluid.

THREE WAY VALVE:

In a three way solenoid valve, three ports are available. One port each for inlet and outlet of the fluid and the third port is exhaust port for controlling the fluid flow in the valve.

The solenoid valves are also classified into different types based on the arrangement of the valves inside it. Even though the solenoid has short stroke

length, it has many applications like electric car-door locks, opening and closing of valves, triggering mechanical latches. Many applications use the solenoid as an on or off device. By varying the input, the variable position control can be done.

4.3 BRAKE CALLIPER:

Brake calipers are essential and one of the most important parts in the automobile brake. Most of the motorcycle has disc brakes now. The brake caliper is used to slow down the vehicle by creating friction with the rotors. The brake caliper consists of pistons ranging from one to four which are mounted to a torque plate and wheel carrier. The brake caliper fits on the rotor like a clamp. The brake pads are a pair of metal plates bonded with a frictional material. When the brake is applied, the brake fluid from the cylinder creates pressure on the pistons in the brake caliper which forces the brake pad against the rotor. The high friction surface in the brake pad is used to slow down the rotor and stop the vehicle. Drum brake is used in older vehicles in which, the motion of the wheel is slowed down by friction in the rotating drum and brake shoes mounted inside. This causes friction and heat is generated, which results in loss of braking power. Thus drum brakes are replaced by disc brakes because, the disc brakes are well ventilated and heat doesn't build up.

4.3.1 TYPES:

Callipers are mainly divided into two main types:

- Floating or sliding caliper
- Fixed caliper

Figure 4.Calliper

FLOATING CALLIPERS:

The floating calliper has an economical design and it is lighter in weight. Depending on the application in which the calliper is used, it has either one or two pistons. In this type, the piston exerts pressure on the pad inside and also moves the calliper body which engages the outer pad. The piston is located on only one side of the calliper. The hydraulic pressure is applied to the piston from the master cylinder and the inner pad is pressed against the disc. Simultaneously an equal pressure acts on the bottom of the cylinder. Due to this pressure, the calliper moves

to the right pressing the outer brake pad against the disc which is located opposite to the piston. It moves in and out relative to the rotor and have one or two pistons inside the rotor. When the brakes are applied, the piston pushes the entire calliper and creates friction on the brake pads on the sides of the rotor.

FIXED CALLIPER:

This type of calliper consists of pad on both sides of the calliper, which provide equal force to each brake pad. It consists of one or two pistons on each side. If multiple pistons are used, it provides a greater braking force and also has a compact design. It does not move and it has pistons arranged on the opposing sides of the rotor. Some fixed callipers have two or more pairs of pistons arranged on each side of the rotor and some may have up to six pairs. The fixed callipers are larger and heavier than the floating calliper and also absorb and dissipate more heat. Fixed callipers are mostly preferred than floating callipers because of their higher performance. Fixed callipers can withstand great number of repeated hard stops without any loss of brake force. Fixed callipers are more expensive than floating callipers.

4.3.2 BRAKE PAD:

The brake pads are mounted to the calliper which is used to apply brake due to friction by pressing against the disc. The brake pads are made up of friction materials. Different design of brakes requires different kinds of friction materials. In the development of brake pads, several considerations are required such as, constant maintenance of the coefficient of friction in the brake pad, they must not wear rapidly also they should not wear the disc and they should be able to withstand high temperature without any wear and it should not produce any noise.

The materials which are used in the brake pad consist of friction modifiers, powdered metals, fillers and binders. The friction modifiers are used to alter the friction coefficient. Some of the friction modifiers used is graphite and cashew nut shells. Powdered metals are used to increase a material's resistance to heat wear. Some of the powdered metals used are lead, zinc, brass, aluminium and other metals. The binders are used to hold the friction materials used in the brake pad together. Commonly used binder is phenolic resin. To reduce the noise produced during braking, fillers such as rubber chips are added in small quantity to the friction materials. To identify when a brake pad has worn out, pad wear indicators are used. They produce a high screeching noise when the pad has worn down to a critical thickness level. This indicator thus warns the driver and helps to prevent damage to the rotor if the brake pad further wears. If it wears further, the indicator contacts the disc while the wheel turns and the brake cannot be applied. Thus the brake pad can be replaced when it has worn down.

Figure 5.Brake Pad

4.4 BRAKE LEVERS:

The brake levers are mounted on the handle bar of the vehicle within the reach of the hands of the rider. Base on how the brake levers transmit the force applied they are classified as:

- Mechanical Brake Lever
- Hydraulic Brake Lever

Figure 6.Brake Lever

4.4.1 MECHANICAL BRAKE LEVER:

The mechanical brake levers are usually used in bicycles which use mechanical cable to actuate the calliper for applying brake. They are of two varieties based on the length of brake cable pulled for a given amount of lever movement.

- Standard pull levers can work with most of the brakes including callipers, traditional cantilever brakes and mechanically actuated disc brakes.
- Long pull levers work with brakes like direct pull cantilever brakes and mechanically actuated disc brake.

4.4.2 HYDRAULIC BRAKE LEVER:

The hydraulic brake levers consist of a master cylinder, which is mounted to the handle bar. It produces the force that is required to move the slave cylinder in the calliper using brake fluid and the brake pads are clamped to the rotor. Hydraulic brake levers are used in most of the motorcycles and are efficient than the mechanical type. [7].

The stroke of the lever can be divided as:

- **DEAD STROKE:**

  It is the initial part of the lever stroke. In this stroke, the primary seal pushes the fluid toward the reservoir before it goes to the caliper through the brake tube.

- **PAD GAP STROKE:**

  It is the part between the caliper beginning to push the pistons from the housings and the pads contacting the disc, since the space between the pads and the rotor is taken up.

- **CONTACT AND MODULATION:**

  The pads clamp the rotor and after further movement of the lever, additional brake power will be generated. The modulation is controlled by the rider and it is not a part of the braking system. However better modulation or control of the braking forces may be allowed by some brakes.

4.4.3 MASTER CYLINDER:

The master cylinder in the hydraulic brake lever can be divided into two groups:

- Open system
- Closed system

OPEN SYSTEM:

This system includes a reservoir and bladder which are used to add or remove fluid from the brake system automatically. When the brake fluid expands due to the heat produced by braking, the reservoirs are used to overflow the fluid. The bladder is used to expand and contract thus as the fluid expands the bladder can compensate without any effect on the brake. As the pads begin to wear due to friction, the piston needs to protrude further to compensate the material lost due to the wear of the brake pad. This can be compensated by the reservoirs as they can provide additional fluid needed for the cylinder to further protrude.

CLOSED SYSTEM:

This system utilizes reservoir of brake fluid but it does not contain an internal bladder. Hence it cannot compensate the wear of the brake pad as the open system does. The levels of the brake fluid within the working system also need to be made manually.

4.5 BRAKE LINES:

Hydraulic brake lines play an important role in connecting the master cylinder and the slave cylinder in the brake. The hydraulic brake lines need to be versatile and its construction is more important. The brake line has three or more layers which are: [7]

- Inner tube
- Kevlar layer
- Outer casing

Figure 7.Brake Line

4.5.1 INNER TUBE:

The inner tube is designed to hold the brake fluid. The material most commonly used in this layer is Teflon since it does not react with the brake fluid also, it cannot be easily corroded.

4.5.2 KEVLAR LAYER:

This layer provides the strength and structure for the brake line. This layer is woven and it is flexible, since it must handle the high pressure of the hydraulic system efficiently so that it will not expand. The material used in this layer is Kevlar which is a synthetic fibre. It is used because; it is very light which is desirable for any component. It can also be cut easily and reassembled by using standard fittings available.

4.5.3 OUTER CASING:

The outer casing serves as a protection layer for both the inner tube and the Kevlar layer. The outer casing is made up of materials such as PVC which protect the inner layers from abrasion and debris from the road.

4.5.4 STEEL BRAIDED BRAKE LINE:

The brake lines can also be braided by steel and they have more advantage than the standard brake lines. It also has a three layer construction in which the inner most layer have the brake fluid and the outer most layer is a protective layer. The main difference from the standard brake line is that, the middle layer is made up of stainless steel braid. This layer is designed in such a way that it can be more resistant against the expansion of the brake line than the standard one. This is an advantage since when the brake is applied; all the force exerted by the rider is transferred to the calliper to cause braking without any loss of pressure in the expansion of the brake line. If there is any expansion in the brake line, some of the pressure may be lost in expansion and the driver has to give additional force in the brake lever to compensate the loss. This improves the effectiveness of the braking system by transferring the driver input force directly to the calliper. The stainless steel braided brake line has an outer coating with a clear or coloured material such as Polyvinyl Chloride (PVC).The steel braided brake lines are desirable due to their aesthetic design and their looks than the standard brake lines.

4.6 SPEED SENSOR:

Inductive proximity sensor is used to measure the rotation speed of motor. They are used to detect metallic targets only. Inductive speed sensors have a wide variety of shapes, sizes and designs. The main components of the sensor include a coil, oscillator, detector and an output circuit. They work on the principle based on a coil and an oscillator which creates an electromagnetic field in its surroundings of the sensing surface. The sensor's operating distance is based on the shape and size of the actuator and on the nature of the material. The sensor is supplied with electrical power which produces an alternating current to flow in the coil. When a conductive or magnetic target such as steel disk gets closes to the coil, the impedance of the coil changes. It detects the magnetic loss due to eddy current generated on conductive surface produced by an external magnetic field. It gives output voltage when subjected to a changing magnetic field. The voltage increases with increase in the speed of the motor. Proximity sensor provides medium or low resolution sensing, depends on the number of pulses measured per revolution. Inductive sensors can be operated in extreme conditions.

Inductive sensors are accurate, robust and reliable though they are bulky. They are also used to detect the presence or absence of a metal target and the electrical output works as a switch. These sensors are widely used in industries for applications which require electrical contacts in a normal switch which otherwise could cause problems due to the presence of dirt or water. They are used for safety related, high reliability applications or safety critical. They are common in aerospace, rail and industrials applications.

Figure 8.Speed Sensor

4.6.1 SENSOR SPECIFICATION[8]:

Table 2. Sensor Specification

TYPE	INDUCTIVE PROXIMITY
Power supply	12-24V
Working distance	About 2mm

ADVANTAGES:

Inductive sensors are widely used because of the following advantages:

- They have high accuracy when compared to other sensors
- The switching rate of inductive proximity sensors are high
- They are robust and can be used to work under harsh environment and have good protection against vibration, dirt, dust and moisture.

4.7 AUTOTRANSFORMER:

Autotransformer also known as auto step down transformer is an electrical device which has a single winding unlike ordinary transformers. In the autotransformer, the single winding act as both the primary and secondary sides of the transformer. Normally, the winding in an autotransformer have at least three taps at which electrical connections are made. They are small, light and cheap than typical dual-winding transformers. But it has a disadvantage in that; it does not have any electrical isolation. It has other advantages like lower leakage reactance, lower excitation current , lower losses, and high KVA rating. Autotransformers are used to step up or step up voltages in the range of 110-115-120V and in the range of 220-230-240V. For example, it allows equipment designed to use in 100 or 120V to be used in 230V supply.

4.7.1 WORKING:

The autotransformer consists of a single winding with two terminals at the end and one or more terminals in between the tap points. It can also be described as a transformer which has a part or all of its turns in common. Across the two terminals, primary voltage is applied and the secondary voltage is applied at two terminals having almost one common terminal always with the primary voltage. Thus the primary and secondary circuits have a number of windings in common. The voltage developed by both the turns is proportional to their number of turns since the volts per turn are same in both the windings. A part of the current flows directly from the input to output terminal in an autotransformer and only part is transferred in inductive form allowing the use of a smaller, lighter and cheaper core also requiring a single winding. The voltage and current ratio of the auto

transformer however can be calculated by the same way as the other two winding transformers.

One end of the winding in an autotransformer is usually connected in common to both the voltage source and the electrical load. The other end of the voltage source and the load are connected to taps in the winding. Different voltages can be applied by connecting in different taps measured from the common end. The load is connected by a tap across a portion of the winding in a step-down transformer while the source is usually connected across the entire winding. In a step-up transformer, the connections are converse, the source is connected to a tap across a portion of the winding and the load is connected across the entire winding.

The autotransformer does not have any electrical isolation between its winding as a normal transformer has. If there is a break in the part of the winding which is used both as primary and secondary winding, it can result in that the transformer may act as an inductor in series with the load. These are some of the important safety considerations while using an autotransformer in an application.

4.7.2 APPLICATION:

Some of the applications where autotransformers are used are power transmission and power distribution. Some of the advantages of the autotransformer are that they are smaller, lighter and cheaper than the dual winding transformer. The autotransformers transfer power by using time-varying magnetic fields. They do not work on direct current but require alternating currents to operate properly. As with transformers having two windings, they are equipped with many taps and automatic switch gear to allow acting as automatic voltage regulators to maintain a steady voltage.

4.8 BATTERY:

A battery is a device which is used to produce electrical energy by converting the chemical energy from the electrochemical cells. Each cell in a battery contains positive and a negative terminal. The positive terminal is known as cathode and the negative terminal is known as anode. The current is produced by the motion of ions between the electrodes and thus the battery works.

Batteries are of two types which are:

- Primary or non rechargeable batteries
- Secondary or rechargeable batteries

4.8.1 PRIMARY BATTERIES:

Primary batteries can be used only once and after use they are disposed. This is because; the electrode materials undergo irreversible change during discharge and they cannot be recharged by passing electric current like a secondary battery. It can be described in general as, the electrochemical reaction taking place in the cell is not reversible thus making it not rechargeable. The major factor that reduces the lifetime of a primary battery is that they become polarized while using. This is caused due to the accumulation of hydrogen at the cathode which reduces the effectiveness of the battery. The primary battery has a lower self-discharge rate, thus they can be stored for a long period thus its full capacity is available for use. Some of the examples are alkaline batteries, silver oxide cell, button cells which are used for many devices.

Figure 9.Battery

4.8.2 SECONDARY BATTERIES:

Secondary batteries are also known as rechargeable batteries. They have to be recharged before they are first used since they are assembled with active materials in the discharged state. They can be recharged by applying electric current; this reverses the chemical reactions that took place during discharge. The lead acid battery is the most common type of secondary battery used. It is because of their low manufacturing cost and they produce high current. Though they are relatively heavy for the amount of current it can supply. The sealed type lead acid battery is popular in the automobile and other electronic applications. The performance of a battery may vary due to charge cycle and over load.

We are using lead acid battery in this project for giving supply to the solenoid valve operation. Another 6V lead acid battery is used for supplying power to the proximity sensor used.

The specifications of this battery are:

- Voltage – 12V
- Capacity – 1.3Ah
- Constant voltage charge

4.9 MOTOR:

An electric motor is an electric device that is used to convert electrical energy into mechanical energy. Most of the electric motors operate through interaction between the motor's magnetic field and winding current required to generate force in the motor. A motor consists of the following parts:

4.9.1 ROTOR:

A rotor is the moving part in a motor which is used to turn the shaft to deliver the required mechanical power. It has conductors which carry current that interact with the magnetic field generated by the stator to produce forces required to turn the shaft. Some of the rotors consist of permanent magnet while the stator holds the conductors.

4.9.2 STATOR:

It is the stationary part in the motor which usually consist of windings or permanent magnets. It is a part of the electromagnetic circuit and its core is made up of many thin metal sheets called laminations. The laminations are used to minimize the energy loss that may occur if a solid core was used in the stator. An air gap is allowed in between the rotor and the stator. The air gap is generally very small since large air gap causes a strong negative effect on the performance of the motor.

4.9.3 WINDINGS:

Windings are wires which are laid in coils that are wound around a laminated soft iron core. This forms magnetic poles when they are energized by passing electric current. Some of the conductors used in used in motors consist of thicker metal such as sheets or bars of metal, usually copper although aluminium may also be used. They are powered by electromagnetic induction.

4.9.4 COMMUTATOR:

A commutator is used to switch the input of AC and DC machines which consists of slip ring insulated from one another and from the motor shaft. The armature current of the motor is supplied through stationary brushes in contact with the commutator. It causes required current reversal and it applies power to the machine in an optimal way as the rotor rotates from pole to pole.

4.9.5 SUPPLY AND CONTROL:

The supply for the DC motor is through slip ring commutator and for an AC motor, it is through either slip ring or they may be externally commutated type. Universal motors can run on either AC or DC supply. AC motors which have fixed speed are controlled with direct on line or starters. Variable speed motors are provided with a range of power inverter variable frequency or electronic commutator.

MOTOR SPECIFICATIONS:

Table 3.Motor Specification

Power	¼ HP (180W)
RPM	1440
Phase	Single
Voltage	220V,50Hz
Current	0.88A

4.10 DISC:

A brake disc is used in automobile brakes most widely. They are more effective in braking than the traditional method. It is usually made up of cast iron and may also be made of composites like reinforced carbon or ceramic composite matrix. The brake disc is connected to the wheel of the vehicle or in axle in four wheelers. Brake is applied on the disc by using brake pads mounted on a calliper which presses against the sides of the disc. The friction caused by the brake pads allows the wheel to stop. Friction causes heat and if the disc gets so hot, the brake becomes less effective. [4]

The brake disc is a component of a disc brake against which the brake pads are applied. Different types of components and sizes are used in the manufacture of the disc brake. Some of the discs are solid while others are hollow with fins or vanes for effective braking. The weight and power ratio of the vehicle is used to determine the type of brake disc to be used. The brake disc is ventilated to dissipate the heat generated during braking. High performance brakes have holes

drilled in it. The brake discs may also be slotted which aids to remove the dust and gas produced during braking. Some of the disc brakes are both slotted and drilled.

To avoid thermal stress and cracking the disc is allowed to expand in a controlled manner by mounting the disc in a half loose way. The drilled or slotted disc has a good effect in wet roads, since the holes prevent water build up between the disc and pads. Motorcycles have floating type discs where the disc is allowed to slightly move laterally. Thus the disc is aligned in the centre when used with fixed calliper. The heat transfer to the wheel hub can be prevented under hard braking by using this type.

The discs used in racing have reinforced carbon material. They provide better frictional performance and have improved structural properties at high temperature. The ceramic discs have high heat tolerance and mechanical strength though they are expensive. The disc may be damaged by the following ways; scarring, cracking, warping or excessive rusting. The disc can be replaced when the thickness of the disc reaches manufacturers minimum recommended value, which makes them unsafe to use or when rusting is severe. The vibration and noise produced by the disc can be rectified by brake disc skimming. It is a machining process, in which a very thin layer of the disc is removed to clean off minor damages and to restore the disc to uniform thickness.

CHAPTER 5

ADVANTAGES IN OUR METHOD:

- We use electronics for braking, so accuracy is more

  There is no mechanical part used in the actuation of the solenoid valve, which reduces any disadvantage of wear in the material and no friction is produced.

- Better comfort when braking

  When operating under ABS, the brake pedal pulses or kick backs under the hand of the driver and could also produce thumping noise and vibrations in the brake lever. Unlike this, the vibrations produced in the brake lever are very low in our method. This ensures the comfort of the driver while riding the vehicle.

CHAPTER 6

LOOKUP TABLE

Table 4.Lookup Table

SPEED	FREQUENCY
950-1000	30
900-950	33
850-900	36
800-850	39
750-800	42
700-750	45
650-700	48
600-650	51
550-600	54
500-550	57
450-500	60
400-450	63
350-400	66
300-350	69
250-300	72
200-250	75
150-200	78
100-150	81
50-100	84
0-50	87

CHAPTER 7

PROGRAM

```
#include"TimerOne.h"

unsigned int bs=8,ss=9,s=10,sp,i,t;

float m=-.06,c=87;


void setup()

{

  Serial.begin(9600);

  pinMode(bs, INPUT);

  pinMode(ss, INPUT);

  pinMode(s, OUTPUT);

  Timer1.initialize();

  Timer1.attachInterrupt(control,8000000);

}


void control()

{

  digitalWrite(s,!digitalRead(s));
```

```
  Timer1.setPeriod(t);
}

void loop()
{
  //    getting_speed
  while(1)
    if(digitalRead(ss)==LOW)
    {
      while(digitalRead(ss)==LOW);
      for(i=0;digitalRead(ss)==HIGH;i++)
        delay(1);
      for(;digitalRead(ss)==LOW;i++)
        delay(1);
      break;
    }

  //    calculating time of pulse
  sp=60*1000/i;
```

```
 t=m*sp+c;
 Serial.println(sp);


 if(digitalRead(bs)==HIGH)
 {
   Timer1.start();
 }
 else
 {
   Timer1.stop();
   digitalWrite(s,HIGH);
 }
}
```

CHAPTER 8

ELECTRONIC PART

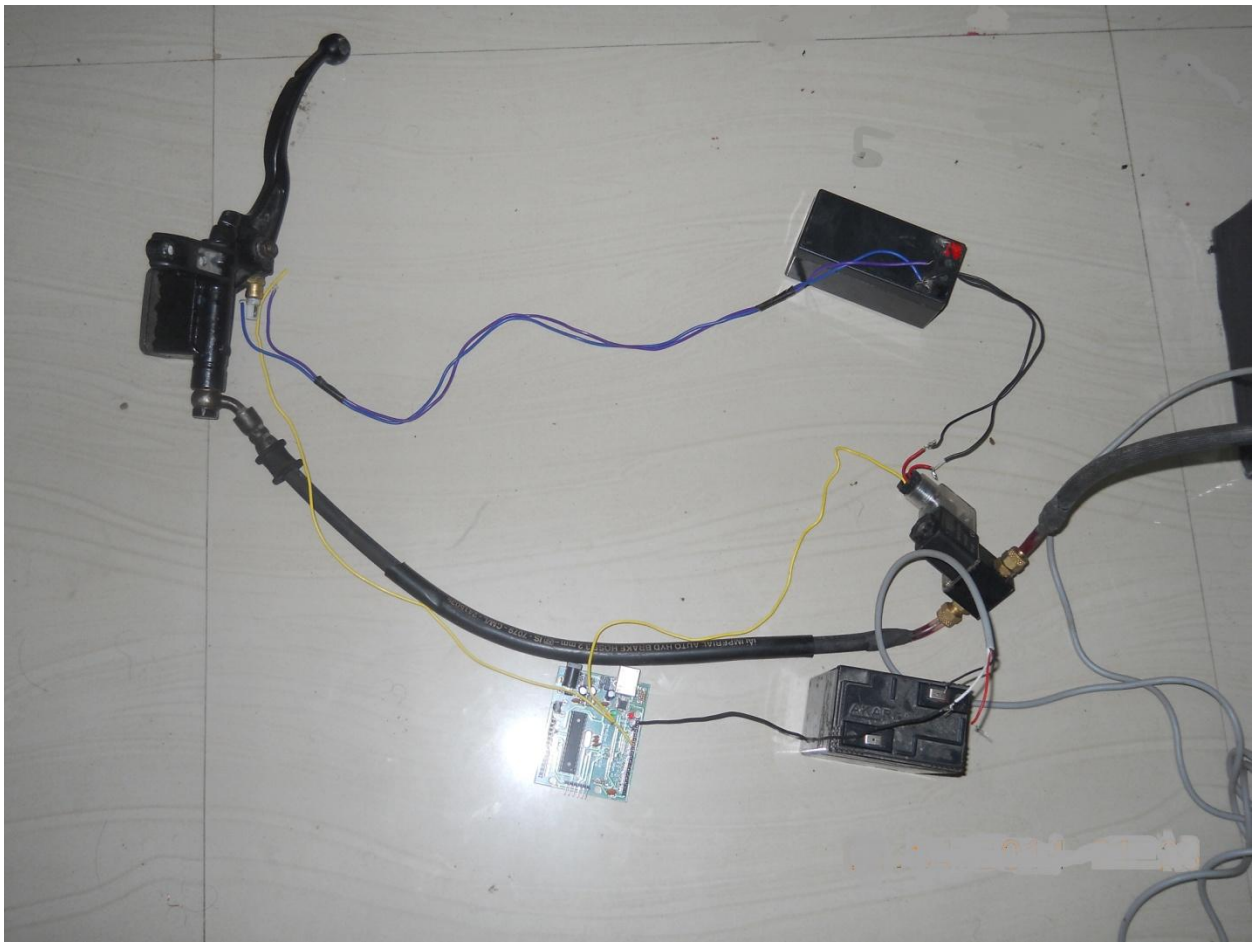

Figure 10.Electronic Part

CHAPTER 9

MECHANICAL PART

Figure 11.Mechanical Part

CHAPTER 10

PROJECT SETUP

Figure 12.Project Setup

CHAPTER 11

RESULT:

The hydraulic modulator in the Antilock Braking System is replaced with electronic control unit using solenoid valve, which is controlled by arduino microcontroller. The speed of the motor is sensed by an inductive proximity sensor and is fed to the controller. The disc is attached with a motor for applying brake. According to the speed sensor value the brake is applied. The prototype was fabricated and the result was obtained as desired.

CHAPTER 12

CONCLUSION:

Thus it can be seen from the experiments that the effect of an applied brake on the rotating disc attached with the motor produces a good result.

In future the implementation of the project in real time motorcycle can produce better value. Good results with current design, a larger budget would improve performance.

CHAPTER 13

COST ESTIMATION

Table 5.Cost Estimation

S.NO	COMPONENTS	QUANTITY	COST (RUPEE)
1.	Arduino microcontroller	1	1700
2.	Solenoid Valve	1	550
3.	Brake Calliper	1	1000
4.	Brake Lever and Line	1	400
5.	Battery	1	500
6.	Motor	1	700
7.	Disc	1	400
8.	USB to Serial Cable	1	60
9.	Miscellaneous Costs	1	800
10.	Brake oil	1	90
TOTAL			**6200**

CHAPTER 14

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