SPEED CONTROL OF A DC MOTOR THROUGH PLC INTERFACING WITH PROXIMITY SENSOR

by

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CERTIFICATE OF APPROVAL

The project entitled as **"Speed Control of a DC Motor Through PLC Interfacing with Proximity Sensor"** submitted by Md. Akram Hossan, bearing Matric ID ET171017 of session December 2021, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial accomplishment of the necessities for the degree of Bachelor of Science in Engineering and permitted for the examination held on date **24th December, 2021.**

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DECLARATION

It is hereby stated that this work has been completed by me and no part of the work contained in this project has been submitted elsewhere for the award of any degree.

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MD. AKRAM HOSSAN

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At first all of my honor and gratitude to almighty Allah, the Most Merciful, the Most Beneficent, who assisting me for completing my work successfully. Then my respect for my parents by whom I am being raised. Then my heartedly respect to my supervisor ‘Engr. Sk. Md. Golam Mostafa’ whose advice and support take me a long way. Not only his supervision helped me academically but he placed a great impact on my life motivationally. Finally, I am gratifying to all of my teachers and friends, who supported me to carry out this work because without their courage I won’t be today where I am.

Author

ABSTRACT

At present in the industry, the DC motor is commonly used because of its simplicity in speed control and it gives specific output, that's why the necessity of the DC motor is in huge demand for industrial purposes. The object of this project is to develop a system where speed of DC The motor can be controlled by collecting the feedback of proximity sensor interfacing with PLC. DC motor speed can be controlled by many ways and also it is conducted for many purposes. The Key benefit of conducting DC motors at present because of the capability of controlling motor speed easily. All kind of DC motor has its inner process such as electro mechanical or electronic for changing the flow of current direction. But huge dc motors have several usage as like as propulsion of electric vehicles, elevators, etc. Basically we can control motor speed by using flux control technique, armature (coil) control technique, voltage control technique. Control of DC motor speed is vital where a huge change of speed is needed. In this project, developed an idea which is implemented for controlling DC motor speed using Proximity sensor feedback and Programmable Logic Controller (PLC) to fulfil the technique for controlling and evaluating the DC motor speed rotation. In an open loop system output is not dependable and also not properly accurate. Therefore to get more accurate output from system closed loop systems are used. Because in the closed loop system it can automatically controls to get a wanted position or set point without human collaboration. PLC is designed for industrial usage. It holds several sorts of i/o which are properly alike with the industrial instrumentation. PLC delivers the elasticity for programming particularly the "ladder language" which is related to industrial standard "ladder Network".

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LIST OF ABBREVIATIONS

C.B	Circuit Breaker
DAQ	Data acquisition
I	Current
IoT	Internet of Things
NO	Normally Open
NC	Normally Close
PLC	Programmable Logic Controller
PID	Proportional integral derivative
PCB	Printed Circuit Board

CHAPTER 1

INTRODUCTION

1.1 Introduction

DC motor speed can be controlled by mechanical system or electrical system. DC motor speed control procedure system is more easy and low costing than AC drive. DC motor has certain essential applications such as different kinds of grinders which is extensively in industry. DC motor basically uses on those purpose where precise and fixed output is essential. The PLC is a devoted method intended for industrial usage. For industrial automation system and controlling purpose PLC system was used first introduced at 1968 and day by day it's developing extensively. PLC holds the several sorts of i/o that are appropriately equivalent with the industrial instrumentation. Also delivers the elasticity for programming mainly "ladder language" that is like to the industrial standard "ladder Network". This is related to industrial standard "ladder Network" [1]. Proximity sensor used for the purpose of detecting object. The object of this project is to develop a system where speed of Dc motor can be control by feedback of proximity sensor interfacing with PLC.

1.2 Background of the Project

Today's industry is increasingly demanding the automated processes in everywhere. Automation leads to higher quality, higher production, and lower costs. Speed control drives that can adjust the speed of AC / DC motors, which are an important control element of automation systems. Depending on the application, some of them are fixed speed drives and others have adjustable speeds. Variable speed drives had some limitations until decades ago. For example, microcontrollers with multiple types on the same silicon wafer completely changed the scene, and today there are variable speed drive systems that are not only small, but also very efficient and reliable. Therefore all of the requirements of different industries is fulfilled.

Direct current (DC) motors have been widely used in speed drives for adjustable the speeds of motor. The drives characteristics of DC motors can provide the high starting

torque required for traction drives. Control over a wide speed range, both above and below the rated speed, is very easy to achieve. Speed control technology is simpler and less exclusive than the technology used in AC motors. Various techniques are available to adjust the speed of the DC motor. Although phase control technology is widely adopted, it has certain limitations, and it also has p.f when it produces harmonics in the power line and operates at low speeds. The second technique is to use pulse width modulation, potentiometers, and IR sensors to control the speed of the DC motor. The purpose of this project is to develop a drive system that can control the speed of a DC motor using proximity sensor feedback connected to a PLC.

1.3 Motivation

Different kind of method can be used for DC motor speed control. But most of them is expensive. Every company in industry wants to implement any system at low cost with proper output. This project is developed a system which is low cost and comparatively get proper output.

1.4 Objectives of the Project

- To design a Control system of DC Motor with higher efficiency
- Numerical analysis of Dc motor speed using proximity sensor with PLC

1.5 Outline of the entire report

This manuscript has the following structure: The Speed control of a DC motor through PLC interfacing with proximity sensor system literature review provided in chapterc2. The methodology of the entire project is given in chapter 3, Result and discussion is given in chapter 4. Last of all, the major contributions of this study are summarized in chapter 5.

Chapter 2

Literature Review

2.1 Introduction

This part gives an overview of DC motor speed control and other types of features. Motor speed control means changing the speed according to the load requirements associated with the motor. This can be done by mechanical means such as stepped pulleys, variator wheel sets, and contact clutch mechanisms. However, electrical speed control has significant advantages over mechanical speed control. DC motors offer simple speed control, so DC motors are better suited than other types of motors for a variety of applications. Several speed controlling technique is acquired this technique for controlling of DC motors speed typically easy and not as much of exclusive rather of AC. Key benefit of consuming DC motors at present, cause of capability of simply controlling its speed. Afterward I made an analysis on work related to design, analysis and testing of several types of DC motor speed control technique.

2.2 Controlling of a DC Motor speed Usage Pulse Width Modulation, Potentiometer and IRSensor

Shubham Banerjee et al. Proposed a system on speed control of DC motor in 2018. It is based on DC motor speed can be controlling by several technique. Here the system is used as Arduino, IR Sensor, and Potentiometer also used motor for controlling speed of the DC. This project hasbeen successfully carried a method to obtain DC motor speed controlling technique. Use of PWM its use of adjusted circuit so motor can control both logical and manual and also has an IR sensor which can modified by Tachometer [3].

2.3 Controlling of Dc motor speed using Lab VIEW

G. Pradeepa et al. proposed similar approach in 2019. The research is a closed-loop system consists of some electrical elements such as DC motor, a proximity sensor, and a PID controller controlled by Lab VIEW. This DC motor is controlled in Edge Lab VIEW via a PID that processes the output from the sensor and controls the output. That is, the engine. Lab VIEW controls the speed of the motor by checking the output and getting

the desired speed of the motor compared to the proximity sensor via the PID controller. **Fig. 2.1** and **Fig .2.2** is the block diagram for controlling DC motor speed. The motor is driven by the driver IC (L293d). The output of the motor is directed to the proximity sensor. The proximity sensor detects the output voltage and transfers it to DAQ. The PID is expected at the start of DAQ. This PID will perform changes or sabotage. Changing the PID amplification reduces errors. [4].

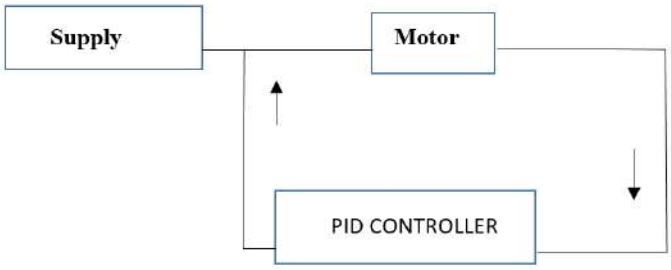


Fig. 2.1: Block Illustration of controlling of DC motor speed [5]**.**

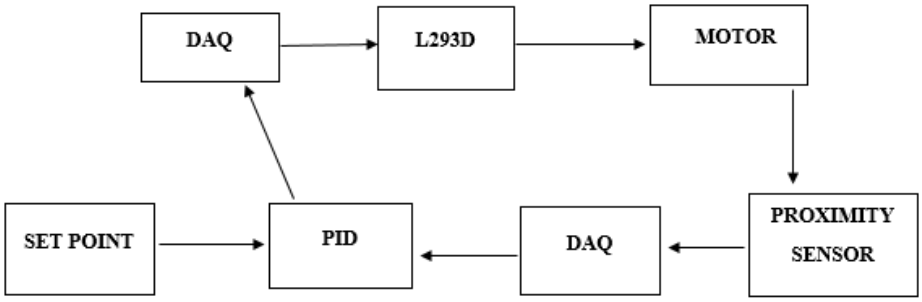


Fig. 2.2: Overall block illustration of Lab VIEW based speed control [4]**.**

2.4 Controlling of DC Motor speed by Using IoT

P. A. Uparwat et al. also proposed a design IoT-based DC motor speed control. The key procedure of this entire project, which relies on IoT-based systems to connect the hardware. B. Using Wi-Fi and the Internet is a very important part of its functionality. All programming is done in the Arduino IDE and then loaded into the ATMEGA328

microcontroller with the help of Wi-Fi and some sensors. The required result is achieved by protecting the motor from irregular or unstable conditions. Monitoring of some motor parameters such as temperature, current, voltage is achieved and the direction of movement of the motor is controlled with the help of heat in the motor recorded by relays and temperature sensors [6]. **Fig. 2.3** is the overall operational of project in terms of block illustration which is shown below.

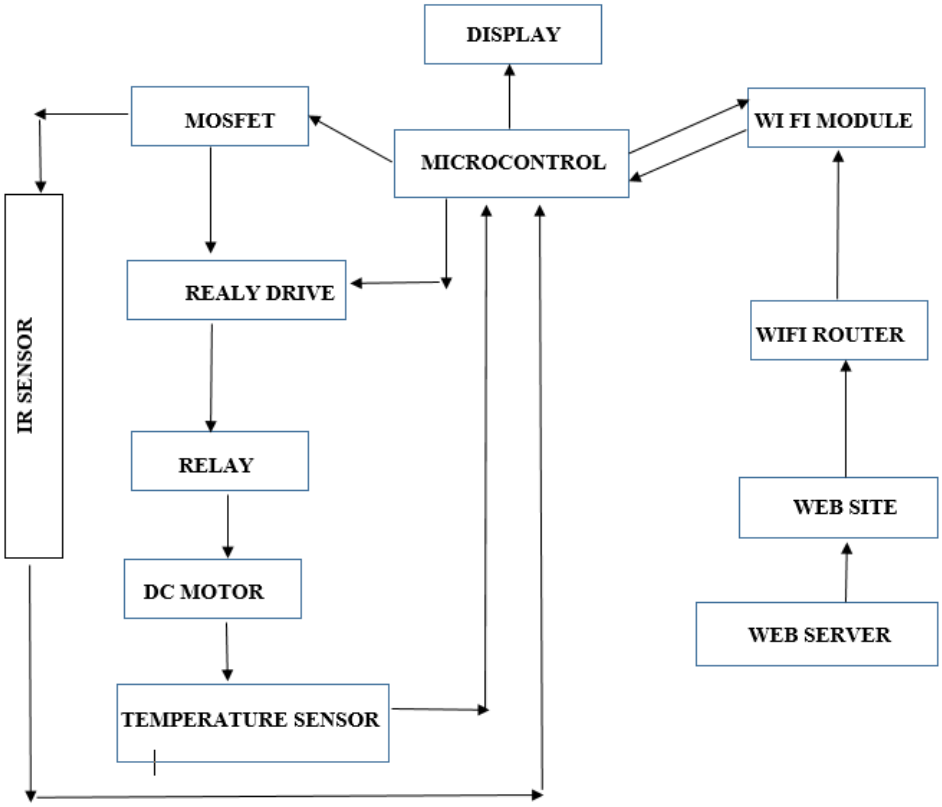


Fig. 2.3: Block Illustration of Speed Control of DC Motor by using IoT [7].

CHAPTER 3
METHODOLOGY

3.1 Introduction

Because of the quick performance of motors, this motor is controlling for extensive variety of speeds that's why it has countless usage. Key benefit for use of DC drive at present cause of controlling speed capability so easily. Speed controlling is compulsory cause of performs a particular work. Electrical speed control has several economic and technical advantages over mechanical speed control. These speed control systems required for industrial machinery vary by category. Some machines may require a permanent identification speed for the overall sorting of a single part of this assembly, while others require double or additional static speed. The purpose of the project is to roughly control the speed of the DC motor by PLC. The advantage of this controller is more than a predictable control loop. Performance properly in the worst of situations. The main methodology for this entire project is controlling the speed of DC motor through PLC interfacing with proximity sensor. PLC interfacing with proximity sensor based system helps to measure the rotation of the motor without spectator and it is a closed loop system it can operate automatically. The system is made up of several electrical and electronic components such as DC motor, Proximity sensor, Relay, PLC, Rectifier Diode, Push button switch, Regulator. Furthermore, transformer also used for step down the supply voltage.

3.2 List of Components

- DC Motor
- Mitsubishi PLC Fx1s
- NPN Proximity sensor
- Transformer 220V to 12V
- Rectifier Diode
- Relay
- C.B

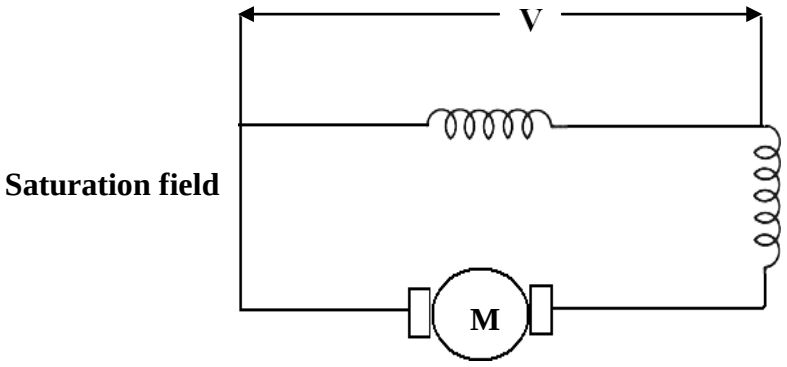
3.3 Description of Components

3.3.1 DC MOTOR

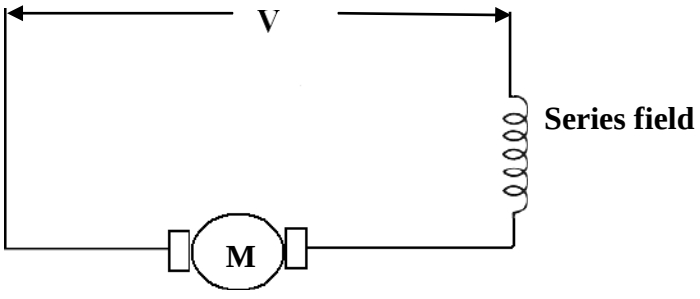
It is defined as a classification of motors which transform energy from electrically to mechanically. It speed can be controlled by using most suitable method. Through speed can be controlled of motor, one may change speed following the necessities and may acquire the requisite process. Controlling speed mechanisms are appropriate in numerous conditions as like as controlling of any robotic machinery.

3.3.1.1 GROUPING OF DC MOTORS:

This motor is categorized in three categories provisional on the mode of their windings. In **Fig. 3.1** this three classes motor has been presented in below.



Shunt motor



Series motor

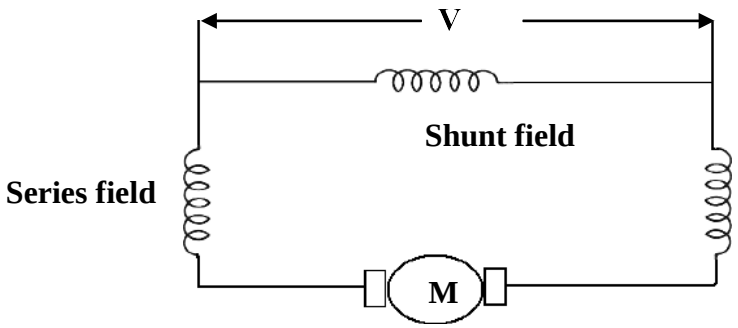


Fig. 3.1: Grouping of DC Motor.

3.3.1.2 CONTROLLING SPEED OF DC MOTOR

Usually DC motor is adaptable speed conduct than AC motors that is linked with fixed speed spinning field. Certainly the prime reasons for huge use of DC motor in current industries as it has extensive variety of quantified deliver which we see from below:

$$N = K(\phi)$$

$$= K(V - Ia\,Ra / \phi)$$

Here V= source energy

Ia = coil current

Ra=coil resistance

Φ=flux each pole

This calculation provides two techniques of successful speed variation.

3.3.1.3 CONTROLLING THE SHUNT MOTOR SPEED

3.3.1.3.1 TECHNIQUE OF CONTROLLING FLUX:

It's recognized Nα1/ Φ via reducing flux, which is improved and contrarily. Hereafter, it's define as technique of controlling flux with the assistance of a shunt field rheostat, DC motor flux may be rebuilt. Because the shunt field rheostat only has to transmit a limited amount of information, the rheostat is compact in size. As a result, this technique is effective in non-interpolar devices. This method can enhance the speed via a factor. But any additional weakening of the flux will have a negative influence on relationships. The construction illustration for controlling speed is presented in **Fig. 3.2**

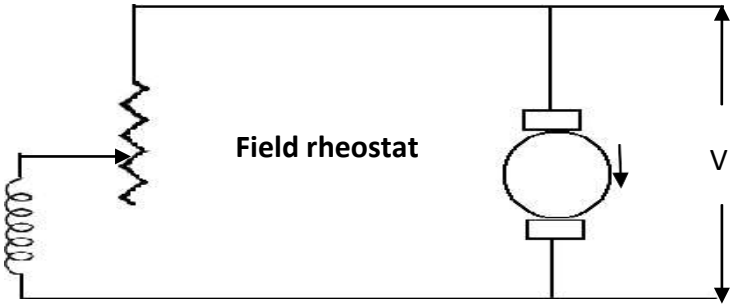


Fig. 3.2: Flux Control Technique.

3.3.1.3.2 COIL CONTROL TECHNIQUE

In **Fig. 3.3** the coil control technique is drawn in below.

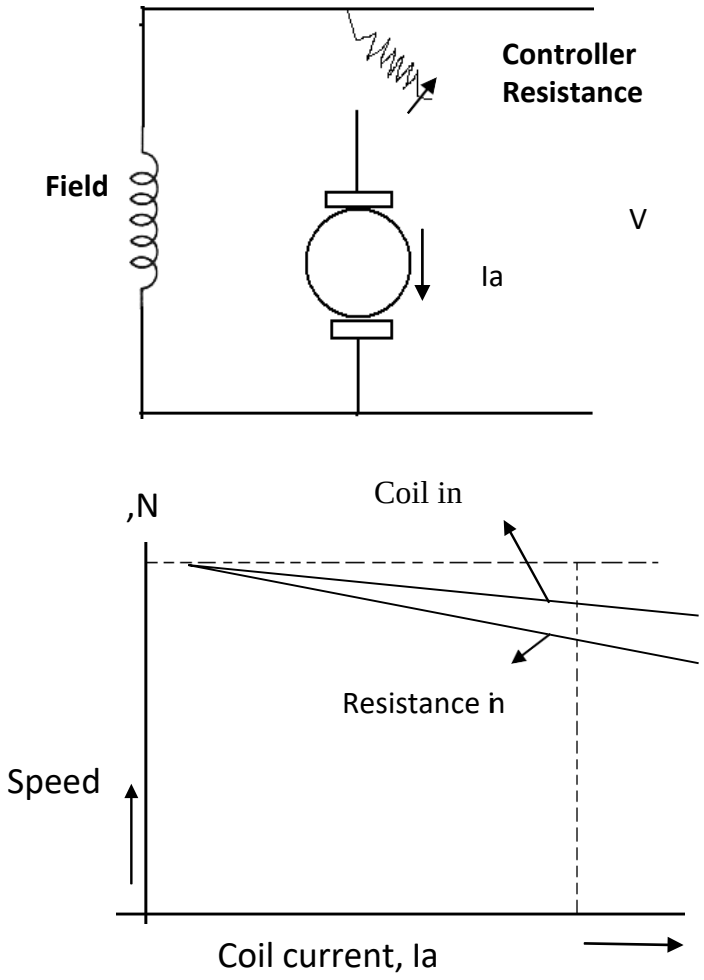


Fig. 3.3: Rheostat Control Technique and Characteristics.

If speeds under the zero load speed is necessary, this approach is utilized. Because the power supply is typically fixed, the power all over the coil is changed by connecting the coil circuit to a changeable rheostat as well as controlling resistor. As the controlling resistance rises, the voltage differential across the coil falls, lowering the field speed. Speed is nearly proportional to the voltage differential for a fixed torque load.

Through the coil electricity properties in figure. Where we see

Suppose,

Ia1 = Coil electricity for first step

Ia2 = Coil electricity in the second step N1, N2 = similar speeds

V = source power

Next N1 (v-Ia1Ra) αEb1

Suppose certain controlling resistance rating R remain additional to coil circuitry resistance thus this rate will be

Next

R+Ra = Rt

N2 α (V-Ia2 Rt) α Eb2 N2/N1=Eb2/Eb1

Bearing in mind zero load speed, then

$\mathbf{N/N0\ (I - (Ia\ Rt)/\ (V - Ia0\ Ra)}$

Ignoring Ia & Ra w.r.t.to V, then

N=No (I-(Ia Rt)/ V

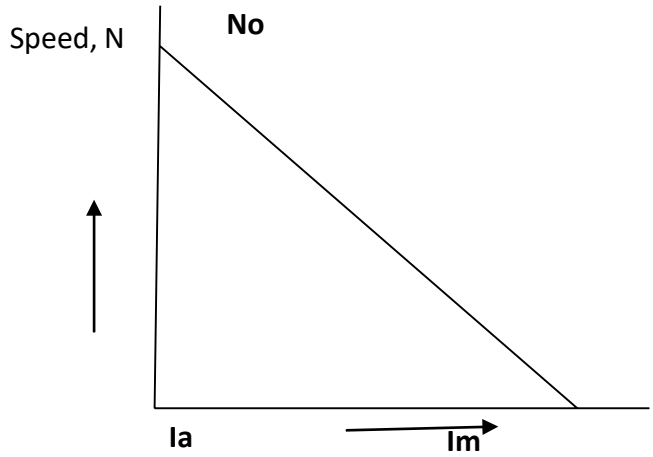


Fig. 3.4: Speed vs Current.

The load current which speed will be found null by when N=0 in upper

0 = N0 ((I-Ia Rt)/V)

Or else Ia = V/Rt

From **Fig. 3.4** and **Fig. 3.5** we observe that its current is determined. Because speed changes with load for a known amount of Rt, this process is costly, limited, and unsuitable for quickly changing loads. To use a deflector all over the coil in conjunction to coil controlling resistance can provide a steadier functioning.

So, variations in coil current are not active for varying the voltage differential all over the coil. The joining illustration for controlling speed process is given away in figure.

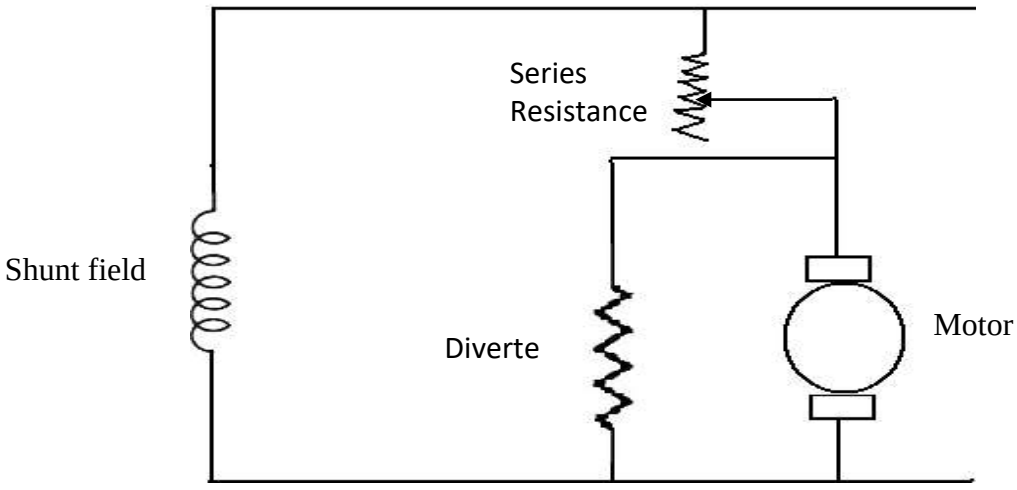


Fig. 3.5: Coil Control Technique.

3.3.1.3.3 TECHNIQUE OF CONTROLLING VOLTAGE

A) CONTROLLING MULTIPLE VOLTAGE:

Motor's shunt field is constantly linked to a set energizing voltage in this approach, however the coil is provided with several voltages by wiring it around one of the voltages using appropriate switchgear. These various voltages will be roughly proportional to the coil. The shunt field regulator may be adjusted to obtain the changeover speeds.

B) SYSTEM OF WARD LEONARD:

The system can be used for electrical tructor, and key operations in manufacturing plants, as well as flourishing in paper industry, where an incredibly complex and quite delicate speed control is compulsory. The area of the machine (M1), which is permanently linked all over the Dc voltage for speed regulation. Some other machine, M2, is linked to Generator G directly. The key drive M1 receives the output voltage of G straight. By using a field regulator, the energy of the generating may be adjusted from nil to highest. The produced voltage and, thus, the manner of spinning of M1 may be changed by varying the path of the field current of G through the reversing switch RS. It's worth remembering that the motor set always follows the similar track.

3.3.1.4 APPLICATIONS FOR MOTORS:

The torque speed properties of DC motors are good, and they have a wide range of speed control. Efforts are being made to achieve a wide range of speed control using ac motors, but dc motor the adaptability are still lacking and can’t be matched by a ac motors. Considering this, the request for dc motors would remain undiminished even in figure. A momentary discussion regarding the dc motor applications is given below.

3.3.1.4.1 SHUNT MOTORS:

- For a certain field current in a shunt motor, speed fall from no load to full load is regularly less than 6% to 8%. Considering this, the shunt motor is called a constant speed motor. So for constant speed drives in industry, dc shunt motors could be employed. On the other hand motor can’t complete with fixed speed squirrel cage induction motor, since the latter cheaper, rugged and requires less.

- When constant speed service at low speeds is requisite, the evaluation is usually between synchronous motors and dc shunt motors. It is for the construction of high performance poly phase induction motor with massive number of poles is difficult. Though, for adjustable speed service at low operating speed, dc shunt motor is a chosen choice
- When the driven load requires a wide range of speed control (both below base speed and above base speed), a dc shunt motor is utilized, e.g. .in latches etc.

3.3.1.4.2 SERIES MOTORS

The remaining feature of series motor is the automatic reduction in speed as soon as enlarged load torque is required. The decreasing speed with increase in load torque or vice versa has only a marginal outcome on the power taken by the series motor. Since a series motor can bear severe starting duties and can deliver high starting torques, it is best suitable for driving hoists, trains, excavators, cranes, etc. wound motor induction motors compete favorably with series motor's nonetheless the selection is directed via the economical. Though for grip drives, sequence motor single selection. So series motor is broadly conducted in all forms of electrical system.

3.3.1.4.3 COMPOUND MOTORS

The properties of a compound motor with a solid sequence field are similar to those of a series motor. As a result, compound motors are employed for loads that require a high beginning torque that is expected to be decreased to nil. The properties of a compound motor with a low sequence field are similar to those of a shunt motor.

3.3.2 PROXIMITY SENSOR

Proximity sensor is used for locating and recognition of metallic substances. Its sensing vary of associate inductive adjustment depends on the Sort of metal being detected. Yield a protracted recognizing vary, whereas metallic element and copper, could cut back the sensing vary by up to sixty p.c. Since the output of associate inductive sensing element has 2 doable states, associate inductive sensing element is typically mentioned as associate inductive proximity switch. Sensors square measure conducting for without touching recognition of gold- bearing items. A 3-wire inductive proximity sensing element is associate device which will sight metal (Fe) targets with none physical contact. Once it detects that focus on, it operates an interior electronic switch. As a result of the sensing element is associate device it needs a DC power supply. Proximity sensors square measure getting used in business these days to exchange devices like mechanical limit switches. There are 2 several types of 3-wire Inductive Proximity Sensors NPN and PNP.

3.3.2.1 Proximity Sensor working procedure

The generator generates a balanced, oscillatory force arena that discharges from primary solid solution metal selection at the identifying face. **Fig. 3.6** is described the working process of proximity sensor. Once a metal goal come in that force field, tiny freelance electricity that square measure elicited on the metal's surface.

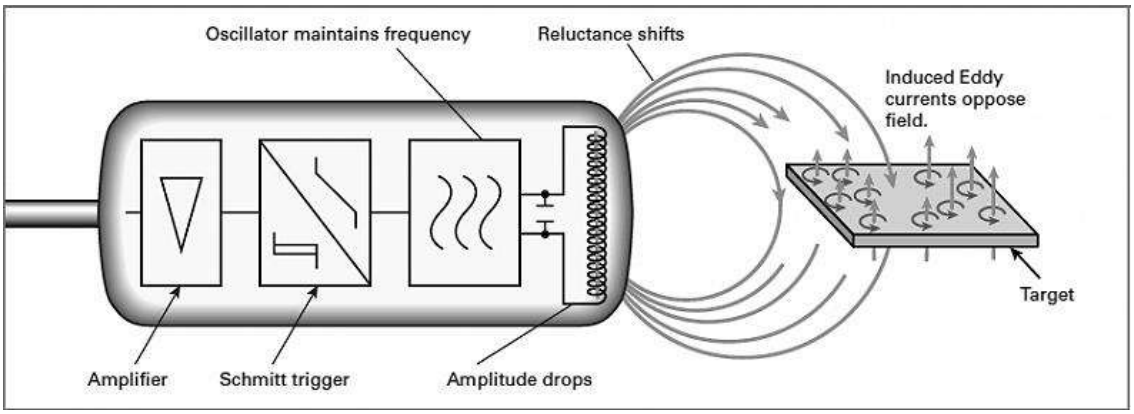


Fig. 3.6: working technique of proximity sensor [8].

Sensor has sensing element also frequency vary ten to twenty cps in ac, or five hundred cps to five kilohertz in dc. Owing to force field boundaries, sensor has a comparatively slender identifying vary similar to sections of mm to sixty metric linear unit on a mean. Here **Fig. 3.7** shows the illustration of proximity sensor.

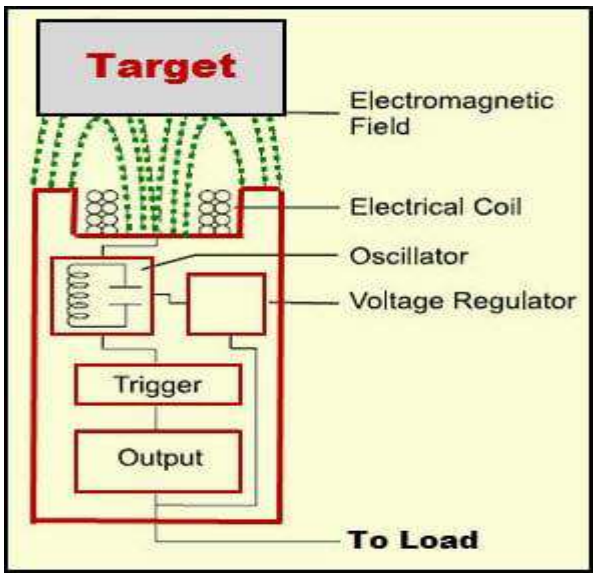


Fig. 3.7: Block illustration of proximity sensor [8].

Cause of this, load are affected on the device which reductions the magnetic attraction field amplitude. The eddy current might flow more freely if the metal item travels closer to the proximity device. We can see the waveform of a proximity sensor from **Fig. 3.8** .As a result, the load on the generator might rise, lowering the section width. The Schmitt trigger prevent checks the generator's amplitude and flips on or off the device when it reaches a certain level. If the metal item or target is moved far away from the source, formerly the width of the generator can growth.

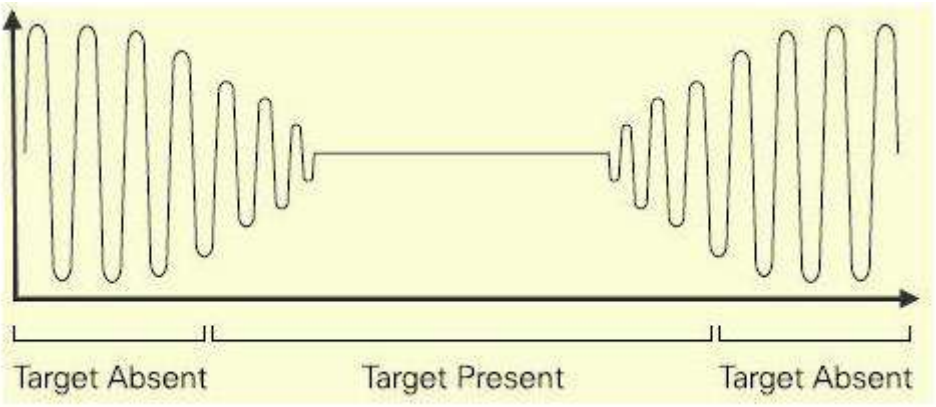


Fig. 3.8: waveform of the inductive proximity sensor [8].

3.3.1.1 Applications of Inductive Proximity Sensors

- Recognition metal portions in severe surroundings.
- Quick movement portions.

3.3.1 RECTIFIER DIODE

Rectifier is two terminal semiconductors which allows just single way of current to flow. Tangency diodes are often made by connecting n type and semiconductor device components. P type appearance is referred to as the anode, whereas the n-type appearance is referred to as the cathode. Diodes come in a wide range of shapes and sizes, and they're utilized in a wide range of usage. These are used to convert AC volts to DC volts and are hence an important component in power supplies. The rectifier diode has 2 teams of technical parameters like permissible limit parameters and characteristic parameters.

3.3.1.1 Rectifier Diode Circuit Working

Chemicals are coupled with a specific manufacturing process to produce combined n type and p type substances, which result in the development of a tangency. Because this tangency contains two endpoints that might be referred to as electrode, it is referred to as a "DIODE." Biasing occurs when an external DC supply voltage is supplied to a device via its connections.

3.3.1.2 Half-Wave Rectifier

Among the most popular applications for the diode to convert AC electricity to DC. Because a diode only conducts current, there will never be any current if the input becomes negative. A half-wave rectifier is what this is called. The half-wave rectifier diode circuit is shown in **Fig. 3.9** which is the illustration below.

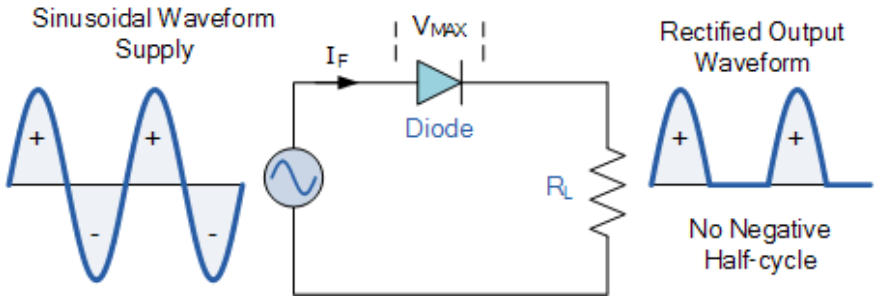


Fig. 3.9: Half-Wave Rectifier [9].

3.3.1.3 Full-Wave Rectifier

- Diode circuit builds by 4 diodes; through this construction we are capable of build each halves for progressive wave. Each positive and negative phases of input, there are an onward path over the diode connection.
- While 2 diodes area unit forward biased, the reverse two area unit opposite biased and efficiently eradicated from circuitry. Each physical phenomenon ways foundation of electricity drifting within the matching path over resistance, accomplishing full-wave rectification.
- Full-wave rectifiers area unit employed energy provides for transform AC volts to DC volts. An enormous electrical device in corresponding through load resistance diminishes the wave from the modification method. Beneath figure **Fig. 3.10** displays the waveform of full wave rectifier circuit.

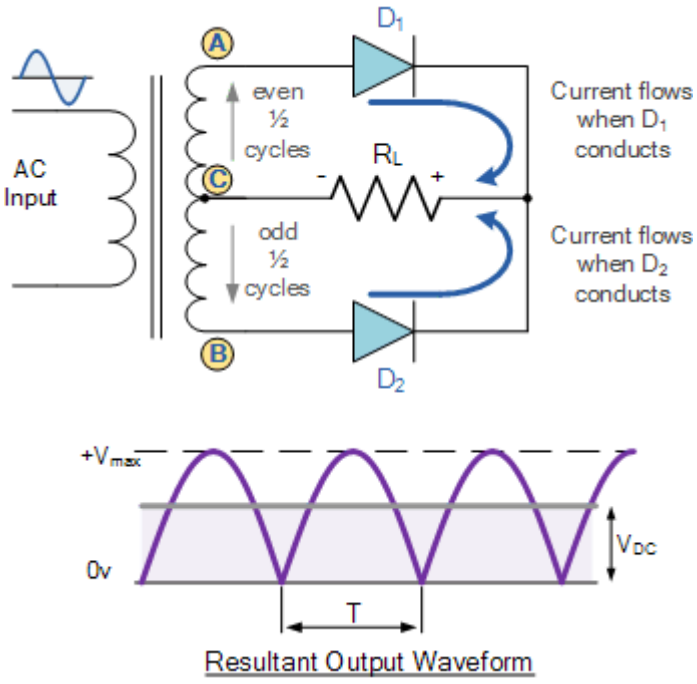


Fig. 3.10: Full-Wave Rectifier [10].

3.3.1.4 Applications

Diodes are used in a variety of ways. A few of the commonplace uses of diodes are as follows:

- Rectify volts, such as converting AC to DC
- Taking indications from an suggestion and separating them
- Having control over a symbol's size
- Signal blending

3.3.1 TRANSFORMER

Transformers also known as a stationary device, it is a device which helps in the conversion of electrical energy from one circuit to electrical energy of comparable frequencies in that other circuit. In a circuit, the volts can be increased or decreased, but only in accordance to the current values.

3.3.1.1 Types of Transformers

Transformers square measure utilized in a variety of sectors, including energy production, ordering, transportation, and electric power usage. Even different sorts of transformers that are classified on the subsequent criteria:

- The operating voltage varies.
- The media that was utilized in the wind.
- Arrangement of that winding.
- Location of the install.

Using Volts Stages

Ordinarily conduct of electrical device kind, trusting on volt that's categorized as:

- Take a step forward Transformers are utilized to connect the ability generating to the facilities. The volts also on auxiliary output are higher than the volts on the source.
- Step-down Transformer: This transformer is used to convert high volts main power into low energy secondary power.

Based on the Medium of Core Used

In an electrical device, we notice many varieties of cores that are used.

- Air core Transformer: The flux linkage between primary and coil is thru the air. The coil or windings wound on the non-magnetic strip.
- Iron core Transformer: Windings square measure wound on multiple iron plates stacked along, that provides an ideal linkage path to come up with flux.

Using the Coil Configuration

- It will be an autotransformer with alone one windy coiled than a laminations. A wind is shared by the elementary and auxiliary, the word also implies "own."

3.3.1.2 Working Principle of Transformer

The shared inductance between dual circuits coupled by a same magnetization is the fundamental concept of transformer operation. Two electrically separate and inductive fields are magnetic linked along a reluctance route in a fundamental transformer. The main and dependent windings of transformers. The kernel covering is joined in the shape of bands, with certain thin spaces visible straight throughout the crossing part of kernel. The connectors are considered to be 'muffled' since they are interrupted. The wind get a full reference inductance when used together. Due to the wind is connected to an ac source, the changing flux which built up throughout the laminations induces a shared induced EMF in transformers. The common induced emf is created when the majority of changing flux created through wind is connected to another wind. The formed induced emf might be clarified by Faraday's laws of Electromagnetic Induction. If the second coil circuit is closed, a current flow in it and thus electrical energy is transported magnetically from the first to the second coil. The alternating current supply is given to the first coil and hereafter it can be named as the primary winding. The energy is strained out from the second coil and so can be named as the secondary winding.

In brief, a transformer carries the processes shown below:

- Transmission of electric power from one circuit to another.
- Transmission of electric power without any conversion in frequency.
- Transmission with the principle of electromagnetic induction.
- The two electrical circuits are related by shared induction.

3.3.1.3 Applications of Transformer

- Transformer transmits electrical energy through wires over protracted distance.
- Transformers with multiple secondary's are used in radio and TV receivers which require several voltages.
- Transformers are used as voltage regulators

3.3.5 MAGNETIC CONTACTOR

Magnetic contactor is a switchgear device similar a relay but it has more current capacity and henceforth has some additional use in power circuits. That's applied to electrical machines to balance the frequencies of a motor's revolutions or even the position of a motor that may be referred to motor's flipping between open and close modes. It's an electromagnetic kind contactor and it can work automatically. It needs a slight amount of control circuit to turn on and off the load. So, the process of this contactor is safe compared to manual contactor. This is the most commonly used contactor in industrial applications. It works electromechanically and hence; it needs a very slight amount of current to make a connection among the load and power supply. Magnetic contactors performance as a protection to defend the power supply and the motor. Magnetic contactors are sometimes considered as circuit C.B because of their similarity of form with the circuit C.B but their functionality is several than that of circuit C.B. When the circuit among the motor and the power source is in brief state the linking is cut off to safeguard the appliance.

3.3.5.1 Magnetic Contactor Types

The key groups in which the magnetic contactors are categorized are the ac contactors and the dc contactors. There are a number of magnetic contactors which are commonly used at each level with several appliances such as:

1. Magnetic starter.
2. Reversing starter.
3. Star-Delta starter.
4. Mercury contactor.
5. Vacuum contactor.
6. Mercury-wetted contactor

3.3.5.2 Construction of magnetic contactor:

Magnetic contactor which has three portions.

1. Power coil
2. Auxiliary coil
3. Spring mechanism.

The power coil bring high current and auxiliary contactor obtains signal to make the contactor open or close or refer the status of the contactor(on or off) to outward systems like PLC, SCDA. The spring mechanism offers mechanical force to making the contact on or off.

3.3.5.3 Magnetic Contactor Functions

The magnetic field is produced by the electromagnet in the magnetic contractor when the electricity starts flow in the magnetic contractor. The magnetic field formed is a strong magnetic field that pulls the iron core of the magnetic contractor in the coil and as a result, an electric arc is produced. The electricity is carry into the magnetic contractor in this manner. To stop the operation of the magnetic contractor it is simply pulled off from the device it is committed with. When there is no electrical current in the magnetic contractor, the assembly of the core with the coil is also detached and the circuit joining is wrecked.

3.3.1 RELAY

The relay is the device that opens or closes the links to cause the function of the other electric control. It notices the unbearable or unwanted condition with an allocated area and gives the commands to the C.B to detach the affected area. Thus defends the system from harm. Relays are the changes which purpose at closing and opening the circuits electronically along with electromechanically. It commands the opening and closing of the circuit contacts of an electronic circuit. A relay is just not energized only by particular change whenever relay is "NO". This relay is just not energized whenever its stopped caused of "NC". Whenever power given, however, this stage is susceptible is changing. Relay is commonly used in circuit boards, manufacture, and automation systems for managing the energy of a controller by changing the lower amp rating. Although, since a volts drop is given to the electrical circuit, a large power is changed through the links, source of enhancing impact could help regulate large amps and volts.

3.3.1.1 BASIC OPERATION

One simple circuit relay consists of an electrical conductor wrapped along a permanent magnet, a metal frame that provides a low resistance magnetization channel, a portable metal loop, or each or even more pairs of connections. This coiled is mechanical connect only one or many sets of movable connections nonetheless it’s attached to axle. Once relays are non-active, the field is enforced via a piston, creating an insulator with in ferromagnetic material. These are some different pairs of links throughout the relay pictured is sealed within that case, another is available. Such relays might rely upon that function of further neither high nor less pairs connections. Wire connecting the circuit to the axle on relay as in illustration. That ensures circuit connectivity between the coil's rolling surfaces or the circuitry path on the PCB via the axle that is attached in it. "Though resistor is robust than diodes, this is fewer successful for removing power spikes caused via relays “and are hence commonly utilized. “These are traditionally accomplished by crimping a thin metals "layering rings" round the part of a metal that forms the postponed, other in section" that retains the links during the controlling voltage's low signal. Added features of thermal transfer and handling of the flash created upon disrupting the circuit

could be included in connectors use for circuitry delivering ratings or thousands of amps. “Several relays, like industrial machinery relays, include ground contacting that can be exchanged if they wear off and reconfigured between NO and NC states to accommodate variety in the controlling”.

3.3.1.2 The Operation of a Relay

It is based upon the electro - magnet attracts theory. **Fig. 3.11** displays the internal illustration of relay. Whenever the relay circuit identifies a short circuit, the electro - magnet is activated, resulting in the generation of a temporary electromagnet field.

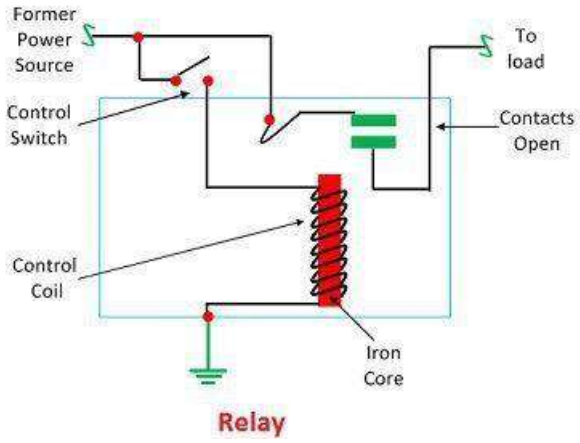


Fig. 3.11: Relay internal illustration [11].

The magnetization is used to transport the relay metal, which opens and closes the connection. The low and high energy relay contains double switches for activating the transition. It features a metal with a controlling circuit around it. The coiled receives energy via the load's terminals and the controlling devices interfaces. The magnetization around the loop is created by the current passing through it.

3.3.7 Circuit Breaker

C.B is a frequently engaged with electrically switch which defends a circuit from harm cause of high current flow. When a problem is found, its primary function is to interrupt current flow. A C.B, unlike a fuse, which only works once before needing to be replaced it needs to be restored its usual operation. Circuit C.B come in a variety of dimensions, ranging from small devices that shield circuits or discrete domestic use to large switchgear that protects huge power circuits that serve a whole city. OCPD is a common abbreviation for the general operation of breaker and fuse, as it is programmed mechanism of removing power from a defective system.

3.3.7.1 Operation of C.B

The approach for breaker schemes is similar, but the specifics differ substantially based on the voltage and current rating, also categories of breaker. Any fault situation must be identified by the C.B. This is usually done inside the equipment. For tiny keys and power circuit C.B. Electrical energy is commonly used to describe thermal or electromagnetic effects. Commonly, circuit C.B for potential for increased or overvoltage's are equipped with preventive relaying starter mechanisms that detect a defect and activate the response analysis. Even though some overvoltage circuit C.B are conscience with power transformer, protection devices, and an automatic feedback power supply, they generally need a battery pack, like as a cell. When a problem is detected, the breaker interfaces need to be released for interrupt network; this is often accomplished by separating the connections utilizing manually storing energy with in stopper, as well as a piston or pressurized air. Fuses could also employ a larger current generated only by defect, like as heat flow or a magnetization, to distinguish the connections.

3.3.7.2 Several types of circuit C.B

1. Voltage-dependent

- Low voltage C.B: This switch is popular in local firms since they can handle above two kV.
- High-voltage C.B: This fuse is suitable for above two kV. Transmitting grade switches are a subset of high voltage C.B.

2. By Location of Installation

- Within circuit C.B—This is intended for using inside structures or in weather-proof shelters. So an iron coated switching casing, this is traditionally functioned at a peak value.
- Outdoor C.B—Because of its design, you may use this breaker outside without a rooftop. In comparison to the interior included system, this exterior include setup is powerful.

3. Through Control structure Interruption

- Air C.B– Air is seen as a dielectric and disrupting media under this fuse. This breaker can be categorized to 2sorts
  1. A low-voltage C.B with a rating of less than 1000 volts.
  2. A high-voltage C.B with a rating of 1000 V or higher. Oil circuit C.B and oil-free circuit C.B are the two types of C.B
- Oil C.B-It makes use of oil only as shielding and inserting media. According to the compression and expansion of fuel utilized, this C.B are divided into 2 types.
- Vacuum circuit C.B. Cause of its large dielectric & dissipative characteristics, air is used as the disrupting media in this C.B.
- MCB (Miniature C.B)-This C.B seems to have a current rating of below 100Ampere and just protection built in. Within that circuit, the excursion parameters weren’t adjustable.
- MCCB (Moulded Case C.B)—the current rating for this C.B is greater over 1000Ampere. They have a long-term ground leakage defense system with protective devices. The Molded Case C.B's travel options are recognizable.

3.3.8 PROGRAMMABLE LOGIC CONTROLLER

PLC is a ruggedized and adapted industrial modern CPU used to switch production procedures like as muster lines, robotic function, and other activities that needs more switching capability, comfort of coding, and way of find error judgment. Minor sectional devices through a few input and output in a covering that is integrated through the CPU that are regularly interacted with others PLC. It's constructed for digital and analog I/O, wide temperature ranges, electrical noise immunity, and vibration and impact resistance, among other things. Battery- backed or non-volatile memory is commonly used to store programs that control machine processes. It is configured for a variety of tasks, including digital and analog I/O, wide temperature ranges, electrical noise immunity, and vibration and impact resistance. Programming for controlling machine. PLC means a sample of "hard" on-time procedure meanwhile results will be formed in reaction to feedback conditions within an inadequate time, else unintentional process result.

3.3.8.1 Construction

A PLC is a microprocessor-based controller for manufacturing that uses programmable memory to store program instructions and perform various activities. [16] It consists of the following components:

- A processor unit that interprets inputs, runs the control program stored in memory, and sends out output signals
- A power supply that converts AC electricity to DC;
- A recollection component storing statistics input program transfer to achieved through processor,

3.3.8.2 Working of PLC

Minor industrial processors modular equipment meant to automatic controller procedures are known as PLCs. Nearly all current industrial automation is controlled by PLCs. A PLC has several components, but the majority of them fall into one of three categories:

•Processor • Inputs • Outputs

PLCs are extremely versatile and powerful computers. However, we may define a PLC's function in simple words. PLCs accept efforts, create sense on the efforts in the

microprocessor, and after that use that sense to turn on or turn off. We'll get into more detail later, but for now, consider the following:

- The processor keeps track of the input's sites (ex. button on, sensor down, regulator 40 percent exposed, etc.)
- The processor takes the data it receives from the inputs and applies logic to it.
- The processor is in charge of the output sense (ex. stop motor, open regulator, etc.)

For a graphic representation of the stages above, see the flowchart below which is described in **Fig. 3.12**

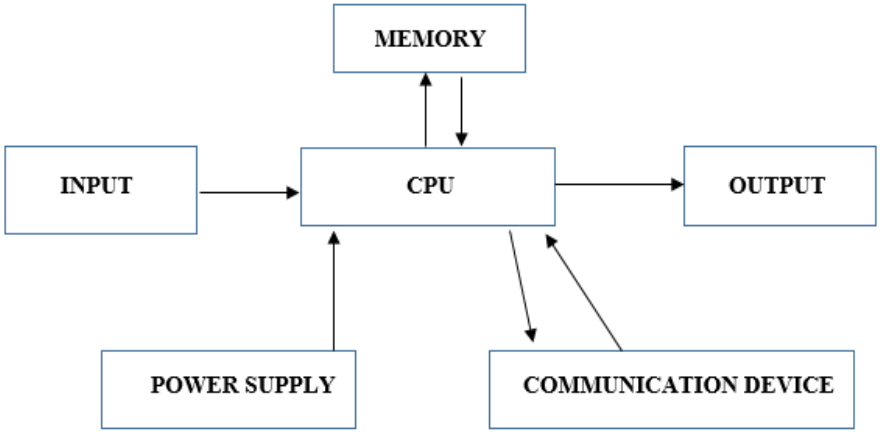


Fig. 3.12: visual illustration of working of PLC [12].

3.3.8.3 Basic Operation

A PLC most fundamental duty is to match the functions of electromechanical relays. Separate inputs are given their own address, and a PLC instruction can determine whether the input is on or off.. A series of "survey if on" commands will boost its output storage bit if all of the input bits are on, alike to how a series of relay contacts accomplishes a logical AND function, preventing current flow unless all of the contacts are closed. A

logical OR can also be done with a parallel series set of instructions. A series of control coil which is named "ladder illustration" in an electromechanical relay wiring diagram, and this concept is also used to explain PLC sense. The number of series parallel orders in single "rung" of judgment is limited in some PLC types. Every rung's output sets or dissipates a storing bit, which is not be tied to a somatic output location. Internal coils of this type can be utilized as a common element in numerous rungs, for example. In contrast to actual relays, the number of times an input, output, or interior coil can be referred in a PLC program is frequently unlimited. For assessing the rung logic, some PLCs require a strict left-to-right, top-to- bottom implementation order. This differs from electromechanical relay contacts, that, depending on the design of adjacent links, can whichever permitted current from left side to right side or right side to left side in a adequately composite circuit. The removal of these "sneak pathways" is either a defect or a feature, depending on how programming is used. **Table 3.1** described various kinds of Mitsubishi PLC series model input and output value and their input, output type.

Table 3.1: Mitsubishi PLC AC power, Relay Output Units

MODEL	INPUT QUANTITY	INPUT TYPE	OUTPUT QUANTITY	OUTPUT TYPE	POWER SUPPLY
FX 1S-10MR	6	24V DC	4	RELAY	85-264 VAC
FX 1S-14MR	8	24V DC	6	RELAY	85-264 VAC
FX 1S-20MR	12	24V DC	8	RELAY	85-264 VAC
FX 1S-30MR	16	24V DC	14	RELAY	85-264 VAC

Fig. 3.13 and **Fig. 3.14** are shown Mitsubishi PLC schematic diagram with details.

Fig. 3.13: Mitsubishi FX 1s 20mr PLC [13].

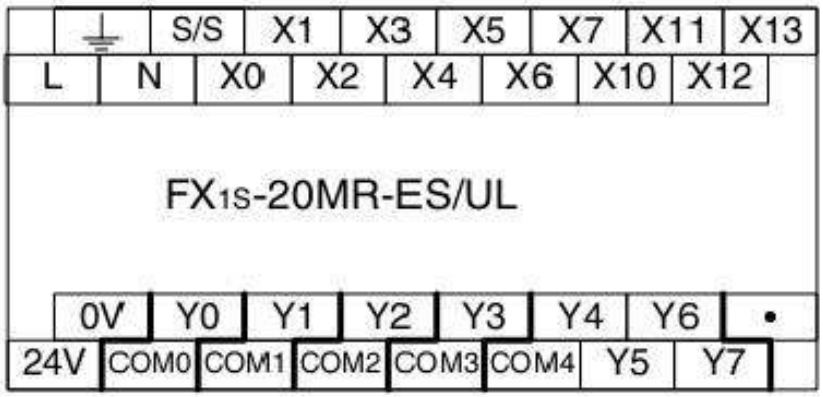


Fig. 3.14: Schematic diagram of Mitsubishi FX 1s 20mr PLC [14].

3.3.9 Project Circuitry Diagram and Explanation

Entire project circuitry block diagram is shown in **Fig. 3.15** which is drawn below.

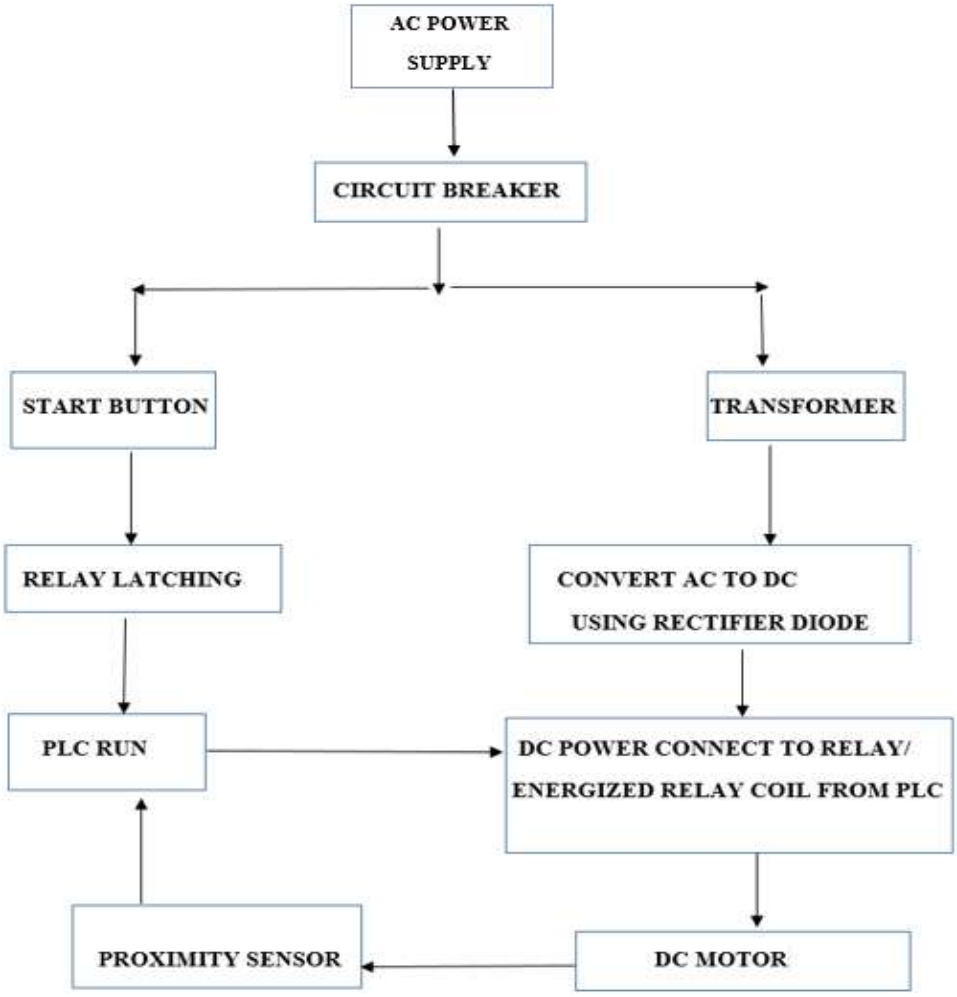


Fig. 3.15: Block diagram of DC motor speed control circuit.

Circuit Development of project

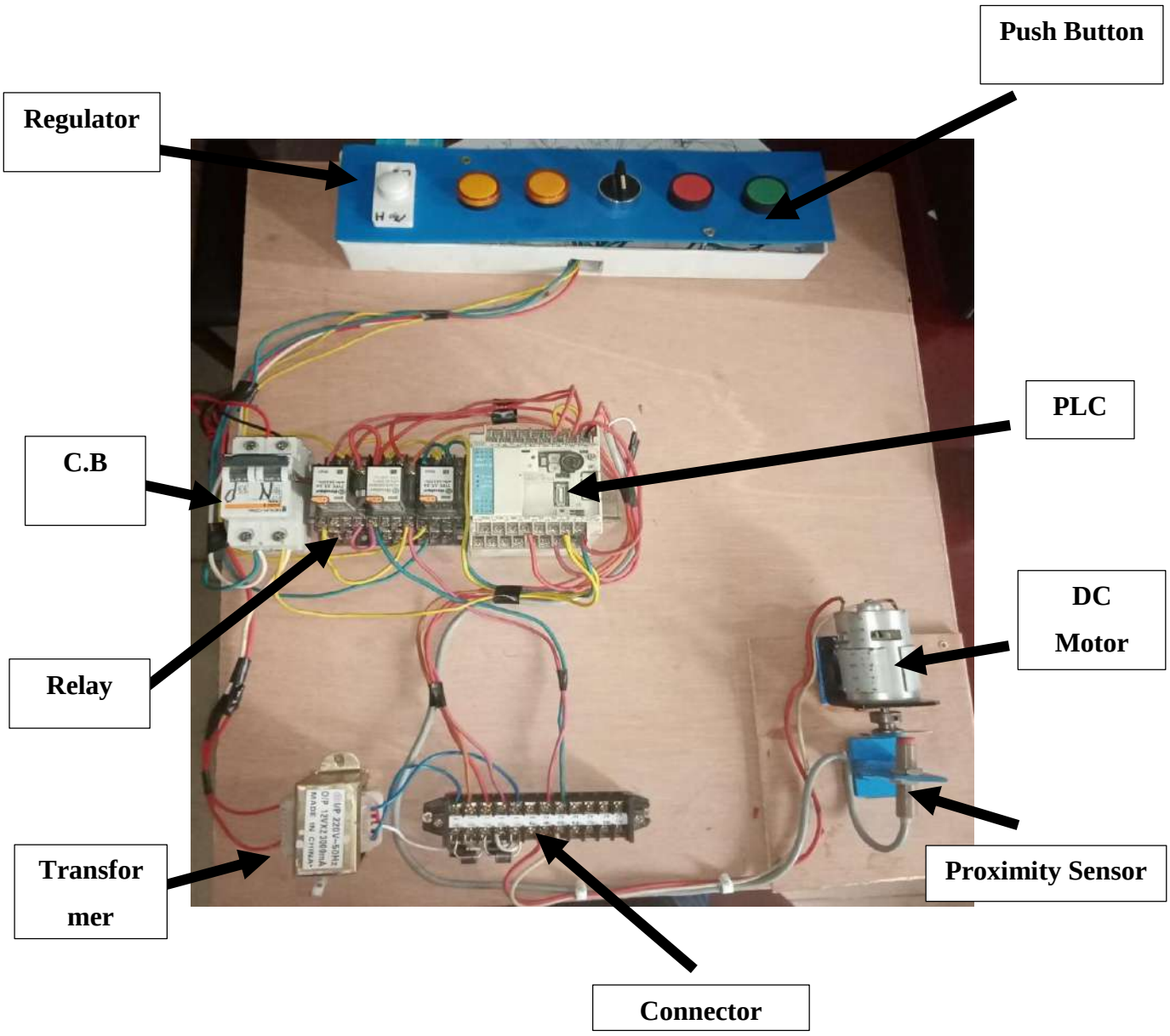


Fig. 3.16: A proposed DC motor speed control circuit.

Explanation of circuit development

The circuit diagram of DC motor speed control system is shown in **Fig. 3.16**. The system is made up of several electrical and electronic components such as DC motor, Proximity

sensor, Relay, PLC, Rectifier Diode, Push button switch, Regulator. Furthermore, transformer also used for step down the supply voltage.

As the he main objective of this project is to take the feedback from proximity sensor for controlling the speed of Dc motor. Here use the proximity sensor, this sensor is a high speed sensor. It is alternative of high speed encoder. (An Encoder is a device that is usage in many industries to deliver feedback. It is a Sensor that senses rotation angle or linear movement. Encoders are used in devices that requisite to work in high speed and with high accurateness). As budget for this project is not so much enough so find out this alternative way for this project. Which is high speed NPN sensor. As for controlling the speed of Dc motor so at first convert electric power ac to dc using diode. Which is bridge rectifier technique. Also use relay for controlling the Speed of Dc motor after certain time with applying condition in PLC programming. This process is done by taking the feedback from sensor. In this PLC the high-speed counter are allocated to the input terminals from X000 to X007.This input terminals can be used as general input terminals. The output terminal of this PLC is Relay types. When turn ON the C.B supply voltage approximately 220V in transformer input terminal and 12V in Output terminal. Also after giving supply, pressing start button and using this start button, a relay is latching and after that PLC is starting. Transformer AC supply is converting to DC through bridge rectifier. Then this DC supply is connected to relays common terminal. When relays are energized, “NO” terminals become “NC” and this wire is connected to DC motor input terminal. Dc motor output side is coupling with a metal and a proximity sensor is setup in front of it. Proximity sensor feedback wire is connected to PLC. This PLC input is a high speed encoder. This high speed encoder is inbuilt function in this PLC. So the sensor feedback is high speed feedback energy. Using a regulator switch for changing voltage, by fluctuating supply voltage the speed of DC motor can be control.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this section I will discuss about the outcomes achieve by this project. Dc Motor is controlled easily and used for many purpose. Key benefit of using DC motors at present because it is the capability to controlling speed easily. All kind of DC motors have internal process such as electro mechanical or electronic to change the flow of current direction. Some essential usage of DC motor are like different kinds of grinders. Tiny horse power DC machine are extensively utilized because of continuous supply capability of adjustable DC supply. The PLC is a devoted method intended for industrial usage. It holds the several sorts of I/O that are appropriately equivalent with the industrial instrumentation. This project I have been used Proximity sensor feedback and PLC for controlling the speed of DC Motor.

4.2 Result Analysis

In this sector, the PLC program is conduct for controlling the motor speed. In industry PLC plays a vital rule. I used PLC for controlling speed of motor. Here is the following programming by which motor speed can be control. When voltage is increasing Motor speed is also increasing. For below 2000 rpm Y0 Relay is activated. If this rpm is over than 2000 then Y1 Relay coil will be operated automatically. This speed is changing if line voltage is fluctuating.

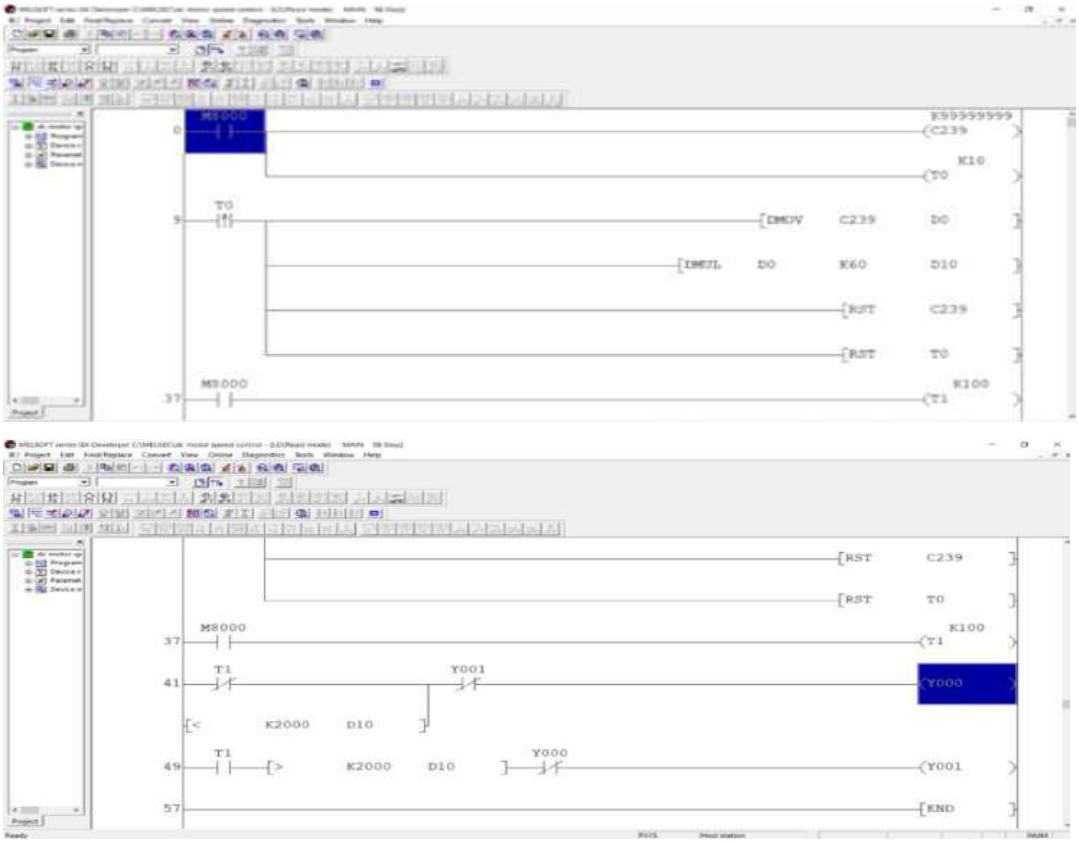


Fig. 4.1: Ladder programming of Dc motor speed control.

As Fig. 3.16 describes, firstly, the circuit is initialized. Now PLC ladder program of DC motor speed control system is shown in **Fig. 4.1**. In this ladder program used one counter, C239 is a counter and two timer respectively timer (T0) and timer (T1). Here M800 is a continuous “ON” memory which means this memory is always operate in “NC” mood. Through this M800 memory C239 counter is enabled and here an unlimited value is given for this counter. When the PLC is run a timer (T0) is also enable at the same time. The value of this timer (T0) is K10. Each time after running the PLC the timer T0 is “ON” for 1sec and after counting 1sec its “NO” is becoming “NC”. After becoming “NC” the timer (T0) is reset automatically because when PLC is run the motor is also start to run because here is not use any start command for it. And we know that after run the PLC a timer (T0) is also “ON” to count the rotation of the motor per second. After counting every second rotation the C239 counter data is register into “D0” data register. Now

multiply this “D0” data register value with 60 to convert this value from RPS to RPM. Each time when the timer (T0) is high then the timer (T0) and counter “C239” will be reset automatically. To get updated value of RPM this reset option is used. Now here use another timer (T1) to run Y0 Relay for first 10 second after 10 second if the speed is changed then Y1 Relay will be operated. Here used a regulator by which voltage can be changing and changing this voltage motor speed (RPM) also varying. And Y0 and Y1 operating automatically depending on the changing of RPM.

Table 4.1: Relay operation changing when speed (RPM) fluctuating

RPM	RELAY OPERATION
100	Y0
350	Y0
500	Y0
800	Y0
1050	Y0
1350	Y0
1500	Y0
1850	Y0
2100	Y1

Table 4.1 shows that if motor rpm less than 2000 rpm than relay YO continue its operation until motor speed rpm great than 2000 rpm and if motor rpm greater than 2000 rpm than Y1 relay operates because in PLC programming this process is design this way.

4.3 Discussion

The dc motor speed is controlled by using PLC with proximity sensor feedback. The closed loop feedback procedure used cause of controlling motor speed where sensor used for sensing rotation of motor shaft. This variation of speed, depend on changed on voltage. This designed was verified for several speed inputs adequately.

CHAPTER 5

CONCLUSION

5.1 Conclusion

In this project a modest, operative and precise speed controlling of dc motor has been designed using PLC rather than controlled of DC motor using other different method. Because most of them is expensive. Every company in industry wants to implement any system at low cost with proper output. This project is developed a system which is low cost and comparatively get proper output**.** This method provides controlling of speed in an extensive variety of the rated speed. A proficient variation in speed by varying supply voltage using regulator has been achieved.

5.2 Future Scope

In future development 2 or 3 metal sensors by 90 degree phase shift can be used, so that we can get more accurate data. If we use encoder instead of proximity sensor we can get more accurate data. Also if we use analog input and get our analog output then our project become more accuracy.

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