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DESIGN AND IMPLEMENTATION OF A PLC-BASED AUTOMATIC PAPER CUTTING AND FAULT FINDING SYSTEM

by

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SEPTEMBER 2021

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A thesis/project

submitted as partial fulfilment of the requirement for the degree of

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SEPTEMBER 2021

CERTIFICATE OF APPROVAL

The thesis/project entitled as "**Design and Implementation of a PLC Based Automatic Paper Cutting and Fault Finding System**" submitted by **Md. Abu Sayed Chowdhury**, bearing Matric ID. **ET-163004** and **Rakibul Mustafa Rakib**, bearing Matric ID. **ET-163013** of session **Autumn 2020**, to the Department of Electrical and Electronic Engineering, International Islamic University Chittagong, has been accepted as satisfactory in partial fulfilment of the requirements for the degree of Bachelor of Science in Engineering and approved for the examination held on **3rd September 2021.**

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

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Md. Abu Sayed Chowdhury

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Rakibul Mustafa Rakib

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Authors

ABSTRACT

Automation is basically the delegation of human control functions to technical equipment's aimed towards achieving: higher productivity, superior quality of end product, efficient usage of energy and raw materials, improved safety in working conditions etc. Before automation paper industry is used to cut the paper manually which was time consuming and large manpower required. So this automation is made for industrial use in automatic paper cutting and folding purpose. The used tools are Programmable Logic Controller (PLC) is an industrial computer that monitors inputs, makes decision based on its program and controls outputs to automate a process or machine. And also RC network and DC motor are used for automation purpose. Here we propose the concept of "PLC Based Automatic Paper Cutting and Fault Finding System". In this mechanism "Programmable Logic Controller" or commonly known as "PLC" are used. In this project "Siemens Logo-OBA4" is used. The PLC being the industrial grade digital computer provides us the full operational control over the system with the help of programming also it makes the system fully automated. These two components make the Automatic Paper Cutting Machine efficient in its task and reliable very up to the mark. For demonstration purpose, our system designed and construct paper cutting and fault finding system. After cutting the paper if any mistake such as length are not accurate then the system indicate and separated the cutting paper. PLC based paper cutting machine has got faster execution time and is more efficient in working along with safety measures to reject faulty paper and ease in operation. The current system outperforms previous systems in terms of both performance and flexibility. This device may also be used to cut thin sheets of metal, cardboard, and plastic. This equipment is quite beneficial for small and medium-sized businesses. By decreasing the quantity of papers at the same time, this project improves the production rate. Furthermore, the running time has been reduced. The main benefit of this project is the decrease of personnel and expense when compared to traditional machinery.

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LIST OF ABBREVIATIONS

PLC	Programmable Logic Controller
CPU	Central Processing Unit
RC	Resistor-Capacitor
DC	Direct Current
ITM	Institute of Technology And Management
GOC	Graphic Operation Controller
PVC	Polyvinyl Chloride
GM	General Motors
LD	Ladder Language
RAM	Random Access Memory
USB	Universal Serial Bus
HMI	Human Machine Interface
PC	Personal Computer
ROM	Read-Only Memory
IC	Integrated Circuit
AC	Alternating Current
VA	Volt-Ampere
IR	Infrared
VCC	Voltage Common Collector
LED	Light Emitting Diode
MOSFET	Metal–Oxide–Semiconductor Field-Effect Transistor
MIL	Malfunction Indicator Lamp
I/O	Input / Output
SMPS	Switched Mode Power Supply
LOGO	Language Of Graphics-Oriented

CHAPTER 1

INTRODUCTION

1.1 Introduction

Automation is the foundation of this project .Automation is the transfer of human control functions to technological equipment with the purpose of increasing production, improving final product quality, conserving energy and raw resources, and improving worker safety, among other things. This automation was designed for industrial use in paper cutting and folding. A PLC is an industrial computer that monitors inputs, makes decisions based on its program, and controls outputs to automate a process or machine. For automation, an RC network and a DC motor are also used. In this section, we propose the concept of "Automatic Paper Cutting Machine PLC." The system is based on a “PLC,” which is a mechanism that converts continuous rotational motion into intermittent rotary motion. This mechanism can be found in the "Automatic Paper Cutting Machine”. Along with this mechanism, the system includes a "Programmable Logic Controller," also known as a "PLC". The PLC, which is an industrial-grade digital computer, gives us complete operational control over the system through programming and also makes it fully automated. These two components contribute to the Automatic Paper Cutting Machine's efficiency and dependability. Our system created and built a paper cutting and fault finding system for demonstration purposes. If there is any error in the cutting of the paper, such as the length being incorrect, the system will inform this and separate the cutting paper.

1.2 Background

The 21st century is known as the automation age because automated system is being used more frequently every day. These applications include automotive robot weapons, automated mining, home automation, industrial drainage, etc. Long before PLC, industrial automation starts. First in the late 1960s programmable logic controllers struck the scene. The main motivation for developing such a device was to avoid the high cost of replacing complex relay-based machine control systems used by major American automobile manufacturers. Automation was mainly done using complex electro-mechanical relay circuits in the early to mid-1900s. Before the PLC, hundreds of thousands of relays, cam timers, drum sequencers, and specialized closed-loop controllers were utilized to regulate, sequence, and safety interlock logic for vehicle manufacture [1]. Relay logic systems were planned to be replaced

by PLC. Relay systems were big and expensive, and they had a lot of problems. It was impossible for design engineers to change the method since it was hard-wired. Even minor adjustments would necessitate rewiring and detailed documentation updates. If just one wire was out of place or one relay failed, the entire system would fail. To fix issues, technicians would typically spend hours examining schematics and comparing them to existing wiring. This is why PLC are programmed in "ladder logic," which resembles a relay logic diagram. Prior to automation, garbage had to be cleaned manually by workers, which was a dangerous job for workers and a costly and time-consuming procedure for businesses. However, because to significant improvements in current technology, we can now do it quickly and safely using a PLC.

1.3 Project Overview

The major goal of our project is to use PLC programming to reduce the amount of hardware used, as well as to reduce the amount of labor and work required. The SIEMENS LOGO PLC is used in this project. There are eight inputs and four outputs on this device. We can develop a program via ladder diagram in the PLC LOGO software and then download it into the SIEMENS LOGO PLC to control industrial loads.

1.4 Motivation

PLC Automation Systems relate to a wide range of machines that are controlled electronically and have a number of applications, such as milling, drawing, extrusion, cutting, and lathing. PLC machines are extremely costly. They're commonly employed in the manufacture of big machine parts, both electronic and mechanical. As a result, our crew has chosen to create a model to learn more about the theoretical and practical aspects of PLC Automation.

1.5 Objectives

The objectives of this project is given below :

- The main objective of this project is to design and construct of automatic paper cutting and fault finding system.
- To create a completely automated PLC control system.
- To create a system for measuring the length of paper.
- To build a system for paper length fault detection and separation.

1.6 Outline of This Report

During the design and development of this project six chapters have been covered. The following are the chapters and their contents:

- **CHAPTER 1** is described the **"Introduction"** part that includes background, motivation, objectives and outline of this report.
- **CHAPTER 2** is the **"Literature Review"** in this chapter history and previous work related to this project are discussed.
- **CHAPTER 3** is the **"Hardware Description"** in this chapter all the components used in this project has described elaborately.
- **CHAPTER 4** Includes **''Methodology''**. Here Block Diagram, Flow Chart Circuit Diagram and Ladder diagram of this project have discussed.
- **CHAPTER 5** is "**System Implementation and Result**" shows the performance of the System. It discuss about Project Overview, Result and Cost Analysis of this project.
- **CHAPTER 6** is the **"Conclusion"** of this Project. In this chapter Advantage, Application, Limitation and Future Improvement of this project have discussed.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, we will discuss various types of PLC language, PLC ladder logic, ladder logic tables, and DC gear motors.

2.2 History of Paper

Early medieval China, which created paper in 105CE and dates back to the 6th century AD, was using it. The Emperor's court required a considerable amount of paper even in the early 14th century. Although paper has been used as a wrapping and cushioning material in China from the 2nd century BC, it is in early medieval China in the 6th century AD that the first documented usage of all paper-related products in human history occurred. The annual manufacturing of paper and toilet paper in modern-day Zhejiang province alone was recorded in the early 14th century at ten million packages of 1,000 to 10,000 sheets of paper each, and the paper produced at the time was large roll of papers called scroll, which are usually stressful to carry around. Because the papers were so large and lengthy at the time, certain sections of the paper were ripped away irregularly. According to documents from 1393, an annual supply of 720,000 sheets of paper (two by three feet in size) was manufactured for the imperial court's general use in Nanjing during the Ming Dynasty (1368–1644 AD). According to Imperial Bureau of Supplies papers from the same year, Emperor Hongwu's imperial household received 15,000 sheets of special soft-fabric paper and toilet paper, each of which was scented. In other places, affluent individuals write knowledge on clothes, while less fortunate people record information on forests and rocks (as the Egyptians proved B.C. by sketching samples and writing laws on rocks). Ancient Romans used parchment (dried animal skin), papyrus (the closest thing they had to Egyptian plant-based paper), and wax tablets for writing (these typically came in pairs of two, which could be folded into two to protect the surface). Julius Preuss, a German physicist, mentions all of them in his classic Biblical and Talmudic medicine (Eng. trans. Sanhedrin Press, 1978). According to Timothy Barrett, paper was crucial in the development of early Chinese written culture, and despite the country's political disintegration, "a robust reading culture appears to have emerged following its introduction." In reality, the arrival of paper had enormous ramifications for the book industry. It means that books would be distributed in their whole rather than in little pieces or

bundles. Instead of being delivered by cart, books may now be carried by hand. As a result, over the ages, individual collections of literary works have grown. One effect of the growth of paper in China, according to Endymion Wilkinson, was that it rapidly overtook the Mediterranean empires in book output. During the Tang dynasty, China surpassed the United States as the world leader in book production. Woodblock's late Tang and Song expansion steadily increased its advantage over the rest of the globe as a result of its reliance. Due to the low cost of a leaf of paper, paper is now readily available in many regions of the world, even rural places. Furthermore, many varieties of paper in various sizes and forms are utilized for usage in many regions of the world, including India, America, and England [2].

2.2.1 Paper Machine

Before the invention of continuous paper manufacturing, paper was created in single sheets by spinning a pulp slurrose container and pouring it into a sheet-mold fabric sieve. While the wet paper is still on the tissue in the sheet mold, the excess water is squeezed out, and the sheet is lifted and hung to dry over a seam or wooden rod. In the year 1799, Louis-Nicolas Robert of Essonne was granted a patent for a continuous press (France). Following that, Robert collaborated with Saint-Léger Didot, with whom he had a squabble about ownership of the invention. Didot thought that the machine could be developed more effectively in England. During the revolutionary era of the French revolution, he was unable to meet his brethren, so he despatched John Gamble, a Frenchman residing in Paris, to do so. The stationers' brothers, Sealy and Henry Fourdrinier, were introduced to Gamble and agreed to fund the project through a network of contacts. On October 20, 1801, Gamble acquired British patent 2487. An modified version of the Robert original was installed at Frogmore, Hertfordshire, in 1803, with the aid of Bryan Donkin, a bright and inventive mechanic, followed by another in 1804. At the Fourdriniers' mill at Two Waters, a third machine was erected. The Fourdriniers also purchased a mill at St Neots with the intention of installing two machines, and technology and equipment were still developing at the time [3].

2.2.2 History of Paper Cutting Machine

The necessity to cut and trim a large number of sheets of the same size prompted the creation of mechanical cutting and trimming equipment, which predates the advent of the bound book of bound leaves. A sharp stone or a stick was most likely used as the initial cutting machine,

followed by a piece of metal pressed over the paper with a guide to keep the cut straight. The sheet was usually kept in place by the hand and also served as a clamp at the straight-edge.

It all started in the 4th century with the invention of paper by the Chinese. Religious decorations and stencils for textile designs were two of the early uses for cutting paper. This form of painting was popular among high-society women for a long time, but it gradually spread to other social strata.

Around the fifth century, it became normal practice to fold vellum into leaves as an essential element of the process. Scissors or shears, as we now call them, are likely to have played a significant role in the early activities. It was essential to cut the pages with bigger and stronger tools when printing was created and books were distributed. While the norm for smaller books and sheet divisions was to cut a book earlier and later, it was necessary to cut a book earlier and later.

A medium-height table; rapid and precise knife adjustments; a foot treadle for lowering the clamp to the pile when required to see exactly where the knife will strike; and an accurate and dependable system for moving the back gage and the pile are all features of the greatest paper-cutting machine. with easy-to-reach starting handles; a powerful clamping pressure that is automatic for all pile heights and instantly adjustable for heavy or delicate work; universal fine adjustments for squaring the back gage with the knife; a simple change for the cutting stick; a low-speed driving shaft; as well as a strong primary driving clutch or friction material. Paper cutting is a type of paper cutting that the artist may make as basic or as complicated as they like. It has endured the test of time and will continue to be a popular art form in many countries. Modern paper cutting methods are influenced by several well-known paper artists from the past. Different methods of cutting papers have also been investigated in depth [4].

2.3 Evolution of PLC

The Programmable Logical Controller was created in the 1960s for the American automobile industry to replace hard-wired re-wired panels with software program updates when manufacturing changes were required. Thousands of relays, cam timers, drum sequencers, and dedicated closed-loop controllers were used in the manufacture of vehicles prior to the development of PLC.

There was a very time-consuming and expensive need to upgrade the production process by replacing relays and other components. In 1968, GM Hydromantic requested that the relay logic system be replaced. The first PLC, the modular digital controller has been developed by

Bedford Associates (Modicum). Dick Morley, one of the Modicon 084 developers, is regarded as PLC 'father'. The Modicon 084 PLC was developed to be programmed in 'leader logic' similar to the schemas of its replacement relay logic. For engineers and technicians, this facilitated the transition to PLC. The auto industry remains one of today's largest users of PLC [5].

2.3.1 Relays

The only means of controlling machinery was by using relays before the times of the PLC. Relaxes work by using a coil to create a magnetic force to pull a switch into or out of position when powered. Relays are used. The commuter releases and returns the device in its ON and OFF standard positions when the relay is removed from power. If someone wants to control whether an engine is ON or OFF, they can connect the motor to the source of power with a relay. This kind of relay is called a power relay. If several engines need to be controlled, several power relays are required. These relays are referred to as control relays.

2.3.2 Problems with Relays

Many motors operate at any moment in modern factories. A large network of ON/OFF switches is necessary to control a single machine. This would be a nightmare for logistics. All of these relieves must be hardwired in a certain order to guarantee that the machine functions properly, and if a relay fails, the system as a whole fails. Troubleshooting took hours, and there was a lot of it since spindles failed and connections wore out. These devices required a lot of room and had to follow a stringent maintenance plan. If someone wanted to alter something, they'd have to rewrite the entire system from scratch. It was clear right away that establishing and maintaining these massive relay control systems was a challenge.

2.4 PLC Programming Language

PLC have evolved and grown, resulting in the creation of programming languages. Programming languages allow users to utilize a predetermined syntax to enter a control program into a PLC. New, more flexible instructions that begin control program activities are included in today's sophisticated programming languages. The processing power available for

single operations performed by the instruction is increased with these additional instructions. For example, in a PLC, data blocks can now be transferred from one memory location to another while a logic or arithmetic operation is performed on another block. As a result of these new, extended instructions, control programs may now handle data more simply.

The development of the power full input module has changed with instructions for the new programming instructions. The ability to send data to a module data can be increased by addressing the location of the module. PLC can now read and write all this advantage into analog module that the most industry needs to generate a stronger demand instruction that will make it easier [6].

2.4.1 PLC Language

The following are the three types of programming languages used in PLC :

- Ladder
- Boolean
- Grafcet

In terms of how operations are implemented, the ladder and Boolean languages are similar, but they differ in how their instructions are written and input into the PLC. Grafcet is a programming language that takes a unique approach to controlling instructions, based on steps and actions in a graphic-oriented program [7].

2.4.2 Ladder language

To describe the program logic necessary to operate the machine or process, the programmable controller was built using existing relay ladder symbols and expressions. The resultant programming language, which employed these fundamental relay ladder symbols, was dubbed Ladder language. A relay ladder logic circuit is shown in **Fig. 2.1**, as well as a representation of the same circuit in PLC ladder language.

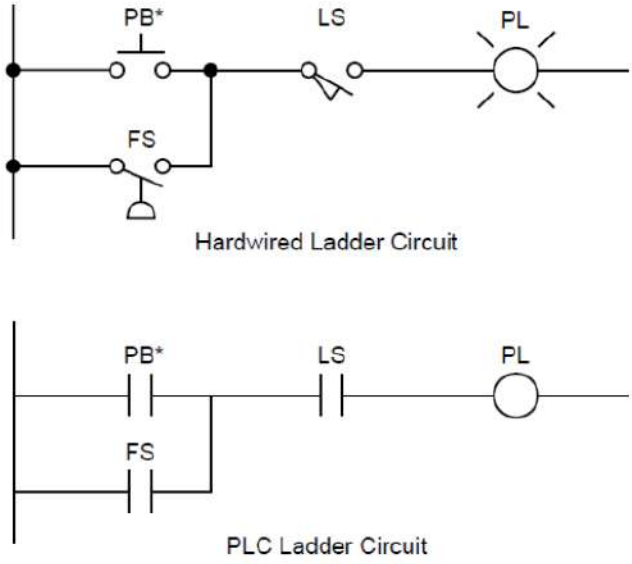

Fig. 2.1: Hardwired logic circuit and its PLC ladder language implementation [8].

The original ladder language has developed into a more sophisticated collection of instructions known as ladder programming. New functionality have been added to the fundamental relay, timing, and counting operations. The term "function" refers to instructions that manage and transport data within the programmable controller, as the name suggests. These instructions are still based on relay logic concepts, but they enable for more complicated operations to be implemented and executed [8].

2.4.3 Ladder Logic

The most popular programming language for PLC is ladder logic. Ladder Language is a visual language that stands for Ladder Language. It may be used to transcribe relay diagrams and is suited for combinational processing. A timer, blocks, and coils are among the basic symbols offered. In the PLC, the program is stored in battery-backed RAM or nonvolatile flash memory. A single PLC may frequently replace thousands of relays. Ladder logic is a programming language that represents a program as a graphical representation based on hardware circuit schematics for relay logic. It was primarily used to create software for programmable logic controller (PLC). The name originates from the fact that the language's

programs are designed to look like ladders, with two vertical rails and a sequence of horizontal rungs between them [9].

2.4.4 PLC Ladder Logic Inputs and Output:

Ladder logic is a PLC programmer that checks all inputs regularly over normal cycle times. The schematics of ladder inputs are shown in **Fig. 2.1**. **Fig. 2.2(A)** is a circuit usually open, so input A closes the connection and the current flow occurs. This is a closed circuit, therefore the contact stop current flow will be opened in **Fig. 2.2(B)** .In **Fig. 2.3** this is the symbol of output [10].

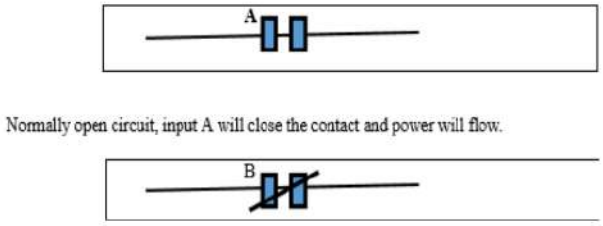

Fig. 2.2: Symbols for Normally Open and Normally Closed Inputs [10].

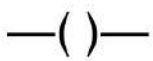

Fig. 2.3: Symbols for Output

2.4.5 PLC and Microcontroller:

PLC

A programmable logic controller (PLC) is a highly portable and widely used industrial digital computer that is used to handle manufacturing processes like assembly lines, robotic devices, or any activity that requires high reliability control, ease of programming, and process fault detection. For industrial signals, the PLC is used through a USB connection or network programming. Easy-to-understand language that can take analog signals and alter programs, as well as link to HMI systems and communicate with them. PLC programming is basic and of the Ladder programming type. PLC is generally used to operate industrial machines. A PLC (programmable logic controller) is a logic controller with continuously expanding inputs and outputs that are generally controlled using an external PC program.

Microcontroller

A microcontroller is a computer with programmable input and output devices, as well as one or more CPUs. On most chips, there is a little amount of RAM as well as program memory in the form of Ferroelectric, RAM, NOR flash, or ROM. Microcontrollers are used to program chips on boards to do specific tasks, after which the circuit on the board must be completed with relays and other components to regulate the current. They are made up of IC with different quantities of input and output and are utilized in other things that do not require modifications. Microcontroller programming, which is highly difficult, required hand coding. Microcontrollers may be used in a variety of applications. A microcontroller is not an infinitely expandable input or output logic controller.

2.5 Review of Previous Work

During this time, research will include a variety of up-to-date PLC & automation methods as well as new technologies to upgrade our system on a daily basis. With that in mind, various revised methods in the field of PLC and automation systems are available, and many more are being researched. The sections that follow will go over a thorough examination of the work involved.

2.5.1 Design and Fabrication of Paper Cutting Machine.

G.Arundeeshi, R.Rathish, Logeshwaran, N.Maniraj, V.Mohan Raju Kamatchi, V.Poovarasan 'Design and Fabrication of Paper Cutting Machine' [11] describes chart paper as a cutter used to perform a cutting .The paper-cutting machine is a relatively new technology in the industrial sector. In recent years, the challenge of developing a successful machine of this sort to satisfy new demands for precision, speed, convenience, and safety has progressively been solved, and there are currently numerous machines that are highly efficient and competent to fulfill these needs. They employed a rack and pinion system, a DC motor, a battery, a switch, and a blade to cut the material. Small and medium-sized enterprises will benefit greatly from this approach. This method is used to cut various thicknesses of paper and sheets. As a consequence, raising production pace by concurrently cutting a large number of sheets in a single pass is a possibility. When compared to typical machinery, there are cost reductions. This is the system's primary benefit.

2.5.2 PLC based automatic cutting machine

Rushikesh Gadale, Mahendra Pisal, Sanchit Tayade, S.V. Kulkarni 'PLC based automatic cutting machine'[12] is based on PLC, they attempted to design a way to incorporate a PLC into a standard cutting process by including a pneumatic cylinder, sensors, and a dc motor. In **Fig. 2.4** system implementation block diagram are included.

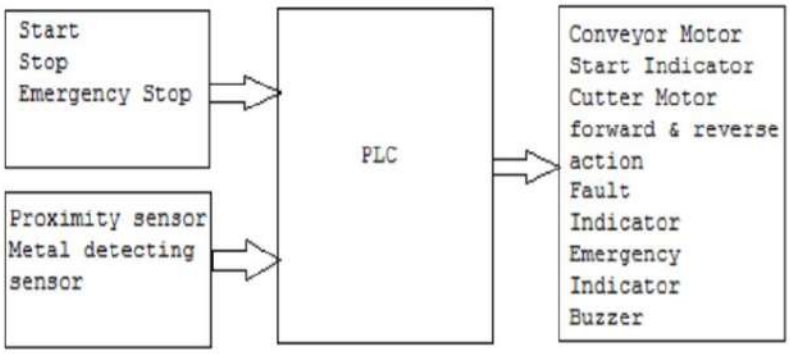

Fig. 2.4: System Implementation Block Diagram [12].

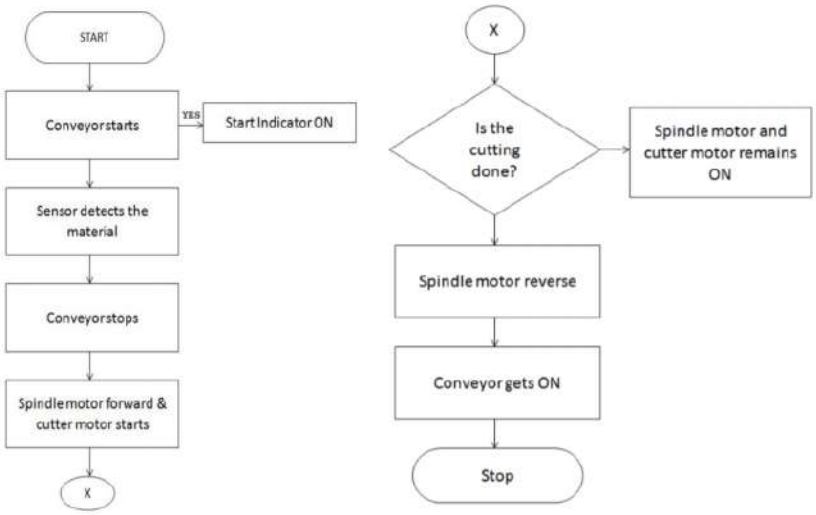

Fig. 2.5: System Implementation Flowchart [12].

The system is made up of the main conveyor assembly, cutter with motor arrangement, object detection, pneumatic cylinder, and proximity sensors. A pneumatic system and a programmable logic controller are included in the proposed system (PLC).**Fig. 2.5** is the flowchart of this project. In this example, the main controller is a PLC, which will take inputs

from the proximity sensor and then operate the conveyor, pneumatic cylinder, and other cutting process assembly components. Pneumatic Setup: A pneumatic setup is a mechanical arrangement that connects a collection of pneumatic actuators and is controlled by a PLC through solenoid valves. To deliver compressed air, an air compressor is utilized. This PLC-based cutting machine works more effectively with safety features to eliminate faulty material and make it easier to use. The current system outperforms the previous one in terms of performance as well as operational flexibility. Furthermore, the running time has been reduced. As a result, this automation has met the desired requirements of customers.

2.5.3 Design and Fabrication of Paper Cutting Machine Using Geneva Mechanism

Praveen Kumar S, Pragatheesan K, Ramachandran M, Ramu P, Sanjay G "Design and Fabrication of Paper Cutting Machine Using Geneva Mechanism" [13] With the help of a DC motor, bearing, and cutting tool, the goal of this project is to create an autonomous paper cutting machine for industries. In order to cut papers in equal and exact dimensions, a Geneva mechanism and a lever crank mechanism are used in the cutting process. This machine is used to decrease paper cutting manual labor while also saving time. This machine is highly beneficial in the paper production business, and we may use it at institutions, stationary stores, and paper stores, among other places.

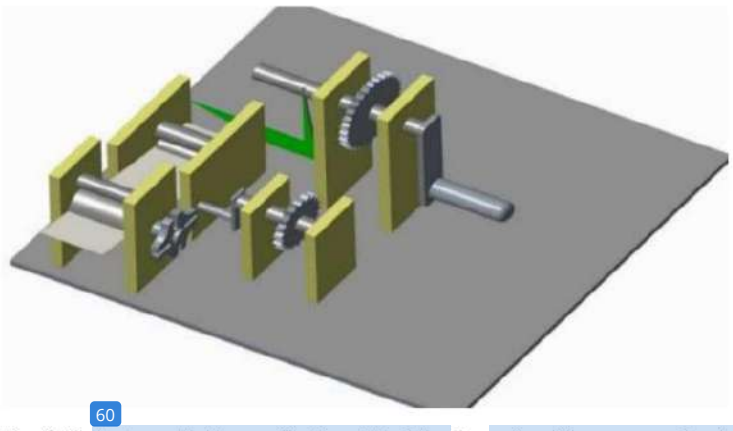

Fig. 2.6: Automatic Paper Cutting Machine by using Geneva mechanism [13].

The design of Automatic Paper Cutting Machine by using Geneva mechanism is shown in **Fig. 2.6.** The design and study of a paper cutting machine that uses the Geneva mechanism

will be extremely beneficial to small businesses. There are paper-cutting machines, but they have drawbacks such as being huge, expensive, requiring specialized labor to operate, and requiring electrical input. The major goal of this machine is to shorten the time it takes to cut paper while ignoring the time it takes to mark the paper. This machine is capable of achieving this goal.

2.5.4 Design and Fabrication of Automatic PVC Pipe Feed and Cutting Machine.

Mohan M, Sathish M, Prakash R, Kalil Rahiman M 'Design and Fabrication of Automatic PVC Pipe Feed and Cutting Machine'[14] has focused on PLC based cutting system. The system's goal is to automate a traditional power-sawing machine so that the working parts are more productive than the machine itself. A motor drives the pipe cutting machine. In **Fig. 2.7** Pipe Cutting Machine has been shown. Small and large-scale pipe cutting, as well as pipe modification in a range of pipe types are all possible with this equipment. At different levels of automation, this is an age of automation, which is defined as the replacement of manual labor with mechanical power.

Fig. 2.7: Pipe Cutting Machine [14].

They used a hacksaw blade, an AC motor, and a DC motor in this system. PVC pipe, Roller, Sensor, Crank and Slider Mechanism. In this method, the pipe is supplied to the cutter assembly, which is guided by a lead screw mechanism. The cutter is used to cut the pipe. This system is an alternative to the present automatic PVC pipe cutting machine in terms of automating pipe entrance into the cutting equipment, reducing power fluctuation, and needing less initial investment. It saves time as compared to hand cutting. This effort yields the intended outcome.

2.5.5 Design and Fabrication of Automatic Glass Cutting Machine

T.R.Veena, R.S.Kadadevaramath, P.M.Nagaraj, S V Madhusudhan 'Design and Fabrication of Automatic Glass Cutting Machine' [15] is presented to increase the accuracy of cut and production rate and decrease the production time and accidents caused due to manual cutting of mirror or glass, the goal of this project is to create an automatic machine that uses a programmable logic controller (PLC) to control the movement of the conveyer as well as the pneumatic circuit. A reflective coating is applied to a suitable substrate to create mirrors. Because of its transparency, simplicity of manufacturing, stiffness, hardness, and ability to take a clean finish, glass is the most well-known substrate. This system had the following components: Bed, C-channel, Rollers, Nylon sheet for conveyer, Guide rod block, Guide rod, Servo motor, Pneumatic circuit, and Pneumatic cylinder. The system's block diagram is shown in **Fig. 2.8.**

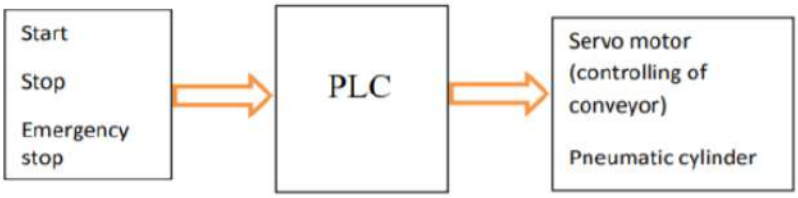

Fig. 2.8: Block Diagram of the system [15].

Fig. 2.9: Veiw of Machine [15].

CATIA V5R20 is used to design the machine elements, and FESTO FLUID SIM software is used to design the pneumatic circuit. Total veiw of this Machine shown in **Fig. 2.9.** This project entails automating the scribing and braking process, which may be done by utilizing a PLC to control pneumatic valves and a servo motor. You will learn more about machine

element design, machining techniques, material selection, pneumatics, and automation as a result of this project work. And the industrial sector's aim of computer integration for automation has been achieved. Furthermore, due to automation, the hourly output rate is twice that of human operation, with a lower rejection rate.

2.5.6 Instinctive foam cutting machine using PLC.

Sasikumar.S , Gowtham.R, Parvathikrishnan.J , Haribalaji.S, Vigneshwaran.A 'Instinctive foam cutting machine using PLC' [16] is based on Automation. This project entails automating the scribing and braking process, which may be done by utilizing a PLC to control pneumatic valves and a servo motor. You will learn more about machine element design, machining techniques, material selection, pneumatics, and automation as a result of this project work. And the industrial sector's aim of computer integration for automation has been achieved. Furthermore, due to automation, the hourly output rate is twice that of human operation, with a lower rejection rate. In this system, Delta PLC was used. Delta PLC is an intelligent system that was developed to replace relay-based logic in the instrumentation and control industry.

CHAPTER 3

HARDWARE DESCRIPTION

3.1 Introduction:

Components are the most important portion of a project; without them, it is impossible to develop a great project. Another major and difficult duty is to select the appropriate components. We will cover the components used in the design of our project in this section. In this section, we will try to discuss hardware descriptions elaborately and also their functions, block diagrams, etc.

3.2 Programmable Logic Controller (PLC):

A programmable logic controller, often known as a PLC or a Programmable Controller, is a digital computer that automates electromechanical processes including industrial assembly lines, amusement rides, and light fixtures. PLC is used in a variety of industries and equipment. Unlike general-purpose computers, the PLC is designed to handle many inputs and outputs, as well as extended temperature ranges, electrical noise immunity, and vibration and impact resistance. Non-volatile or battery-backed memory is frequently used to store programs for managing machine functions.

Fig. 3.1: Logo 230 RC [17],[18].

Depending on the inputs and outputs, a PLC may monitor and record run-time data such as machine productivity or operating temperature, start and stop operations automatically,

produce alerts if a machine malfunctions, and more. PLC (Programmable Logic Controller) is a versatile and dependable control system that may be utilized in almost any circumstance. Few PLC are shown in **Fig. 3.1** [17],[18].

3.2.1 Operation of PLC:

The functioning of a PLC is extremely simple. The processor makes a judgment based on a ladder logic program written by the user. To use the program effectively, the PLC must communicate with the various field devices it is responsible for monitoring and controlling. It then compares the actual circumstances of the field devices to the program's instructions and adjusts the output devices as necessary.

Fig. 3.2: Siemens Logo

The following is the operating sequence:

- The input switch has been pushed.
- The input module adds a single digit to the input data table.
- When the ladder logic software detects the "1," it inserts a "1" into the output data database.
- The output data table energizes the appropriate location in the output module.
- The output device is turned on.

The PLC we using in this project is Siemens Logo 6EDI 052-1HB00-OBA4 Shown in **Fig. 3.2**

3.2.2 Features of PLC:

Siemens' 6EDI 052-1HB00-OBA4 logic display module is LOGO! 24RC. It has manual control, integrated control, and a display option. Additional modules can be added to this module.

- The input voltage is rated at 24 DC/AC
- Relay output current: 3 amps (inductive) and 10 amps (resistive) load
- Eight digital inputs (four of which can be used as analogue), and four relay digital outputs
- There are 130 memory blocks.
- Protection rating of IP20
- Approved by UL, CSA, FM, IEC, and VDE.
- The measurements are 72mm x 90mm x 55mm.
- The working temperature ranges from 0 to 55 degrees Celsius.
- Can be mounted on a 35mm DIN rail.
- Suppression of radio interference in accordance with EN55011, Class B Limit Value.

3.2.3 Advantages of PLC

- PLC is resistant to harsh environmental conditions such as dust, moisture, heat, and cold.
- Programming a PLC is easier than wiring a relay control panel.
- If necessary, the PLC may be reprogrammed. Traditional controllers need rewiring and are often damaged instead.
- PLC take much less room on the floor than relay control panels.
- A PLC has the ability to expand input/output configurations.
- The PLC is easier to maintain and has a higher level of reliability.
- PLC may readily implement special functionalities such as time-delay actions and counters

3.3 5V DC Gear Motor:

A gear motor is a combination of a motor and a gearbox. The speed of a motor is lowered when a gear head is added, but the torque production is raised. The most important characteristics for gear motors are speed, torque, and efficiency. To produce a highly efficient gear motor solution, most of our DC motors may be coupled with one of our one-of-a-kind gearheads [19].

Fig. 3.3: 5V DC Gear Motor [19].

3.3.1 DC Gear Motor Include Following Components

- A stator (stationary part)
- An armature (rotating part) and
- A Gearbox head

3.3.2 DC Gear Motor Working Principle

The torque is experienced and travelled when a driver is placed in a magnetic field. In other words, as the coils are turned on and off in sequence, a spinning magnetic field is created, which communicates with the various fields of the stationary magnets inside the stator to produce a torque that permits it to spin.

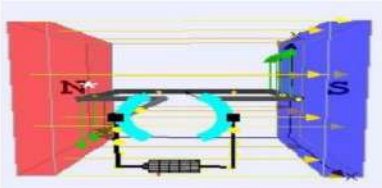

Fig. 3.4: DC Gear Motor Working Procedure [20].

Fig. 3.4 is the operation of a DC Gear Motor. Fleming's left law states that if your left index finger, middle finger, and thumb are extended perpendicular to one another and your left index finger indicates magnetic field directions, your middle finger indicates current direction, and your thumb points in the direction where the force is perceived, then the thumb points in the direction where the force is perceived [20].

3.4 Communication Cable:

A data transmission line that connects two locations that are apart geographically. The logo communication cable is shown in **Fig. 3.5.** A communications cable's transmission medium, which might be optical fibers, coaxial conductors, or twisted wire pairs, is at its core. A mechanical structure protects the cable's heart from handling pressures and the outside environment. The intended purpose of a cable determines its construction [21].

Fig. 3.5: Logo Communication Cable [21].

3.5 DC Power Supply 24V DC, 10 Amps:

AC mains electricity is used to power DC power supplies. In this power supply, a transformer will be utilized to convert the input voltage to a higher or lower AC voltage. A rectifier converts the transformer output voltage to a fluctuating DC voltage, which is then passed through an electronic filter to produce an unregulated DC voltage. In **Fig. 3.6** 24 VDC, 10 Amp Power Supply is shown.

The filter eliminates the majority, but not all, of the AC voltage fluctuations; the resulting AC voltage is known as ripple. The amount of filtering needed by a power supply is governed by the ripple tolerance of the electric load.

Fig. 3.6: 24 VDC, 10 Amp Power Supply [22].

In some applications, high ripple is acceptable, thus no filtering is required. A mains-powered DC power supply may be achieved in some battery charging applications using only a transformer and a single rectifier diode, with a resistor in line with the output to restrict charging current [22].

3.6 12V DC Gear Motor:

A rotary electrical machine that transforms direct current electrical energy into mechanical energy is known as a direct current gear motor. A DC gear motor is a combination of a motor and a gearbox. When a gear head is added to a motor, the speed is slowed while the torque production is increased. To produce a highly efficient gear motor solution, most of our DC motors may be coupled with one of our one-of-a-kind gearheads.

Magnetic field forces are used in the most common forms. Almost all DC gear motors include an internal mechanism, either electromechanical or electronic, that periodically changes the direction of current flow in a section of the motor.

Because they could be supplied by existing direct-current lighting power distribution networks, DC gear motors were the first widely used type of motor. A DC gear motor's speed may be adjusted across a wide range by changing the supply voltage or the current strength in its field windings. Small DC gear motors may be found in a wide range of appliances, toys, and equipment. The universal motor is a small brushed motor that runs on direct current and

is commonly used in portable power devices and appliances. In **Fig. 3.7** 12V DC Gear Motor are shown. Electric vehicle propulsion, elevator and hoist drives, and steel rolling mill drives are all using larger DC gear motors. The advancement of power electronics makes it possible to replace DC gear motors with AC motors in many applications.

Fig. 3.7: 12V DC Gear Motor [23].

A coil of wire with a current running through it generates an electromagnetic field aligned with the coil's center. The direction and amplitude of the magnetic field produced by the coil may be altered by the current flowing through it. A single DC gear engine has a fixed set of magnets in the statistics and an armature that wraps the magnetic field around a soft iron core with one or more separate windings. In big motors, the windings usually contain a lot of turns around the center, and multiple parallel current channels can be employed. The ends of the wire wrapping are connected to a commutator [23].

The commutator energizes each armature coil individually and connects the rotating coils to the external power source using brushes. The overall amount of current provided to the coil, the coil's size, and what it's wrapped around influence the strength of the electromagnetic field generated. A Direct Current (DC) gear motor is a rotating electrical device that uses direct current to convert electrical energy into mechanical energy. A magnetic field is created when DC voltage is applied to the terminal of an inductor (coil) within a DC gear motor, causing rotational motion. Inside the motor, an iron shaft is wrapped in a coil of wire. On each ends of this shaft are two fixed magnets, north and south, which create a repulsive as well as attractive torque.

Rated voltage: 12 V DC

Reduction Ratios: 1:270

Direction of rotation: CW

At no load:

Speed: 10.8 ±10%rpm

Current: 0.035A(max 0.43A)

At max efficiency:

Torque: 2.4kg.cm

Speed: 9.3 ±10% rpm

Current 0.068 A(max 2.4A)

3.7 Push Button Switch:

A typical type of control interrupter is the push-button, which is used to enable and deactivate the control circuit. It is used in automatic circuits for electric control to manually transmit control signals to controllers, relays, electromagnetic starters, and other devices. The Start/Stop Pushbutton Switch is shown in **Fig. 3.8**. Its distinguishing feature is that the system and instrument are mounted in the work phase, frequently in their original location in a free state, and are changed into a second stage only when required by an external force (position). By using spring movement, the switch returns to its previous position after removing the external power. The button is used to perform simple functions such as start, stop, forward and backward rotation, speed change, and lock-in [24].

Fig. 3.8: Start/Stop Pushbutton Switch [24].

3.7.1 Push Button Switch Structure:

The majority of control pushbuttons function in the same way. An electromagnetic adsorption kit is housed within the button. **Fig. 3.9** is Push Button Switch Structure.

A push-button switch typically consists of the following components:

- A button cap
- A return spring
- A bridge-type moving contact
- A static contact, a pillar connecting rod, and a shell.

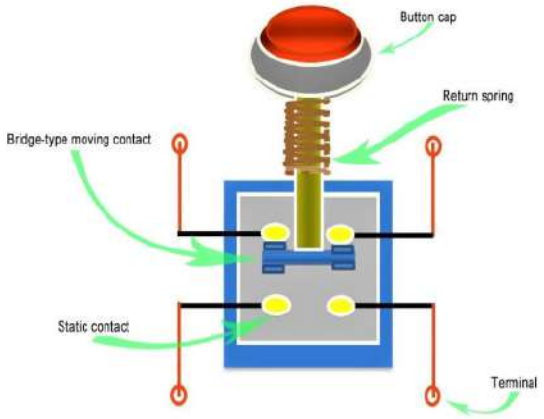

Fig. 3.9: Push Button Switch Structure [24].

3.7.2 Push Button Switch Working Principle:

The button or actuator is pressed, and the bottom of the switch's contacts are depressed until secure connections are made. There are two types of electrical circuits: open and closed. When the pressures are applied again, the spring will retract and the connection to the pushbutton will change. When the button is pressed, the symbol toggles and flips between two states (sound on/off) [24].

3.8 Limit Switch:

An object's physical force activates a limit switch, which is an electromechanical device. Limit switches are used to control the flow of power. Object presence may be detected using

limit switches. Limit Switches got their name from their original purpose of defining an object's journey limit.

Fig. 3.10: Limit Switch [25].

Limit switches are classified into four types:

1. Whisker
2. Roller
3. Lever
4. Plunger

In **Fig. 3.10** limit switch is shown. Depending on the application, a limit switch may be a combination of two general kinds, such as roller-lever. Limit switches are available in a number of configurations, such as typically open, normally closed, or a mix of the two [25].

3.8.1 Limit Switch Structure

Limit switches are used to detect or sense the existence of an object, as well as to monitor and alert if the object's movement limits have been exceeded.

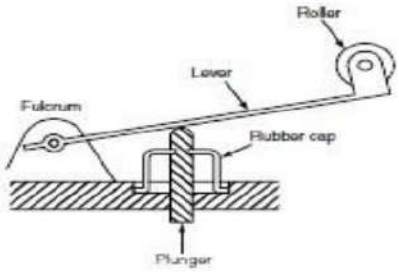

Fig. 3.11: Limit Switch Structure [25].

Fig. 3.11 is the limit switch structure. Limit switches, as the name implies, were initially intended to define the limit or endpoint past which an item may go before being stopped. At this point, the switch that controls the trip limit was turned on.

3.8.2 Limit Switch Working Principle

A standard limit switch is an electromechanical device used in industrial applications that consists of a mechanical actuator connected to a series of electrical connections. When an item (also known as the target) makes physical contact with the actuator, the plunger moves, forcing the electrical connections within the switch to shut (for a normally open circuit) or open (for a normally closed circuit) (for a typically closed circuit). Limit switches use the mechanical movement of the actuator plunger to regulate or modify the state of the electrical switch. . Similar devices, such as inductive or capacitive proximity sensors, or photoelectric sensors, can achieve the same result without touching the object. Limit switches, in contrast to these other forms of proximity detecting devices, are contact sensors. The majority of limit switches operate mechanically and have heavy-duty contacts capable of switching larger currents than alternative proximity sensors [26].

3.9 Relay:

A relay is an electromechanical device that makes or splits an electrical connection. It's a small mechanical component that can be controlled electronically using an electromagnet. A relay is similar to a mechanical switch, except that instead of physically turning it on or off, you can control it with an electrical signal.

Fig. 3.12: Relay [27].

Production and construction automation relays are commonly used in control panels to control energy and alter lower current levels on a control circuit, as well as the control system **Fig. 3.12** shows a relay [27].

3.9.1 Relay Pin Diagram:

Relay is an electromechanical device that makes or splits an electrical connection. It's a small mechanical component that can be controlled electronically using an electromagnet. A relay is similar to a mechanical switch, except that instead of physically turning it on or off, you can control it with an electrical signal.

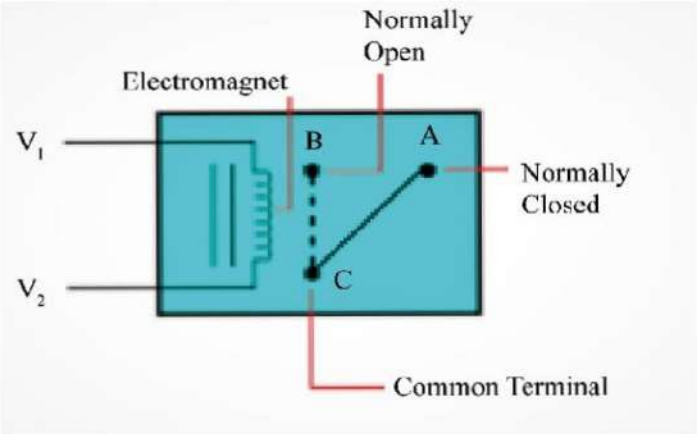

Fig. 3.13: Relay Pin Diagram [27].

Production and construction automation relays are commonly used in control panels to control energy and alter lower current levels on a control circuit, as well as the control system.

Table 3.1: Pin description of Relay

One	The pin is common,
2nd	Normally close
3rd	Normally open
Two Common pins	Pins for the coil

3.9.2 Relay Working Principle:

Electromagnetic attraction is the basis for its operation. When the relay circuit detects a failed current, the electric field that generates a transient magnetic field is strong. The relay armature is pushed by this magnetic field, allowing contacts to be opened or closed. The working procedure of relay shown in **Fig. 3.14** .

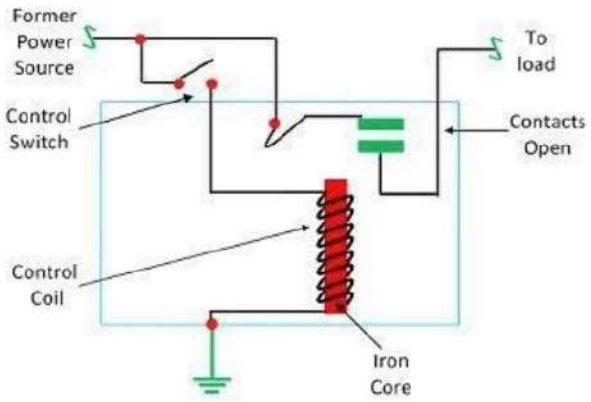

Fig. 3.14: Relay Working Procedure [28].

To open the switch, the small power relay requires only one touch, while the high power relay requires two connections. The inner workings of the relay are shown in the diagram below. A regulating coil with an iron heart burns it. The electricity is delivered to the bob via load connections and a control switch. The magnetic field is created by the stream moving through the spiral. Because of the magnetic field, the higher arm of the magnet absorbs the lower arm. As a result, the circuit closes and the current can flow through the load. If a contact is locked, it reverses the process and opens connections [28].

3.9.3 Advantages of Relay:

- It enables us to operate a device from faraway. It is not essential to be in close proximity to the device for it to work.
- Changing contacts is simple.
- Isolates the actuating parts activating portion.
- It is effective at high temperatures.
- You can control several contacts with a single signal.
- It has the ability to switch between direct and alternating current.

- It is activated with a tiny current, yet it has the ability to activate massive machines with a lot of power.

3.9.4 Disadvantages of Relay:

- These relays have a larger VA burden than static and numerical relays. As a result, the capacity of the Potential and Current Transformers should be increased.
- These relays must be calibrated and tested on a regular basis.
- These relays are showing signs of wear and tear. The springs and connections inside the relay deteriorate over time. As a result, the setting values drift. This can lead to errors and erroneous journeys.
- The mechanical inertia of the moving components limits the speed of operation.
- It is not possible to multitask. Only one function can be performed by a relay.

3.10 IR Obstacle Sensor:

A glowing electrical component that detects an item in the surroundings is known as an infrared sensor. An infrared sensor can detect motion as well as the temperature of an object. The basic idea behind an Infrared Sensor as an Obstacle Detector is that an infrared signal reflects off the surface of an object and receives a signal from an infrared receiver.

Fig. 3.15: IR Obstacle Sensor [29].

3.10.1 IR Obstacle Sensor Pin Diagram:

The VCC pin receives a 5 VDC supply input, and the supply negative is linked to the module's GND terminal.

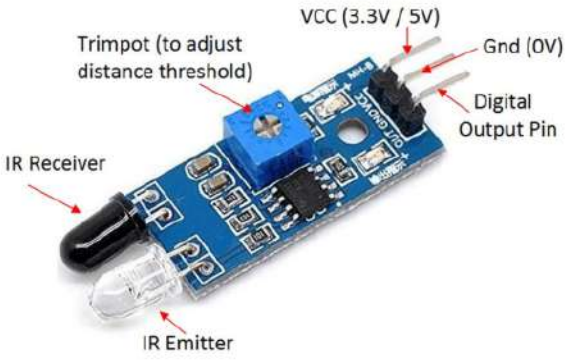

Fig. 3.16: IR Obstacle Sensor Pin Diagram [29]

The output LED remains off when no item is detected within the IR receiver's range. When an item is identified inside the IR sensor's range, the LED flashes. The pin design for the IR obstacle sensor is shown in **Fig. 3.16** and the pin description for the IR obstacle sensor may be found in **Table 3.2.**

Table 3.2: Pin description of IR obstacle sensor

Pin No	Pin Name	Description
1	Vcc	3.3 to 5V DC Supply Input
2	And	Ground Input
3	Out	The output that goes low when an obstacle is in range
4	Power LED	Illuminates when power is applied
5	Obstacle LED	Illuminates when the obstacle is detected
6	IR Emitter	Infrared emitter LED
7	IR Receiver	The infrared receiver receives a signal transmitted by the Infrared Emitter.

3.10.2 Types of IR Obstacle Sensor:

Infrared sensors, both passive and active, might be used. Passive infrared cameras are infrared detectors. Passive infrared detectors detect obstacle emitting power in the visual system without using infrared light. Active infrared sensors include two parts: an infrastructure source and infrared detection. Infrared sources include LEDs and infrared laser diodes. Infrared detection is accomplished using photodiodes or phototransistors. An entity reflects the infrared source radiation, and the infrared sensor falls.

3.10.2.1 IR Transmitter:

A light-emitting diode (LED) that absorbs infrared radiation is known as an infrared transmitter. Then they're referred to as infrared LEDs. While an IR LED seems to be a normal LED, it produces undetected radiations. The frequency, output power, and reaction time of infrared transmitters are all categorized. A simple infrared transmitter may be made with an infrared LED, a current resistor, and a power source. The IR transmitter draws around 3 to 5 mA when supplied by a 5V source. The quantity of infrared light produced by infrared transmitters can be adjusted [29].

3.10.2.2 IR Receiver:

Infrared sensors, often known as infrared sensors, detect light from an IR transmitter. Photodiodes and phototransistors are provided by IR receivers. Infrared photodiodes are different from regular photodiodes since they only detect infrared energy.

IR receivers are available in a wide range of wavelengths, voltages, enclosures, and other options. When utilizing an infrared inverter-receiver pair, the wavelength of the recipient should match the frequency of the transmitter. There's an IR phototransistor, a diode, a MOSFET, and an LED in there. If an infrared signal is received, the current going via the picture transistor and MOSFET is triggered. As a consequence, the load-friendly LED flashes. The phototransistor's intensity is controlled by the potentiometer [29].

3.10.3 Working Principle of IR Obstacle Sensor:

An infrared sensor is similar to an object detector in that it detects objects in the dark. This sensor, which has an IR LED and an IR A photodiode, will form an opt coupler when combined with these two. A type of IR radiation transmitter is an IR LED.

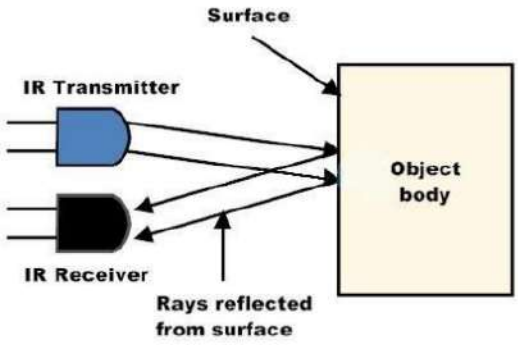

Fig. 3.17: IR Obstacle Sensor working procedure [30].

In **Fig. 3.17** IR Obstacle Sensor working procedure are described.It works like a regular LED, and the resultant radiation is undetectable to the human eye. Infrared receivers detect the radiation emitted by an infrared transmitter. The photodiodes are used as infrared receiving. IR photodiodes differ from ordinary photodiodes in that they detect infrared energy. Various varieties of infrared receivers exist, depending on voltage, wavelength, box, and other factors. The receiver must match the wavelength of the transmitter after being utilized as an IR transmitter and receiver pair. The transmitter is an IR LED, and the receiver is an IR photodiode. When an infrared LED emits infrared light, the infrared photodiode reacts. The resistance of the photodiode and the voltage shift are proportional to the amount of infrared radiation. The IR sensor's core working theory is as follows. Some of the infrared emissions will come to an entity and reflect back to the infrared receiver after they are formed. The sensor output can be determined by the IR receiver based on the strength of the reaction [30].

3.11 Conveyor Belt:

Two motorized lights run through a lengthy, robust line of dense merchandise on a conveyor belt. Because both motors operate at the same speed and rotate in the same direction, the belt is installed in both. Belt conveyor systems have two or three pulleys. In **Fig. 3.18** conveyor belt is shown. An infinite circle of the media, the conveyor belt, circulates around them.

If the objects are very big or voluminous, or if the conveyor belt is long-distance, sturdy

rollers may be installed on the conveyor belt's side for protection.

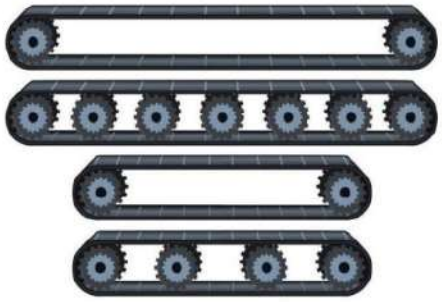

Fig. 3.18: Conveyor Belt [31].

Artifacts are preserved by rollers, and the belt is not broken.

3.11.1 Conveyor Belt Function

The goal of a transport belt is to carry products from point A to point B with minimal effort. The conveyor belt's speed, direction, thickness, and scale vary depending on the user's requirements. In some industries, a conveyor belt transports goods back and forth through the output or packaging line. Light belting is developed to meet a variety of material processing standards in a variety of industries. A lightweight belting device's operational stress is less than 160 pounds per inch [31].

3.11.2 Conveyor Belt Application

- Easily and efficiently transport a diverse range of products
- At the end of the line, stacking materials.
- Make the process of getting from point A to point B easier.
- Vertically or horizontally, move a product with tremendous adaptability.

3.12 Indicator Lamp:

A malfunction indication lamp (MIL), sometimes known as a check engine light, is a warning light used by a computerized engine management system to signal a problem. The legendary check engine, service engine or engine soon bear an image of an engine is seen on the instrument panel of most cars and is often lighted by an amber or red colour.

Indicator Lamp is shown in **Fig. 3.19.** In general, the light has two stages: constant (showing a minor defect) and flashing (indicating a severe fault).

Fig. 3.19: Indicator Lamp [32].

When the MIL lights, the engine control unit records a fault code linked to the problem, which may be recovered - albeit many models require the use of a scan tool. This warning light can indicate a wide range of problems, from a loose gas cap to a serious engine knock.

3.12.1 Indicator Lamp Working Principle

The turning signal circuit receives power when the ignition key is turned on. A fuse panel supplies electricity to the thermal flasher. Depending on the direction of the turning signal trunk, the power either stops or is transmitted to the left or right turning signals (including the indicator lights on the dashboard) [32].

3.13 Magnetic solenoid coils

A solenoid is an electromagnet made out of a coil of wire. It also refers to any device that converts electrical energy to mechanical energy via a solenoid. The device generates a magnetic field with electric current, which it then uses to create linear motion. Solenoids are frequently used to power a switch, such as a car's starter, or a valve, such as a sprinkler system's valve. A solenoid is a coil of wire coiled around a piston in a corkscrew form, generally made of iron. A magnetic field is generated when an electric current passes through the wire, as it occurs in all electromagnets. Magnetic solenoid coils is shown in **Fig. 3.20**

Electromagnets have the benefit over permanent magnets in that they can be switched on and off by sending an electric current through them, making them useful as switches and valves and allowing for total automation.

Fig. 3.20: Magnetic solenoid coils [33].

An active solenoid's magnetic field, like that of other magnets, contains positive and negative poles that attract or repel magnetically sensitive objects. A solenoid coil generates motion by creating an electromagnetic field that forces the piston to travel backward or forward.

3.13.1 Magnetic Solenoid Coils Working Principle

A direct-acting valve's solenoid is triggered by an electric current, which moves a piston or plunger that would otherwise obstruct air or fluid flow. In some solenoid valves, the electromagnetic field does not immediately open the conduit. In pilot-operated valves, a solenoid pulls the plunger, creating a tiny hole through which pressure activates the valve seal. Solenoid valves of both types require a constant flow of electrical current to remain open since the electromagnetic field dissipates and the valve returns to its original closed state when the current is withdrawn. This is a lengthy enough derivation of the magnetic flux density around a solenoid to account for fringe effects. Inside the solenoid, the flux density vector points in the positive z direction, whereas outside the solenoid, it points in the negative z direction. Using the right hand grip rule, we wrap a wire around the field to verify this. If we wrap a wire around our right hand's thumb pointing in the direction of the current, the field behaves as shown by the curl of the fingers. Due to the length of the solenoid, symmetry prevents all magnetic field components from pointing upwards. Outside, a similar cancellation happens, with the field just pointing downwards [33].

Take a look at the fictional loop that occurs within the solenoid. Because it encloses no electrical currents, the loop integral of B (the magnetic flux density vector) around this loop is zero, according to Ampère's law (it can also be assumed that the circuital electric field passing through the loop is constant under such. conditions: a constant or constantly changing current through the solenoid). The horizontal sections of loop C do not contribute to the integral since the field within the solenoid is directed upwards as shown above. As a reason, the up side 1's integral matches the down side 2's integral. Because we may change the loop's size arbitrarily and receive the same result, the only physical explanation is that the integrands are indeed equal, that is, the solenoid inside the magnetic field is radially uniform. However, nothing stops it from moving longitudinally, which it does.

CHAPTER 4

METHODOLOGY

4.1 Introduction:

This is the most important chapter of any project report. In this chapter, we will discuss about the design methodology of the project, which includes block diagram, flow chart, circuit diagram and ladder diagram with their operations briefly. The step by step discussion of this project is given below:

4.2 Block Diagram:

For this project, we created a block diagram. We used a LOGO OBA4 PLC, which has eight inputs and four outputs. The PLC we utilized is the LOGO OBA4 PLC, which is an AC/DC 24V relay-based PLC. **Fig. 4.1** depicts the project's block diagram. **Fig. 4.1** shows the needed block diagram.

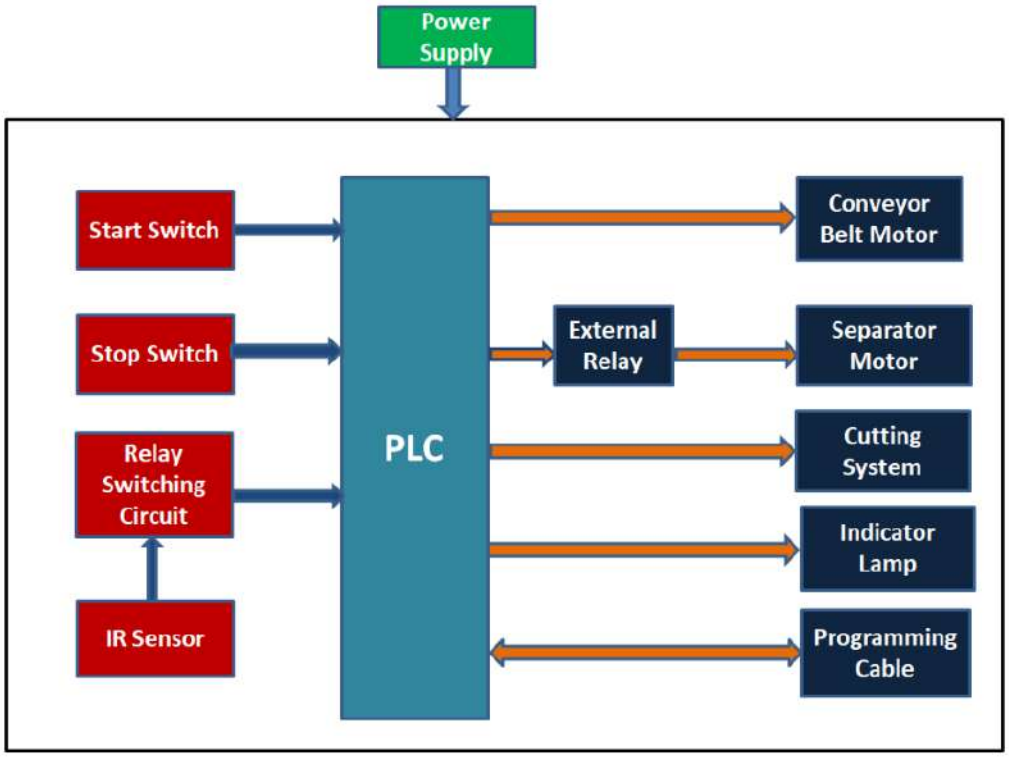

Fig. 4.1: Project Block Diagram

We're using a PLC (programmable logic controller), which is a microprocessor-based device. All PLC has feature flash memory, which can be used to save or erase programming. I/O, CPU, and power supply are the three primary components of a PLC. As can be seen in **Fig. 4.1**, the presented block diagram is divided into three sections: input, PLC, and output.

This block diagram includes an SMPS power supply, an IR sensor, a DC Gear Motor, an external relay, an indicator light, and push button switches. We are providing supply voltage to the PLC using the SMPS Power Supply block. For the PLC, we used a 24V SMPS power supply. The block diagram shows an IR sensor and a 5V relay. We are unable to connect the IR sensor directly to the PLC due to the IR sensor's low output voltage. As a result, we used a relay to connect the IR sensor input to the PLC. When a sensor detects something, it sends a voltage to the PLC as an input. Then, based on the sensor, we'll execute an output. We also used an external relay for the dc gear motor because the separator dc gear motor had to work in both directions. As a result, we used an external relay in connection with a separator dc gear motor. Here are the outputs of the indicator bulbs that are connected to the PLC.

When the cutting system is turned on, it cuts the paper and the conveyor belt runs at the same time. The IR sensor is always on and measures the length of the paper on the conveyor belt. If the size is incorrect, the paper is rejected, and the rejected paper is separated from the acceptable size paper in a separate box by a separator motor. The indicator bulb also shows the status of accepted and rejected papers. This is our project's entire block diagram description.

4.3 Flow Chart:

Description:

We need to establish a system's workflow before we can develop the system itself. The flowchart also helps to understand the workflow. As a result, we've created a flow chart for our system. **Fig. 4.2** displays the project's created flow chart.

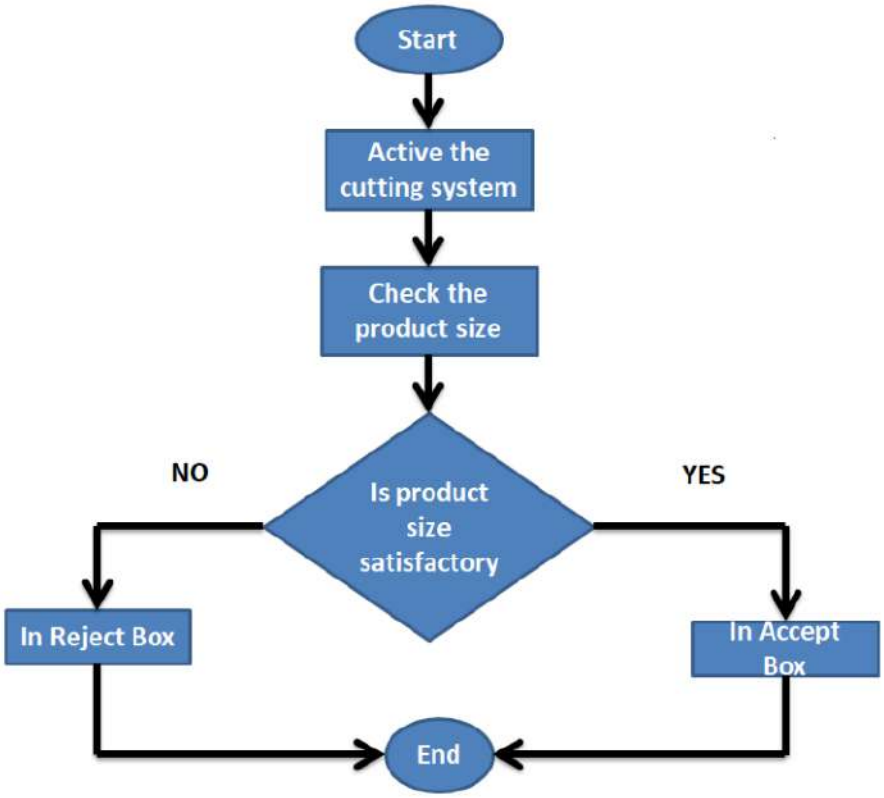

Fig. 4.2: Flow chart of this project

This flow chart is not big or complicated. The operation of the flow chart is discussed below:

- Initially active the cutting system.
- Then check the product size.
- If the product size is satisfactory then the product will proceed to the accepted condition, otherwise it will go to the rejected condition .
- Then the desired output will be found.

4.4 Circuit Diagram:

Description:

A Logo PLC is utilized in the diagram depicted in **Fig. 4.3**. There are 8 inputs and 4 outputs on the Logo PLC. Two of the eight inputs can be utilized as digital inputs, and one can be used as an IR Obstacle sensor.

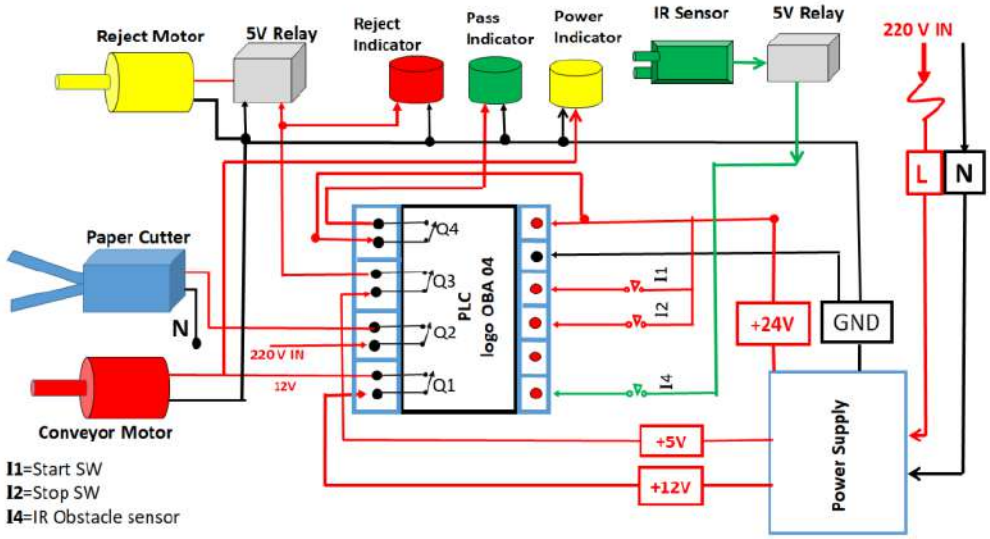

Fig. 4.3: Project Circuit Diagram

Three inputs and four outputs are used in the circuit diagram above. The input and output details are given here –

- I1 –Push Button Switch 1(System Start)
- I2 – Push Button Switch 2.(System Stop)
- I4– IR Obstacle Sensor.
- Q1 – 12V DC gear Motor Conveyor Belt connection and Power Indicator .
- Q2 – Paper Cutter/Scissors.
- Q3 – 5V DC gear Motor for Rejection and Reject Indicator.
- Q4 –Pass Indicator.

In the circuit design illustrated in **Fig. 4.3**, we have a start switch I1 that starts the conveyor belt motor and a power indicator that shows the system is on. Q1 connects the conveyor belt motor and the power indication. In Q2, a paper cutter is connected for sizing paper. Q4 is linked to the pass indicator. When the paper size is acceptable and accepted, the pass indicator turns on. Input I4 is coupled to an IR Obstacle sensor. The length of the paper is measured by an infrared sensor, which detects any length errors. The length of the paper is measured using an infrared sensor. If the length measurement on the paper is exact, it will be accepted; if it is not, it will be refused. We linked the reject motor to Q3 to reject improper paper. Also attached to Q3 is a reject indicator, which indicates that the paper has been rejected. We also have a stop switch that is connected to I2 and is used to halt the system.

4.5 Ladder Diagram

We have covered the PLC programming through the ladder diagram here. We include ladder diagram of this project in below:

In this ladder diagram **Fig. 4.4** , we used I1 to start the system and I2 to stop the system. Both are connected with latching relay. The NO contact of latching relay SF009 connected with Q1. Q1 is conveyor belt motor and Q2 is the cutter. Here we set a condition, when cutter cut the paper, in the meantime conveyor belt stop. That's why we are used Q2 interlock to apply this condition. I4 is an IR Obstacle sensor which is measure the paper size.I4 are connected with three ON Delay Timer T001, T002 and T003 set three different times as 85ms, 95ms and 1s. SF004 is AND gate and three NO contact of three ON Delay Timer are connected as input with this. When one input is HIGH then AND gate is HIGH. Edge Trigger Timer T008 is connected with AND gate and set Edge Trigger Timer pulse time is 1.05s, interpulse time is 3s.Q4 is pass indicator and NO contact of T008 connected with this. Also NO contact of T008 are connected with cutter which set cutter preparing for another cutting operation. I4 measure the paper size, if paper size is small or large then it pulse T005 Wiping Relay Timer. NO contact of T005 is connected with Edge Trigger Timer T006. Edge Trigger Timer T006 pulse time is 4s, interpulse time 4s.Q3 is reject motor.NO contact of T006 is connected with Q3 and T007.

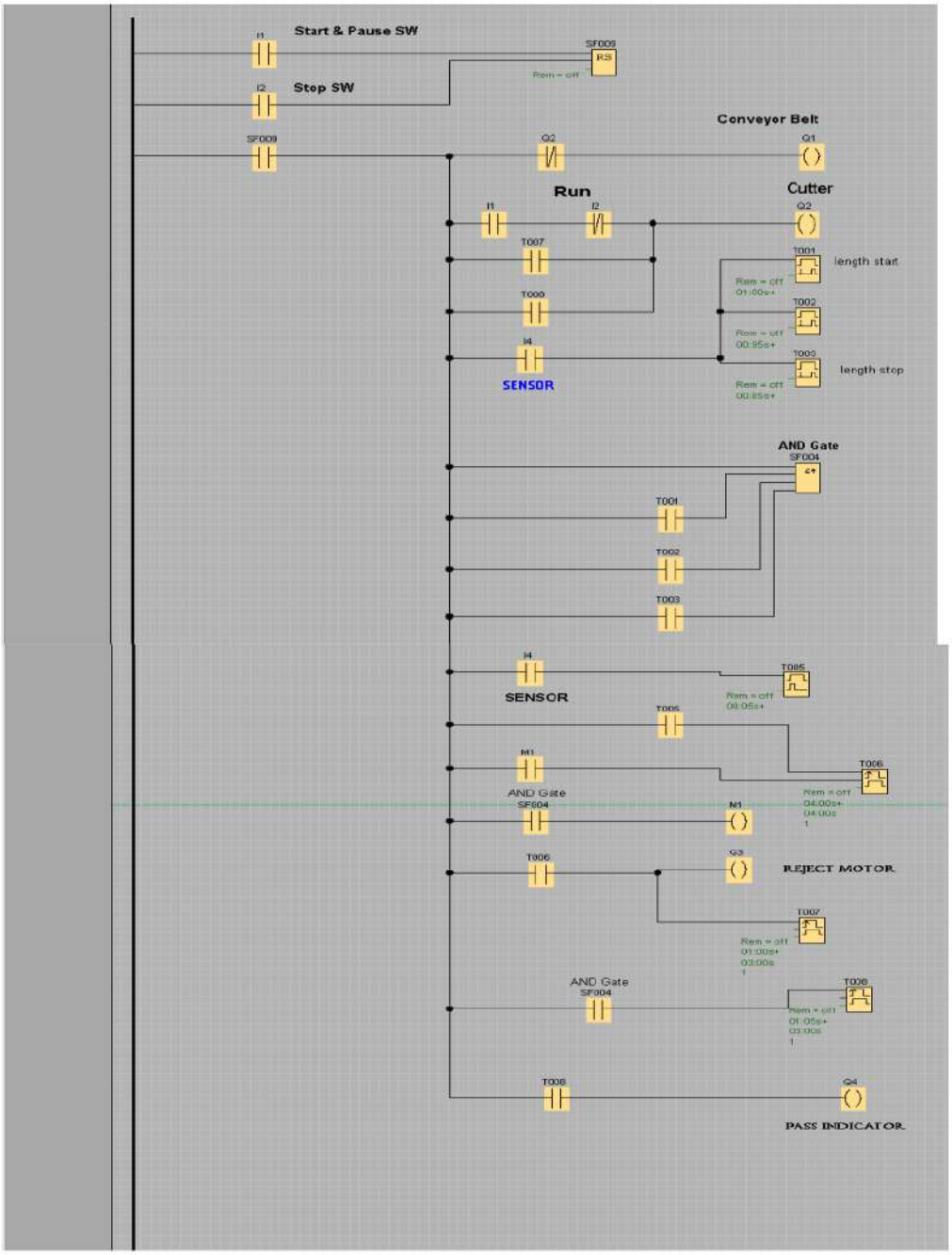

Fig. 4.4: Ladder Diagram

Edge Trigger Timer T007 pulse time is 1s, interpulse time 3s. Also NO contact of T007 are connected with cutter Q2 which set cutter Q2 preparing for another cutting operation.

CHAPTER 5

SYSTEM IMPLEMENTATION AND RESULT

5.1 Introduction:

This project is designed for the basic PLC concepts. We created the project's programs using the LOGO software's ladder diagram. The experimental setup, objective justification, cost analysis, and project results are all discussed in this chapter.

5.2 Implementation:

All the machinery in this system is put in a wood board. In a PLC connected board is set the dc Gear Motor, magnetic solenoid coil, IR Obstacle Sensor, conveyor belt, indicator and relay. With connectors all equipment is connected to PLC. In addition, for additional connections, we use connectors.

5.2.1 Project Overview:

The whole system overview will discuss in **Fig. 5.1**. An OBA 04 PLC logo has been used. There are four inputs and four outputs on the Logo OBA 04 PLC. Two of the four inputs can be utilized as digital inputs, and one can be used as an IR Obstacle sensor. Three inputs and four outputs were used in the circuit schematic above. The input and output details are given here –

- I1 –Push Button Switch 1(system start)
- I2 – Push Button Switch 2.(system stop)
- I4 – IR Obstacle Sensor.
- Q1 –12v dc gear Motor Conveyor Belt connection and Indicator .
- Q2 – Paper Cutter/Scissors.
- Q3 – 5v dc gear Motor for Rejector and Indicator.
- Q4 –Pass Indicator

We're employing a PLC (programmable logic controller), which is a microprocessor-based device. The Flash memory of all PLCs is used for saving or deleting code on the PLC. I/O,

CPU and electricity are the primary components of PLC. The project is broken into three components (input, plc and output), as we can see in **Fig. 5.1**.

In this project, SMPS, IR sensor, Motor, External relay, Alarm, Indicator Light, and pushbutton switches are used. The SMPS Power Supply indicates that we are supplying voltage to the PLC. For the PLC, we used a 24V SMPS power supply. The PLC is coupled to an IR sensor and a 5V relay. We are unable to connect the IR sensor directly to the PLC due to the lower output voltage of the IR sensor. As a result, we used a relay to connect the IR sensor input to the PLC. When a sensor detects something, it sends a voltage to the PLC as an input. Then, based on the sensor, we'll execute an output. Because the operating voltage of the separator dc motor is 5V, we also employed an external relay for the dc gear motor. The outputs that are connected in the PLC are indicated by the indicator lamps.

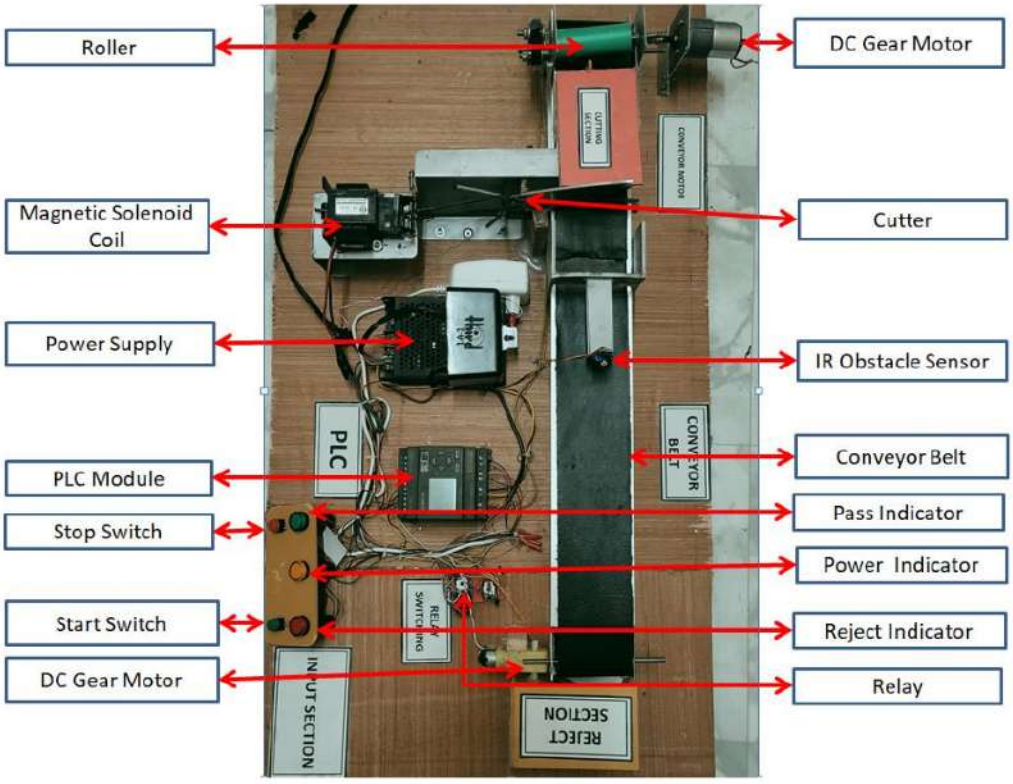

Fig. 5.1: Project View

When the cutting system is turned on, it cuts the paper and the conveyor belt runs at the same time. The IR sensor is always on and measures the length of the paper on the conveyor belt. If the size is incorrect, the paper is rejected, and the rejected material is separated from the correct size paper in a separate box by a separator motor. If the information is valid and incorrect, the indicator lamp will blink.

We use a start switch I1 in the PLC code to start the conveyor belt motor, and a power indicator to signal that the system is up and running. Q1 connects the conveyor belt motor and the power indication. In Q2, a paper cutter is connected for sizing paper. Q4 is connected to the pass indicator, and the indicated paper is passed through the conveyor belt. Input I4 is coupled to an IR Obstacle Sensor. The paper measurement is faulted and an IR sensor is utilized to find it. The paper's measurement is detected by an infrared sensor. If the paper measurement is correct, it will be accepted; if the size is incorrect, it will be refused. We linked reject motor Q3 to reject improper paper. Also attached to Q3 is a reject indicator, which indicates that the paper has been rejected. We also have a stop switch that is connected to I2 and is used to stop the system.

5.3 Performance of the System

First, we must use a programming cable to download the software from the PC-PLC. Then, from the PLC module, begin the program. The system must then be reset by pressing the push button switch. After that, we must begin taking the output one by one. Before taking the output of any system, we must first set-reset it with a push button switch. To display the output, we used indicator lamps. Each desired output will be shown by the indicator lamps turning on/off, as shown in the video.

5.4 Demonstration and Result of the Project

Here we have shown the result that we have obtained from our project:

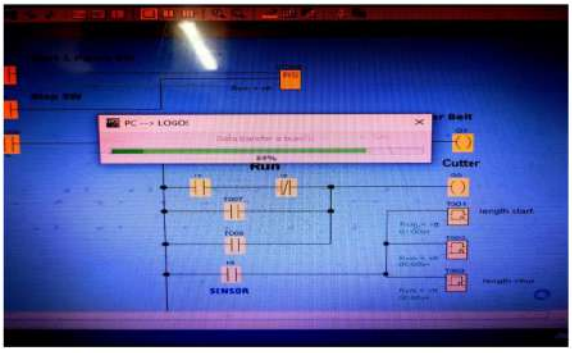

Fig. 5.2: PC-Logo in PC's

Fig. 5.3: PC-Logo in PLC's

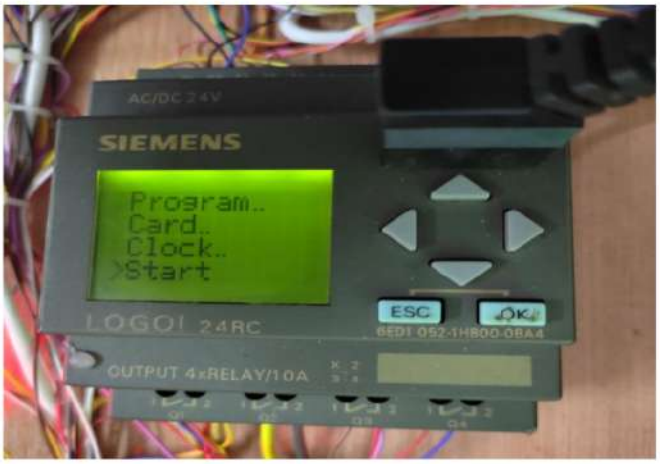

Fig. 5.4: Start the program

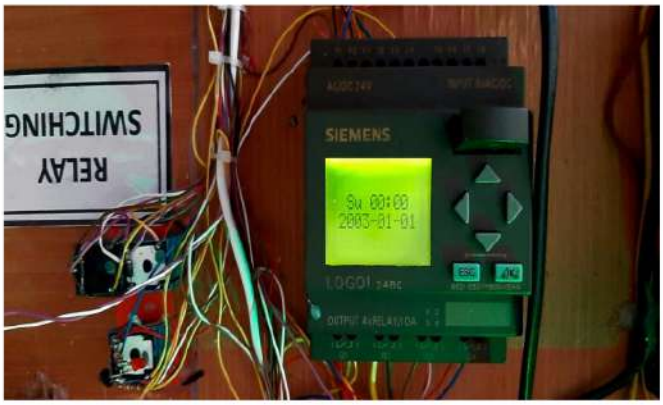

Fig. 5.5: Program is running

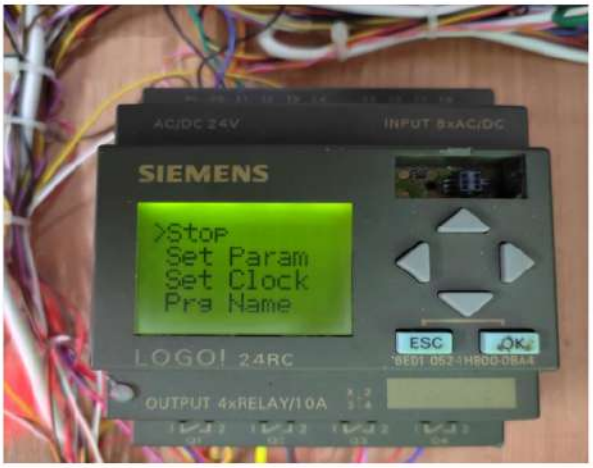

Fig. 5.6: Stop the program

Fig. 5.7: Program is stopped

First of all, the program is downloading by a programming cable from PC-PLC which is shown in **Fig. 5.2** and **Fig. 5.3**. After that, the program is ready to run. The program then begins, as shown in **Fig. 5.4** and **Fig. 5.5**. Finally, the program is stopped after the output is taken shown in **Fig. 5.6** and **Fig. 5.7**.

The procedure described above should be done before taking the output of each program.

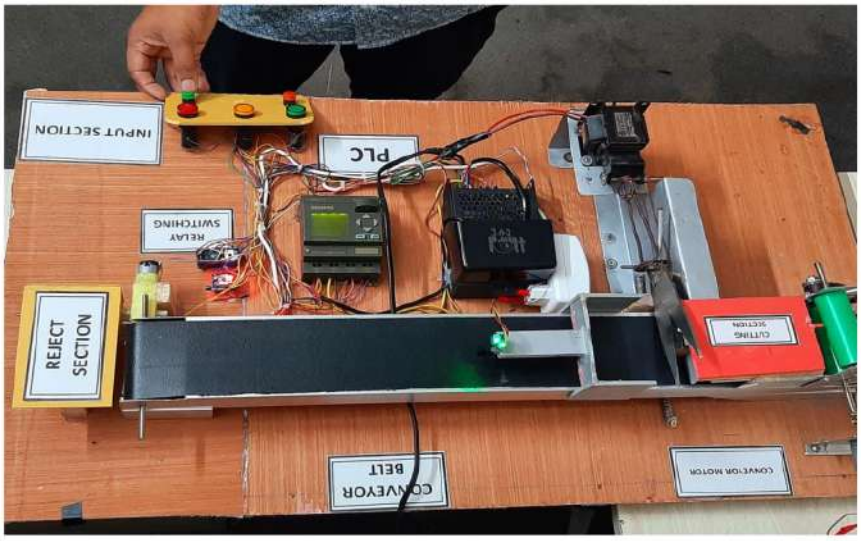

Fig. 5.8: Set the system

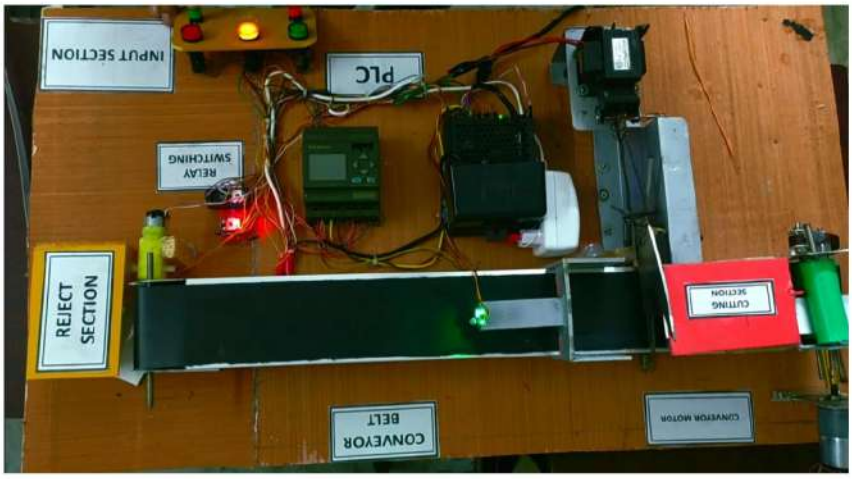

Fig. 5.9: Power indicator is ON and system is start

Fig. 5.10: Cutter is cutting paper

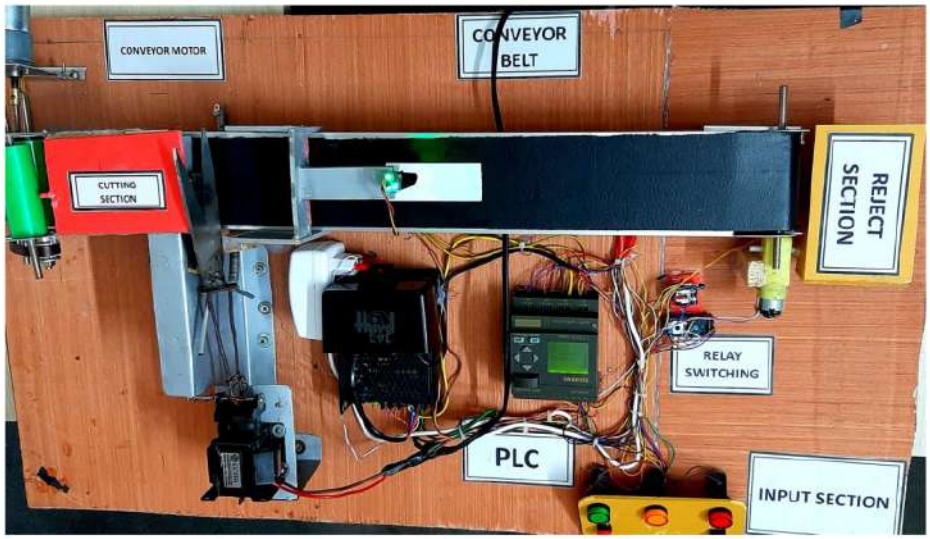

Fig. 5.11: IR Obstacle sensor measure paper size

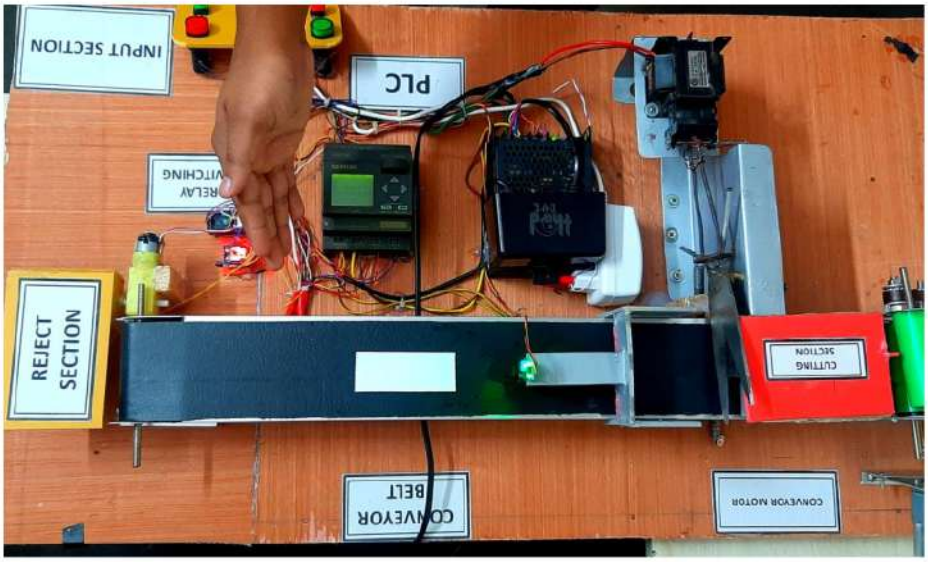

Fig. 5.12: Conveyor belt is running

Fig. 5.13: Pass indicator is ON and paper is accepted

Fig. 5.14: Reject indicator is ON and paper is rejected

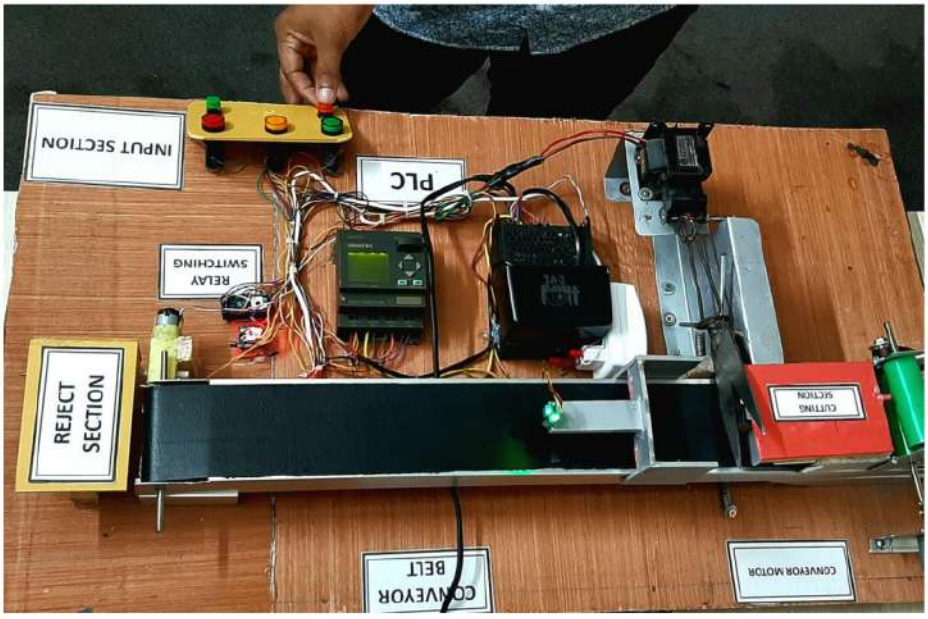

Fig. 5.15: Stop the system

5.5 Objective Justification:

In today's automation, the programmable logic controller is already widely used, and one could argue that it is nothing new. However, it is claimed that PLC is responsible for the management of various machine devices. The majority of individuals anticipate a complex and costly system of controls. It is true that the usage of PLC can simplify the machine while also saving the industry a lot of money. It helps to reduce the number of workers, and by utilizing this plant, we are able to store the project in a smaller space. As a result, we don't require a large workspace, and the program reduces the machine's wiring. In addition, we can locate a machine that will provide greater output and produce more products in the sector. Then came the development of the industry. The purpose of this essay is to demonstrate that there are applications where automation with the help of a PLC can be justified.

5.6 Cost Analysis:

Our project is quite expensive because it is typically utilized for industrial purposes. We need to cut or replace some equipment if we want to reduce the cost of this project, which is more than 10,000 taka. However, the project's performance will suffer as a result. Because this is the fundamental concept of using PLC for industrial applications, it is critical to employ high-quality, long-lasting equipment. **Table 5.1** shows the total cost of the project.

Table 5.1: Total cost of the project

Serial NO	Component	Price (BDT)
1	PLC	5000/-
2	24V SMPS Power Supply	550 /-
3	DC Motor	150 /-
4	DC Gear Motor	500/-
5	Conveyor Belt	1000/-
6	Cable Channel	20/-
7	Cutter	150/-
8	DC Relay	75/-
9	Indicator Lamps	120/-
10	Limit Switch	50/-
11	Magnetic solenoid coils	1500/-
12	Push Switch(2ps)	200/-
13	Obstacle Sensor	80/-
14	Mechanical Structure	600/-
15	Wood and Color	300/-
	Total Amount	= 10,295/-

5.7 Comparative Study:

As per our research, when compared to related projects published in renowned journals and articles, we conclude that this article is – **"Design and Fabrication of Paper Cutting Machine"** [11] the approximate cost of this project is around **BDT 12,000.** The main key feature of this project is Rack and Pinion Mechanism are used for paper cutting operation.

Table 5.2: Comparative Table

Name	Cost(BDT)	Key Features
Design and Fabrication of Paper Cutting Machine	12,000	Rack and Pinion Mechanism are used for paper cutting operation.
Design and Fabrication of Paper Cutting Machine Using Geneva Mechanism	18,500	Paper Cutting machine using Geneva Mechanism and Lever Crank Mechanism
Design and Fabrication of Automatic Glass Cutting Machine	32,050	Decrease the production time and accidents caused due to manual cutting of mirror or glass
Design and Fabrication of automatic PVC Pipe feed and cutting machine	21,430	Automatic PVC pipe cutting machine automate the conventional power hacksaw machine in order to achieve high productivity.

Another paper is – **"Design and Fabrication of Paper Cutting Machine Using Geneva Mechanism"** [13] the approximate cost is not less than **BDT 18,500.** The key features of this project are paper cutting machine using Geneva Mechanism and Lever Crank Mechanism. In this research paper – **"Design and Fabrication of Automatic Glass Cutting Machine"** [15] the approximate cost of this project is around **BDT 32,050.** The key function of the system is decrease the production time and accidents caused due to manual cutting of mirror or glass.In **"Design and Fabrication of automatic PVC Pipe feed and cutting machine"** [14] the approximate cost is not less than **BDT 21,430.** The key features of this project are automatic PVC pipe cutting machine automate the conventional power hacksaw machine in order to achieve high productivity.

After analysing possible journals and papers and comparing them to our project, we have come to the conclusion that the main objective of this project is to design and construct of automatic paper cutting & fault finding system. It is a completely automated PLC control system. Which is used for measuring the length of paper. Also this system is used for paper length fault detection & separation .But these features are combined in different projects. It will cost a lot build a project that has all these features and it will not be less than **BDT 20,000-25,000.** Another notable thing is that the main difference in costing between our project and the projects mentioned above is the choice of PLC module.

In our project, we have designed a PLC based automatic paper cutting and fault finding system which can help measuring the length of paper, paper length fault detection and separation using the PLC programming language Ladder diagram. Our project approximate cost is **BDT 10,295** and we have combined possible industrial features such as safety and security system, automatic paper cutting, paper length fault detection and separation and automatic conveyor belt control in it. Finally, we can say that our project is cost effective and improves the previous one in terms of performance as well as operational flexibility.

5.8 Why PLC is better than microcontroller for industries:

The cost of a microcontroller is less than that of a PLC. However, today, all sectors utilize PLCs since writing a PLC is easier than programming a microcontroller. The design of a PLC modular controller is simpler than that of a microcontroller. A PLC is a more secure system than a microcontroller. Because of their robustness, PLCs require extremely little maintenance. PLCs are still king in the automation and control systems for industries. Microcontrollers may be useful in highly specialized systems, but they aren't up to the challenges that the PLC faces in the workplace. PLCs are favored for industrial control systems because they are less complicated, cost-effective, and reliable.

CHAPTER 6

CONCLUSION

6.1 Introduction:

This is the final chapter of this project report. We shall talk about the project's end in this chapter. The project's limits, future improvements, applications, and benefits will be covered as well.

6.2 Conclusion:

In the printing business, cutting jobs play a significant role. There is a standard size for all paper goods, from the tiniest label to the largest billboards, magazines, novels, and newspapers. Paper cutters are therefore necessary both before and after printing. Paper cutters are used in the printing industry for a variety of reasons, including sizing the paper appropriately for the printing machine, separating duplicate copies that have been produced, and trimming the excess paper off the edges of printed and bound documents. Before automation paper industry is used to cut the paper manually which was time consuming and large manpower required. So this automation is made for industrial use in automatic paper cutting and folding purpose. Automation is utilized for a variety of reasons, including increased productivity, better end-product quality, more effective use of energy and raw materials, and improved workplace safety. Our Cutting machines that use a programmable logic controller have a faster execution time and are more efficient in their operations, as well as safety features such as rejecting incorrect material and ease of use. Relay contactor logic necessitates additional hardware, as well as more complex wiring, which is now addressed by today's programmable logic controller machines. The current system improves the previous one in terms of performance as well as operational flexibility. Furthermore, the running time has been reduced. As a result, this automation has met the desired requirements of consumers.

6.3 Advantage:

Small and medium-sized enterprises will benefit from this equipment. This machine is used to cut thin-thickness paper and sheets. As a result, cutting a large number of sheets in a single pass may be an option for increasing production pace. Reduction in manpower. When compared to typical machinery, there are cost reductions. Other advantages of this project are;

1. To reduce the manpower
2. Small and portable matching.
3. Low-cost and long-lasting
4. To increase the productivity
5. The dimension of the paper will be accurate.
6. It will reduce the time for marking the paper.
7. It is automated, so it does not require additional staff to operate; simply set the program to PLC.
8. We can use it to check the length of the paper and separate the rejected paper.
9. The number of accidents caused by the operation is very low.

6.4 Application:

1. Paper Meals.
2. Packaging Machine.
3. Paper Printing Machine.
4. Sheet Metal Laser Cutting Machine.
5. Tape Cutting Machine
6. Label Cutting Machine

6.5 Limitation:

- When power is restored, some PLCs turn on, potentially causing an accident.
- Only cut small-sized paper.

6.6 Future Improvement:

Some improvements can be made to this project in the future for the further research work that are discussed below:

- By modifying the concept of this project, we used it for auto sealed product when it can be accepted or rejected product.
- By changing cutter shape we can cut paper with different designs.
- By modifying slots we can cut different standard size paper.

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