Sudan University of Science and Technology

Collage of Engineering

Electrical Engineering Department

Design of Liquid Filling System Using Programmable Logic Controller

تصميم منظومة لملء السائل باستخدام المتحكم المنطقي القابل للبرمجة

A Project submittedin Partial fulfillment for the Requirements of the Degree of B.Sc.(Honor)in Electrical Engineering

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الآيـــــــة

قـــال تعــالـــى:

((قُلۡ هَلۡ يَسۡتَوِي ٱلَّذِينَ يَعۡلَمُونَ وَٱلَّذِينَ لَا يَعۡلَمُونَۗ إِنَّمَا يَتَذَكَّرُ أُوْلُواْ ٱلۡأَلۡبَٰبِ))

سورة الزمر (9)

صدق الله العظيم

DEDICATION

To our dear mothers, fathers, families and to everyone who taught us something. They are the source of our inspirations. Their continuous support gave us the ability to pass the difficulties. Without their support this project wouldn't be possible.

We ask The Almighty Allah to provide you with health, wealth and in this life and hereafter, and give us the faith and ability to serve ourselves and the people around us.

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Finally thankful be to everyone helped and contributed us from the beginning until to the completion of the Bachelor degree. We hope improve in reward and success for all.
The combining effort from all of the mentioned above made this project possible. Thank you.

ABSTRACT

Traditional methods of filling the different types of liquids into the bottles involve manual handling which consumes time, increases the production cost and lack the quality of the product due to human errors.

This project is based on industrial automation and is a vast application used in many industries like milk industries, chemical, food, mineral water, and other industries. The work provides a lot of benefits like low power consumption, low operational cost, less maintenance, accuracy and many more.

The filling of the bottles is controlled by using a controller known as programmable logic controller (PLC) which is also the heart of the entire system.

A prototype has been designed to illustrate the project. For the conveyor system, a dc motor has been selected for better performance and ease of operation. A sensor has been used to detect the position of the bottle. In the project, less number of systems and components used hence, the overall cost has been reduced to an extent.

Ladder logic has been used for the programming of the PLC, which is the most widely used language for the programming of the PLC.

مستخلص

الطرق التقليدية لملء أنواع مختلفة من السوائل في الزجاجات تتضمن معالجة يدوية تستهلك الوقت وتزيد من تكلفة الانتاج وتفتقر الي جودة المنتج بسبب الأخطاء البشرية.

هذا المشروع يعتمد على الأتمتة الصناعية وهو تطبيق يستخدم في نطاق واسع في العديد من الصناعات مثل صناعات الألبان والكيماويات والأغذية والمياه المعدنية وغيرها من الصناعات.يوفر العمل الكثير من الفوائد مثل انخفاض استهلاك الطاقة,تقليل التكلفة التشغيلية,تقليل الصيانة ,الدقة وغيرذلك الكثير.

يتم التحكم في تعبئة الزجاجات باستخدام المتحكم المنطقي القابل للبرمجة والذي يعد قلب النظام بأكمل,وتم تصميم نموذج أولي لتوضيح المشروع.وبالنسبة لنظام النقل،تم اخيار محرك يعمل بالتيار المستمر لاداء أفضل وسهولة التشغيل.كما تم استخدام حساس لاكتشاف موضع الزجاجة.

في تصميم المشروع تم استخدام عدد أقل من الأنظمة والمكونات وبالتالي تم تخفيض التكلفة الاجمالية الى حد ما.منطق السلم أستعمل لبرمجة المتحكم المنطقي المبرمج وهي اللغة الأكثر استخداما لبرمجة المتحكم.

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LIST OF ABBREVIATIONS

PLC	Programmable Logic Controller
CAD	Computer Aided Design
CAM	Computer Aided Manufacturing
OSHA	Occupational Safety and Health Act
PID	Proportional integral derivative
SCADA	Supervisory Control and Data Acquisition
HMI	Human Machine Interface
CPU	Central Processing Unit
I/O	Input/Output
DC	Direct Current
AC	Alternating Current
PC	Personal Computer
LAD	Ladder

CHAPTER ONE

CHAPTER ONE

INTRODUCTION

1.1 Preface

Industry automation becomes a spacious field in manufacturing which had important role in an extensive range of industries beyond manufacturing. Nowadays the rapid development of manufacturing and technology has led to an increase in production level. Where the production managers are faced challenged to reduce the cost of the product with maintaining product quality within a time framework and due to the increased demand for on consumer products so competition among manufacturing companies has become dependent on cost, accuracy, time, and quality for that the key to such a problem is the use of integrated processes in the industry.

Programmable logic controller (PLC) is extensively used in industrial automation and it act as a brain in industry application. PLCs in the industrial field are utilized to control a certain process in order to get better performance and higher accuracy to give more production in an efficient manner.

The filling operation is an essential part of manufacturing processes that the product is required to be preserved in containers, thus maintaining the products quality in an important attribute when filling various products and the filling operation shouldn’t change the product characteristics. Many studies had been made to assure good filling of products.

1.2 Problem Statement

Filling system using electromechanical relay logic or manually control systems have too much human intervention in manufacturing process and reduce the product quality.

The troubleshooting in the traditional control systems is very hard especially when the system is complex. Hence, there is a lot of time wasted in maintenance.

1.3 Objectives

Design and implementation of automatic filling system using programmable logic controllers to obtain the following objectives:

1. Reduce the manufacturing time.
2. Increase the product quality and quantity.
3. Make the filling system more flexible and easy to troubleshoot.

1.4 Methodology

Firstly select the components (LG PLC, Sensor, Pump, indicator lamps, Tank, DC motor, power supply, selector switch, belt, pushbuttons) .The PLC used is master-k120s with specifications shown later, and the programming software is KGL-WIN.

This project is design and implementation a hardware model of a liquid filling system using a master-k120s PLC. The performance is observed and the coordination is shown by the software to make the software and hardware with each other.

1.5 Project Layout

This project consists of five chapters. Chapter one is an introduction and providing general information,the previous studies and the literature review mentionedin chapter two.Chapter three discusses the methodology and theoretical approach of the project.While the chapter four deals with the system design and software implementation. The conclusion and recommendations are mentioned in chapter five.

CHAPTER TWO

CHAPTER TWO

LITERATURE REVIEW

2.1 Automation overview

Automation refers to a technology which based on the usage of mechanical, electronic and computer system in handling process and manufacturing process control.

The usage of automation technology started when work done by worker was started replace by machine. Technology development process continuous improve until human started introduce the usage of robotic, computer aided Design (CAD) and computer aided manufacturing (CAM), Flexible manufacturing system and others technology to increase human quality of life and increase productivity in the industrial. [1]

2.1.1 Advantages for Automation

Companies undertake projects in manufacturing automation and computer integrated manufacturing for a variety of good reasons. Some of the reasons used to justify automated are the following:

1. To increase labor productivity. Automating a manufacturing operation usually increases production rate and labor productivity. This means greater output per hour of labor input.

2. To reduce labor cost. Ever-increasing tabor cost has been and continues to be the trend in the world's industrialized societies. Consequently, higher investment in automation has become economically justifiable to replace manual operations to reduce unit product cost.

3. To migrate the effects of labor shortages. There is a general shortage of labor in many advanced nations and this has stimulated the development of automated operations as an alternative solution.

4. To reduce or eliminate routine manual and clerical tasks.

5. To improve worker safety. By automating a given operation and transferring the worker from active participation in the process to a supervisory role, the work is made safer. The safety and physical well-being of the worker has become a national objective with the' enactment of the Occupational Safety and Health Act (OSHA) in 1970. This has provided an impetus for automation.

6. To improve product quality. Automation not only results in higher production rates than manual operations; it also performs the manufacturing process with greater uniform and conformity to quality specifications. Reduction attraction defect rate is one of the chief benefits of automation.

7. To reduce manufacturing lead lime. Automation helps to reduce the elapsed time between customer order and product delivery, providing a competitive advantage 10 the manufacturer for future orders. By reducing manufacturing lead time, the manufacturer also reduces work-in-process inventory [3].

8. To accomplish processes that cannot be done manually. Certain operations cannot be accomplished without the aid of a machine. These processes have requirements for precision, miniaturization or complexity of geometry that cannot be achieved manually.[1]

2.1.2 Automation pyramid

Automationpyramid is a pictorial example of different levels of automation in a factory or industry.

There are five levels of industrial automation plant shown in the figure 2.1 below:

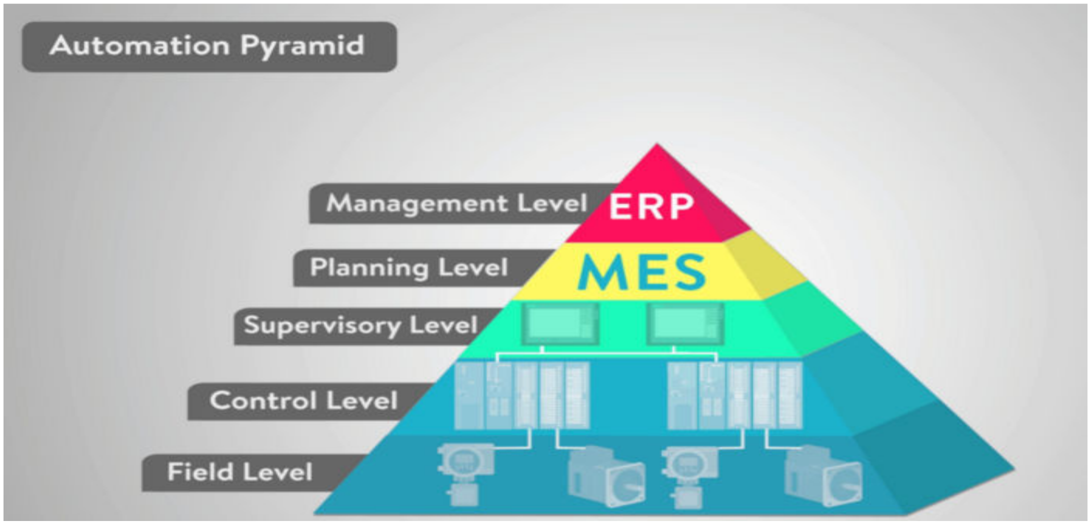


Figure 2.1: levels of industrial automation plant

2.1.2.1 Field level

These are the devices actuators and sensors that you can see in the field or the production floor. The field level is the production floor that does the physical work and monitoring.

Electric motors, hydraulic and pneumatic actuators to move machinery, proximity switches used to detect the movement or certain materials and photoelectric switches that detect similar things will a part in the field devices.

2.1.2.2 Control level

In this where the Programmable logic controller (PLC), the Proportional-integral-derivative (PID) and other controllers come in to play.

The control level uses these controllers to control and run the devices in the field level that actually do the physical work.

They take information from all of the sensors, switches and other input devices to make decision on what outputs to turn on to complete the programmed task.

2.1.2.3 Supervisory level

This level utilizes SCADA (Supervisory Control and Data Acquisition).

SCADA is essentially the combination of the previous levels used to access data and control system from a single location, plus it usually adds a graphical user interface, or a human machine interface (HMI) to control functions remotely.

2.1.2.4 Planning level

This solves the decision problems like production targets, resource allocation, task allocation to machines, maintenance management.

2.1.2.5Management level

It is the top level in the automation pyramid.

This deals less technical and more commercial activities like supply, cash flow, demand, product marketing etc. [2]

2.2 Programmable Logic Controllers

Programmable logic controllers showed in the Figure 2.2 are now the most widely used industrial process control technology. A programmable logic controller (PLC) is an industrial grade computer that is capable of being programmed to perform control functions. The programmable controller has eliminated much of the hardwiring associated with conventional relay control circuits. Other benefits include easy programming and installation, high control speed, network compatibility, troubleshooting and testing convenience, and high reliability. [3]

Figure 2.2: Programmable logic controller

2.2.1 Advantages of PLC

1. Increased Reliability. Once a program has been written and tested, it can be easily downloaded to other PLCs.

2. More Flexibility. It is easier to create and change a program in a PLC than to wire and rewire a circuit.

3. Lower Cost. PLCs were originally designed to replace relay control logic, and the cost savings have been so significant that relay control is becoming obsolete except for power applications.

4. Communications Capability. A PLC can communicate with other controllers or computer equipment to perform such functions as supervisory control, data gathering, monitoring devices and process parameters, and download and upload of programs.

5. Fast response time. PLCs are designed for high-speed and real-time applications.

6. Easier to Troubleshoot. PLCs have resident diagnostics and override functions that allow users to easily trace and correct software and hardware problems. To find and fix problems, users can display the control program on a monitor and watch it in real time as it executes. [3]

2.2.2 Parts of a PLC

A typical PLC can be divided into parts, as illustrated in Figure 2.3. These are the central processing unit (CPU), the input/output (I/O) section, the power supply, memory and the programming device.

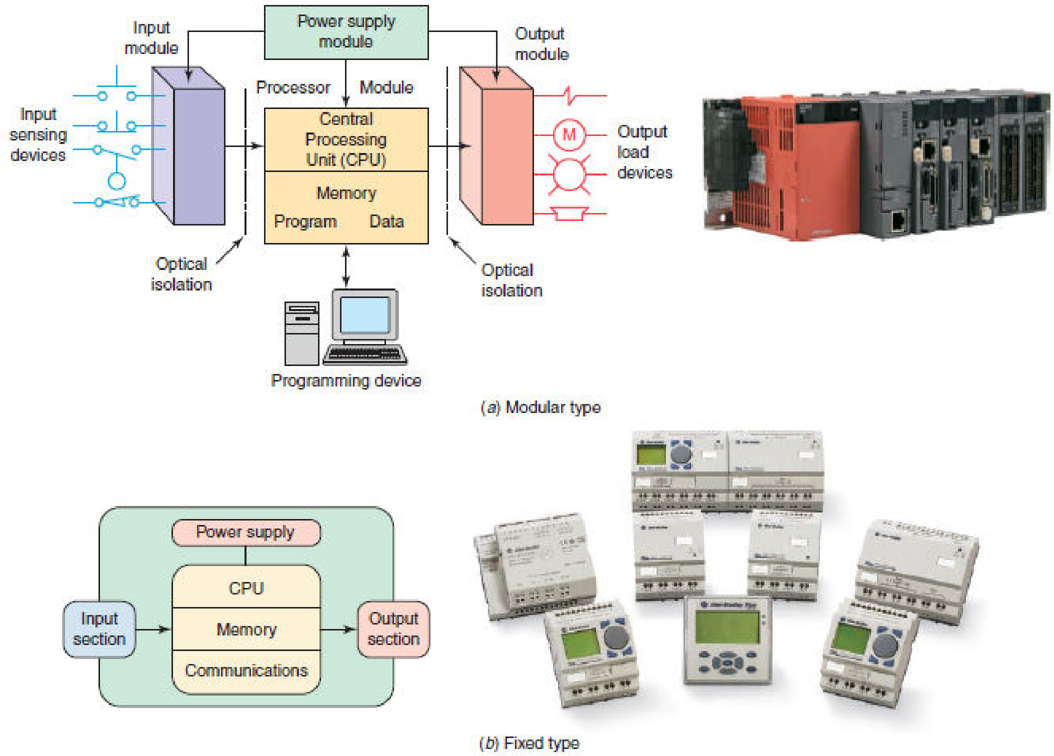


Figure 2.3: Typical parts of a programmable logic controller

2.2.2.1 Modular I/O:

Modular I/O is divided by compartments into which separate modules can be plugged. This feature greatly increases your options and the unit's flexibility.

You can choose from the modules available from the manufacturer and mix them any way you desire. The basic modular controller consists of a rack, power supply, processor module (CPU), input/output (I/O) modules, and an operator interface for programming and monitoring. The modules plug into a rack. When a module is slid into the rack, it makes an electrical connection with a series of contacts called the backplane, located at the rear of the rack.

The PLC processor is also connected to the backplane and can communicate with all the modules in the rack.

The I/O system forms the interface by which field devices are connected to the controller Figure 2.4. The purpose of this interface is to condition the various signals received from or sent to external field devices. Input devices such as pushbuttons, limit switches, and sensors are hardwired to the input terminals. Output devices such as small motors, motor starters, solenoid valves, and indicator lights are hardwired to the output terminals.[3]

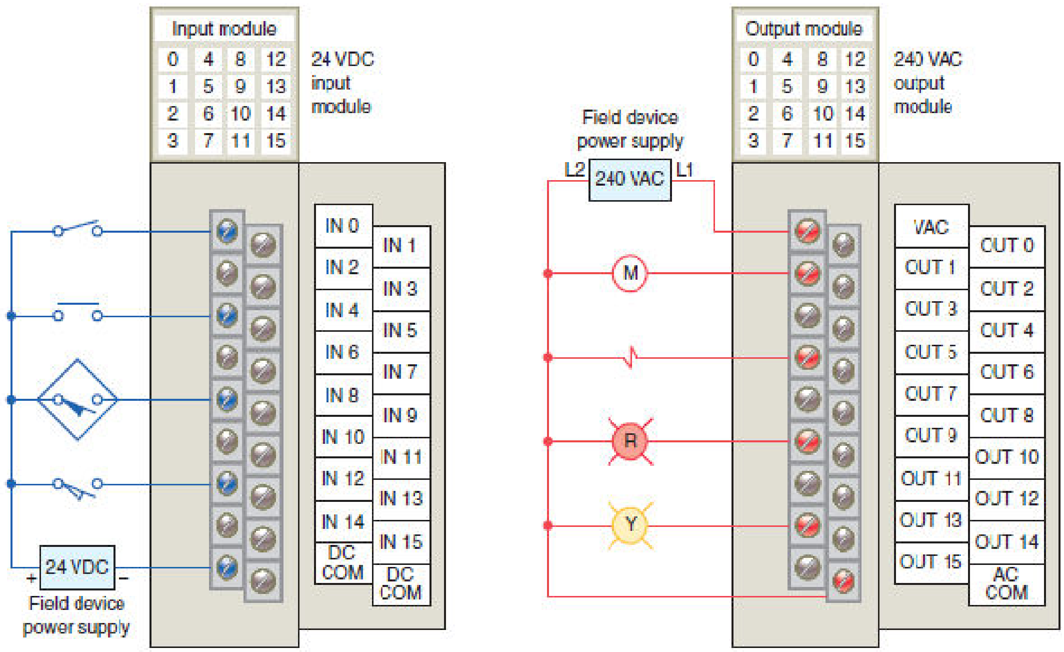


Figure 2.4: Typical PLC input/output (I/O) system connections

2.2.2.2 Power supply

The power supply supplies DC power to other modules that plug into the rack. For large PLC systems, this power supply does not normally supply power to the field devices. With larger systems, power to field devices is provided by external alternating current (AC) or direct current (DC) supplies. For some small micro PLC systems, the power supply may be used to power field devices.[3]

2.2.2.3 The processor

The processor (CPU) is the "brain" of the PLC. A typical processor usually consists of a microprocessor for implementing the logic and controlling the communications among the modules.

The CPU controls all PLC activity and is designed so that the user can enter the desired program in relay ladder logic. The PLC program is executed as part of a repetitive process referred to as a scan figure 2.5. A typical PLC scan starts with the CPU reading the status of inputs.[3]

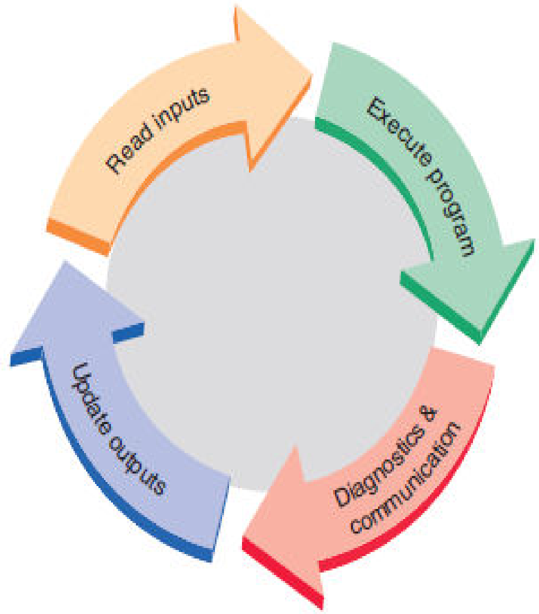


Figure 2.5: Typical PLC scan cycle

Then, the application program is executed. Once the program execution is completed, the CPU performs internal diagnostic and communication tasks. Next, the status of all outputs is updated. This process is repeated continuously as long as the PLC is in the run mode.

- Operating Modes of the CPU:

The CPU has three modes of operation: STOP mode, STARTUP mode, and RUN mode.Status LEDs on the front of the CPU indicate the current mode of operation.

1. In STOP mode, the CPU is not executing the program. We can download a project.
2. In STARTUP mode, the STARTUP(if present) is executed once. Interrupt events are not processed during the startup mode.
3. In RUN mode, the program cycle are executed repeatedly. Interrupt events can occur and be processed at any point within the RUN mode.

2.2.2.4 Memory

The most important characteristic of a programmable controller is the user'sability to change the control program quickly and easily. The PLC's architecture makes this programmability feature possible. The memorysystem is the area in the PLC's CPU where all of the sequences of instructions, or programs, are stored and executed by the processor to provide the desired control of field devices. The memory sections that contain the control programs can be changed, or reprogrammed, to adapt to manufacturing line procedure changes or new system start-up requirements.

The total memory system in a PLC is actually composed of two different memories showed in Figure 2.6:

- The executive memory. It is a collection of permanently stored programs that are considered part of the PLC itself. These supervisory programs direct all system activities, such as execution of the control program and communication with peripheral devices. The executive section is the part of the PLC's.
- The application memory.it is divided into the data table area and user program area. The data table stores any data associated with the user's control program, such as system input and output status data, and any stored constants, variables, or preset values. The data table is where data is monitored, manipulated, and changed for control purposes. The userprogram area is where the programmed instructions entered by the user are stored as an application control program.
- Memory can be separated into two categories volatile and nonvolatile.

✓ Volatile memoryloses its programmed contents if all operating power is lost or removed, whether it is normal power or some form of backup power.Volatile memory is easily altered and quite suitable for most applications when supported by battery backup and possibly a disk copy of the program.

✓ Nonvolatile memoryretains its programmed contents, even during a complete loss of operating power, without requiring a backup source. Nonvolatile memory generally is unalterable, yet there are special nonvolatile memory types that are alterable. Today's PLCs include those that use nonvolatile memory, those that use volatile memory with battery backup, as well as those that offer both.[4]

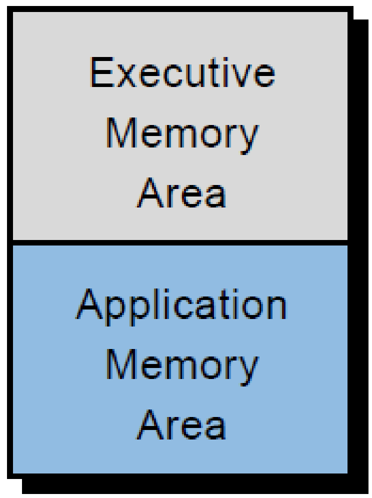


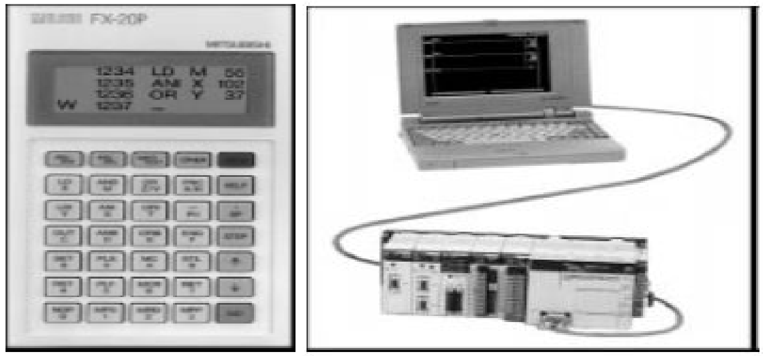
Figure 2.6:Simplified block diagram of the total PLC memory system

2.2.2.5 Programming device

A programming device is used to enter the desired program into the memory of the processor.

Hand-held programming devices Figure 2.7 are sometimes used to program small PLCs because they are inexpensive and easy to use.

A personal computer (PC) is the most commonly used programming device. Most brands of PLCs have software available so that a PC can be used as the programming device. This software allows users to create, edit, document, store, and troubleshoot ladder logic programs Figure 2.7b.



a b

Figure 2.7: Hand-held programming devices Typical PC software used tocreate a ladder logic program

The PLC ladder logic program would be constructed and entered into the memory of the CPU. The format used is similar to the layout of the hardwired relay ladder circuit. The individual symbols represent instructions, whereas the numbers represent the instruction location addresses. To program the controller, you enter these instructions one by one into the processor memory from the programming device. Each input and output device is given an address, which lets the PLC know where it is physically connected. Note that the I/O address format will differ, depending on the PLC model and manufacturer. Instructions are stored in the user program portion of the processor memory. During the program scan the controller monitors the inputs, executes the control program, and changes the output accordingly. For the program to operate, the controller is placed in the RUN mode, or operating cycle. During each operating cycle, the controller examines the status of input devices, executes the user program, and changes outputs accordingly. Each symbol can be thought of as a set of normally open contacts. The symbol is considered to represent a coil that, when energized, will close a set of contacts. [3]

2.2.3 Principles of Operation

The PLC ladder logic program would be constructed and entered into the memory of the CPU. The format used is similar to the layout of the hardwired relay ladder circuit. The individual symbols represent instructions, whereas the numbers represent the instruction location addresses. To program the controller, you enter these instructions one by one into the processor memory from the programming device. Each input and output device is given an address, which lets the PLC know where it is physically connected. Note that the I/O address format will differ, depending on the PLC model and manufacturer. Instructions are stored in the user program portion of the processor memory. During the program scan the controller monitors the inputs, executes the control program, and changes the output accordingly. For the program to operate, the controller is placed in the RUN mode, or operating cycle. During each operating cycle, the controller examines the status of input devices, executes the user program, and changes outputs accordingly. Each symbol can be thought of as a set of normally open contacts. The symbol is considered to represent a coil that, when energized, will close a set of contacts. Either of these conditions provides a continuous logic path from left to right across the rung that includes the coil.

A programmable logic controller operates in real time in that an event taking place in the field will result in an operation or output taking place. [3]

2.2.4 PLC PRODUCT APPLICATION RANGES

Figure 2.8 graphically illustrates programmable controller product ranges. This chart is not definitive, but for practical purposes, it is valid. The PLC market can be segmented into five groups:

1. Micro PLCs
2. Small PLCs
3. Medium PLCs
4. Large PLCs

5. Very large PLCs

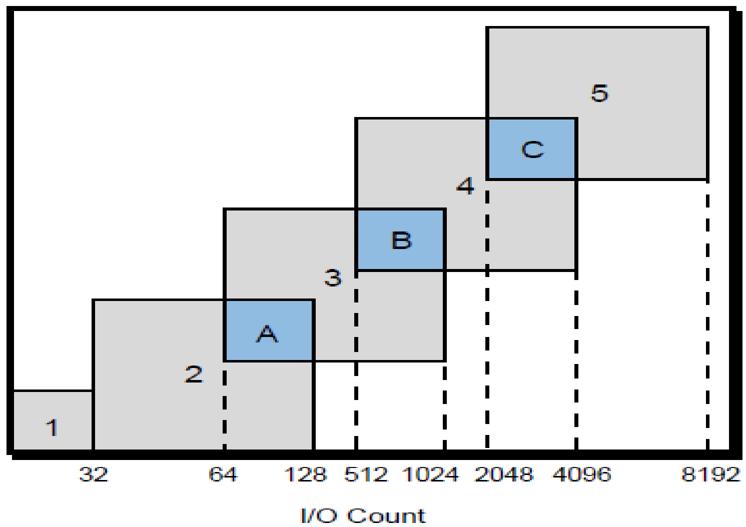


Figure 2.8: PLC product ranges

Micro PLCs are used in applications controlling up to 32 input and output devices, 20 or less I/O being the norm. The micros are followed by the small PLC category, which controls 32 to 128 I/O. The medium (64 to 1024 I/O), large (512 to 4096 I/O), and very large (2048 to 8192 I/O) PLCs complete the segmentation.

The A, B, and C overlapping areas in Figure 2.8 reflect enhancements, by adding options, of the standard features of the PLCs within a particular segment. These options allow a product to be closely matched to the application without having to purchase the next larger unit. There are differences between PLCs in overlapping areas. These differences include I/O count, memory size, programming language, software functions, and other factors. An understanding of the PLC product ranges and their characteristics will allow the user to properly identify the controller that will satisfy a particular application. [4]

2.3 sensors and actuators

Sensors and actuators are two critical components of every control system which consists of a sensing unit, a controller, and an actuating unit as shown in Figure 2.9. The controller accepts the information from the sensing unit, makes decisions on the basis of the control algorithm, and outputs commands to the actuating unit. The actuating unit consists of an actuator and optionally a power supply and a coupling mechanism.

Sensors are used for detecting, and often measuring, the magnitude of something. They convert mechanical, magnetic, thermal, optical, and chemical variations into electric voltages and currents. Sensors are usually categorized by what they measure, and they play an important role in modern manufacturing process control.

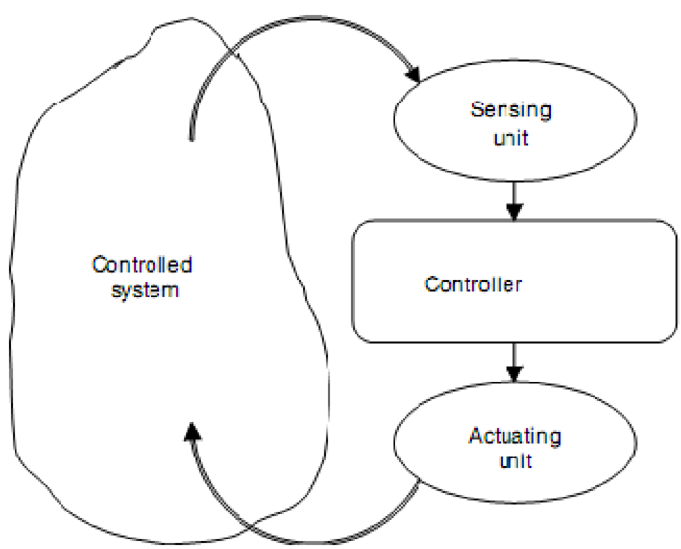


Figure 2.9: Sensing and actuating units

An actuator is any mechanical, electrical, or electromechanical system that produces linear or rotary motion to drive mechanical events. The purpose of an actuator is to convert one form of energy into mechanical work in the form of motion. [5]

CHAPTER THREE

CHAPTER THREE
METHODOLOGY

3.1 Overview

No one type of fillers can fill all types liquids of different properties, but filling mechanisms are varied according to the product characteristics. Also there are different methods to detect that a bottle has been filled, such as in timed gravity fillers where the main valve is opened for a certain period of time to fill a bottle. Where as in overflow fillers, the liquid flows into the bottle to a certain height detected by a sensing device and then the flow stops.

3.2 System Component Description

There are various components used in designing a filler and how they were combined together to achieve such a design**.**

For a filling system design the components used is divided into follows:

3.2.1PLC master-k120s

Master-k120s series is extremely compact, to fit a wide range of applications, and have the following features:

1. High speed processing. High speed processing of 0.1~0.9μs/step with an general purpose processor included.
2. Various built-in functions. The main unit can perform many functions without using separate modules. Therefore; it is possible to construct various systems just using the main unit.

- Fast Processing Applications like pulse catch, high speed counter(Economic) and External interrupts.
- Using built-in PID control function, PID control system can be constructed without using separate PID module.
- Using RS-232C and RS-485 built-in port, MASTER-K120S can connects with external devices, such as personal computers or monitoring devices.

3. Battery-less. The user's program can be saved permanently, because it is stored to EEPROM.
4. When program is edited during processing, it is stored to EEPROM automatically
5. Open network by use of communication protocols in compliance with international standard specifications.
6. Various special modules that enlarge the range of application of the PLC
7. It can easily do On/Off of the system, using RUN/STOP switch.
8. It can easily save the user program in EEPROM by simple manipulation in KGLWIN without using external memory.
9. Strong self-diagnostic functions. It can detect the cause of errors with more detailed error codes.
10. It can prevent unintentional reading and writing, using password.
11. Debugging function(Standard type). On-line debugging is available when the PLC Operation mode is set to debug mode.

- Executed by one command.
- Executed by break-point settings.
- Executed by the condition of the device
- Executed by the specified scan time.

12. Various program execution functions. External and internal interrupt program as well as scan program can be executed by setting the execution condition. Therefore, user can set variously program execution mode. figure 3.1 shown the master-k120s. [5]

Figure 3.1: LG Master -k120s

3.2.2 DC Geared motor

DC motor is type of rotary electrical machines that convert electrical current into mechanical motion. In our project DC motor is used to rotate the conveyor belt to move the bottle first under the valve and after it filled move it away from valve. This DC motor operate 24 DC supply with gear box which is used to increase the torque and reduce the speed as required as shown in Figure 3.2.With a maximum output speed of 50 rpm.it draws about 3A current.

Figure 3.2: DC motor with gear box

3.2.3 Power Supply

An AC-DC power supply converts alternating current into direct current that most electronic components require, usually at a lower voltage. Thus, despite its name a power supply actually requires an external supply of power to operate.

A power supply has two primary variants which are linear regulated power supply and switching power supply. Figure 3.3 shows a block diagram of a power supply.

A linear regulated power supply has three components. A transformer which reduces the AC input to lower voltage AC, as well as a rectifier which converts the AC reduced by the transformer to unsmoothed DC. Also, a voltage regulator in conjunction with one or more capacitors which control the DC voltage, smooth it and remove transients.

Generally, PLCs used in automated manufacturing systems are powered by 24V DC. So, a power supply is needed in order to convert 220V AC to 24V DC. Figure 3.4 shows a 24V DC power supply used to power motor.

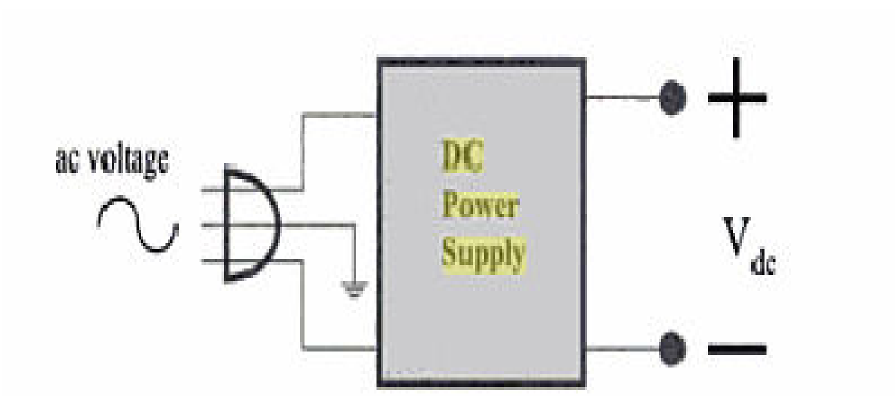


Figure 3.3: Block diagram of a power supply

Figure 3.4: 24V Switched mode power supply

3.3.4 Conveyor System

Nowadays with many industrial applications, a conveyor system is used to move object from one location to another in effective way to reduce losing time and effort and it is very useful in packaging process. A conveyor system has several forms but in this project, a flat belt type is used to move the bottles as shown in Figure 3.5. Conveyors are especially useful in applications which including the transportation of heavy or large materials.

A flat belt conveyer has dimensions of (90*18)cm the belt is made from plastic material. Two pulleys a distributed on the belt sides, the first one rotates with the rotation of motor shaft and it usually called drive pulley and the other pulley called idler pulley.

Figure 3.5: Conveyor system

3.2.5 Photoelectric Sensor

The photoelectric sensor used in this project is NPNs showed in the figure 3.6.The range of measurement is 10 cm, and connected to a DC power supply source through a two-wire connection. The output of photoelectric sensor is acontact that changes state when the switch is energized. The NO or NC contact change is transformed into a digital signal that can be sampled by an external control unit in order to trigger a variation in the operation of the overall controlled system.

Figure 3.6: Typical exterior view of a photoelectric sensor

3.2.6 Pump

The work of the pump is to create enough pressure to overcome the operating pressure of the system to transport water into the bottle .In this project was used 220 V AC pump it presented in figure 3.7.

Figure 3.7: Pump

3.2.7 Relays

Since electric motors are supplied with electric power through the utilization of relays or contactors.In general, a relay is a binary actuator as it has two stable states, either energized and latched or de-energized and unlatched.

The electric contacts of a general purpose relay are passing a current rated up to 10A, and the rated operating current of the coil is 24vdc.

The relay used in this project showed in the figure 3.8.

Figure 3.8: Typical form of a general purpose relay

3.2.8 Pushbutton, selectorswitch and indicator lamp

Pushbutton is a simple switch mechanism to control some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal. The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed.The push button can be normally open showed in figure 3.9 a or normally closed showed in figure 3.9 b and selector switch is an electric switch that selects a particular circuit or group of circuits.in this project it used to select between manual operation or automatic operation as shown in figure 3.10.

The indicator lamp is a device for showing the operating condition of some system and in this project 24V DC indicator lamp was used present in figure 3.11.

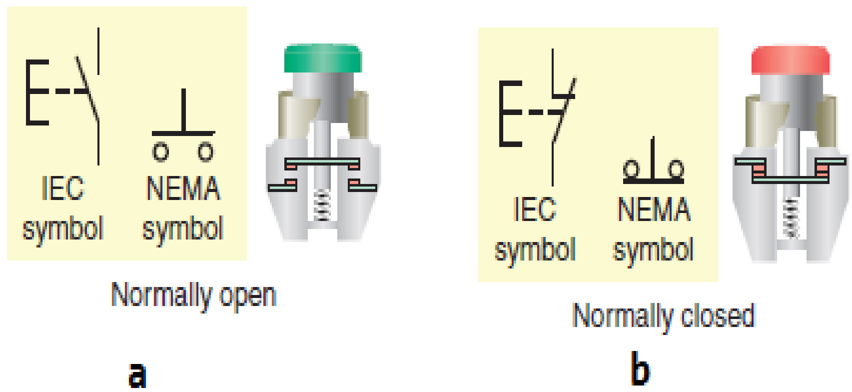


Figure 3.9 Normally open and normally closed pushbuttons

Position	Contacts	
	A	B
1	X	
2		
3		X

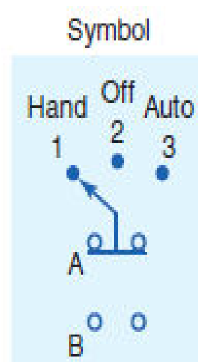


Figure 3.10 Three position selector switches

Figure 3.11: Indicator lamps

3.3 System Flow Chart

The flow chart in figure 3.12 explains the process steps for the automatic bottle filling system using PLC

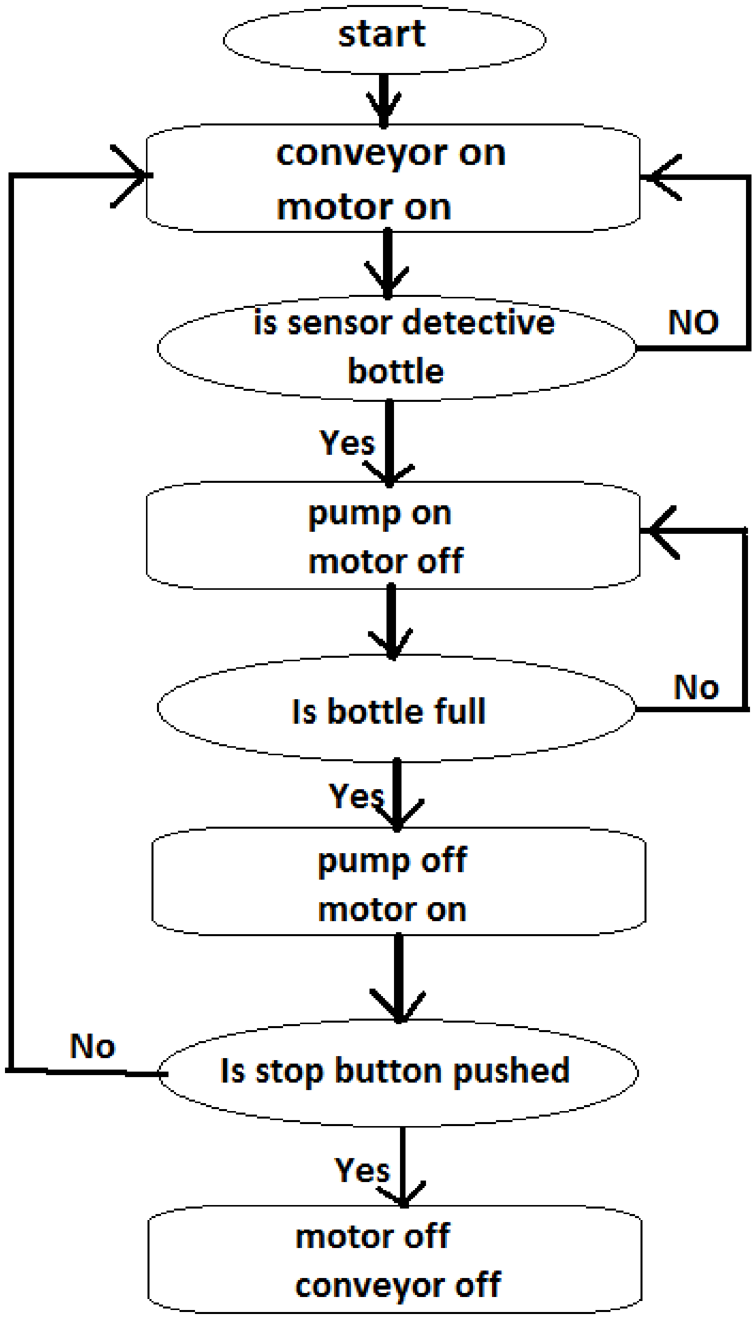


Figure 3.12: System flow chart

The process steps were as follows:

1. Push start button.

2. The conveyor run while it carry bottle, and still run until the sensor detective bottle.

3. When sensor detective the bottle the pump pumps water in bottle until bottle is full.

4. When bottle full the pump stop and conveyor return to run.

5. This cycle continuous until stop button pushed.

CHAPTER FOUR

CHAPTER FOUR

SYSTEM DESIGN

4.1 Overview

This is one of the important application of PLC in the filling industry where the bottle, which are moving on the conveyor belt, to be automatically detected at the appropriate position and get it filled by any liquid and also after getting filled the queued bottle gets chance to be filled. As PLC becomes requisite controller for these types of industry. Software and hardware design will be used in order to implement this project.

4.2 System Connection

Firstly, the common of the three position selector switch is connected with the negativewire of internal PLC power supply 24vdc, and the other side of them connected with the PLC inputs.

The first side of indicators lamps are connected with the negative wire of internal PLC power supply 24vdc, and the other side of them are connected with output of PLC.

One wire of pump is connected with the negative wire of AC power supply 220v, the second terminal of the pump connected with the power terminals of the relay which is acts as interface between the PLC and pump.

The photoelectric sensor power terminals connected with DC 24v come from the internal PLC power supply, and the output of sensor is connected with the input of plc.

One terminal of the DC motor is connected with the negative of external DC power supply 24v and the other side of the motor is connected to the power terminals of the relay.

The first side of relays coils are connected with the negative of DC power supply 24v and the other sides are connected with the output of PLC.

The diagram in figure 4.1 bellow shows the connection of the components with each other.

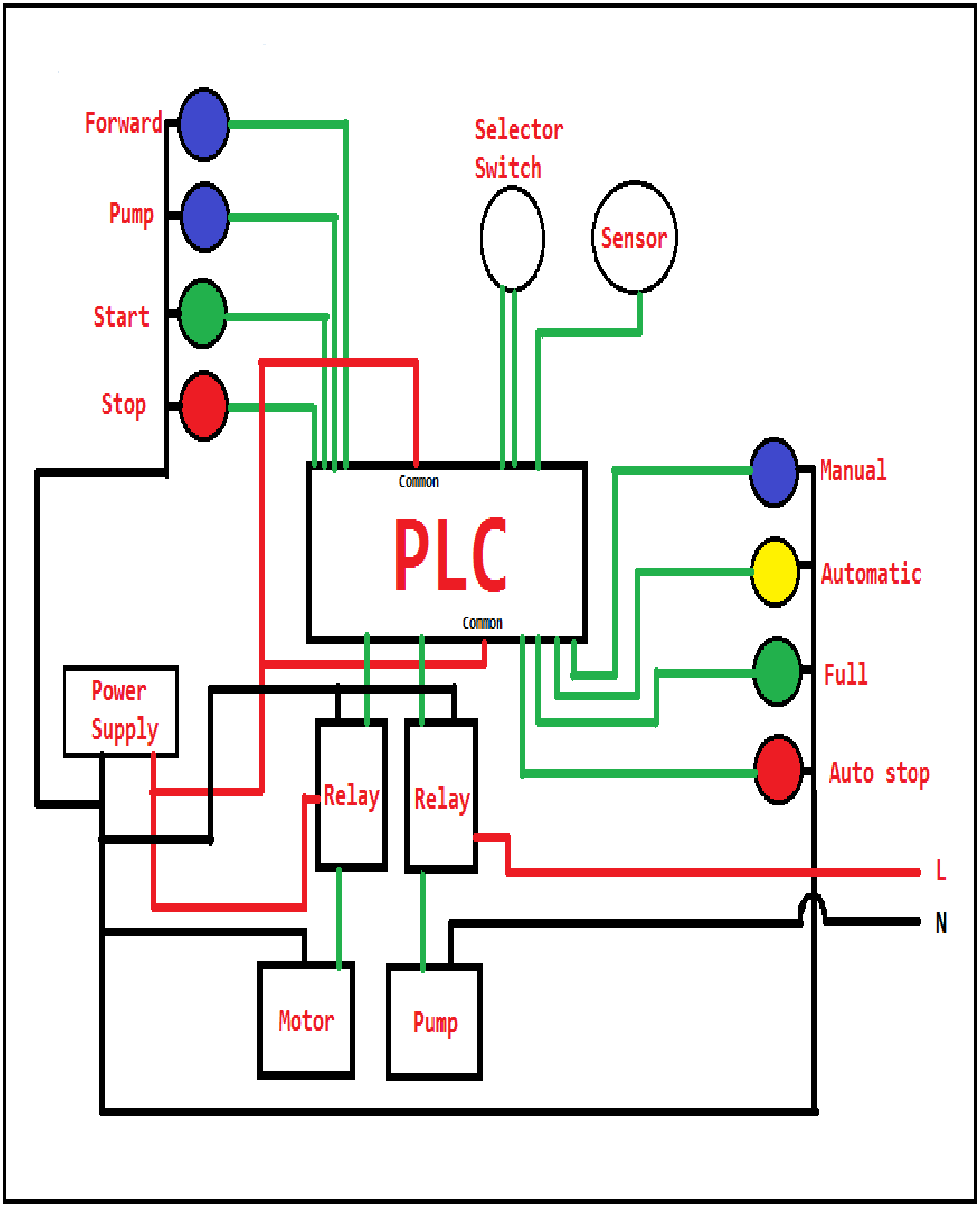


Figure 4.1: System connection diagram

4.3 Software Implementation

A PLC program is generally executed repeatedly as long as the controlled system is running. The status of physical input points is copied to an area of memory accessible to the processor. The program is then run from its first instruction rung down to the last rung. It takes some time for the processor of the PLC to evaluate all the rungs and update the I/O image table with the status of outputs. This scan time may be a few milliseconds for a small program or on a fast processor.

As PLCs became more advanced, methods were developed to change the sequence of ladder execution, and subroutines were implemented.

4.3.1 Language Used For Programming PLC

Ladder logic is a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. It is primarily used to develop software for programmable logic controllers (PLCs) used in industrial control applications. The name is based on the observation that programs in this language resemble ladders, with two vertical rails and a series of horizontal rungs between them.

Ladder logic has contacts that make or break circuits to control coils. Each coil or contact corresponds to the status of a single bit in the programmable controller's memory. Unlike electromechanical relays, a ladder program can refer any number of times to the status of a single bit, equivalent to a relay with an indefinitely large number of contacts. So-called "contacts" may refer to physical ("hard") inputs to the programmable controller from physical devices such as pushbuttons and limit switches via an integrated or external input module, or may represent the status of internal storage bits which may be generated elsewhere in the program.

Each rung of ladder language typically has one coil at the far right. Some manufacturers may allow more than one output coil on a rung.

In the figure 4.2a show regular contact, closed whenever its corresponding coil or an input which controls it is energized. Figure 4.2b show "not" contact, open whenever its corresponding coil or an input which controls it is energized. Figure4.2c show regular coil, energized whenever its rung is closed.

The "coil" (output of a rung) may represent a physical output which operates some device connected to the programmable controller, or may represent an internal storage bit for use elsewhere in the program.

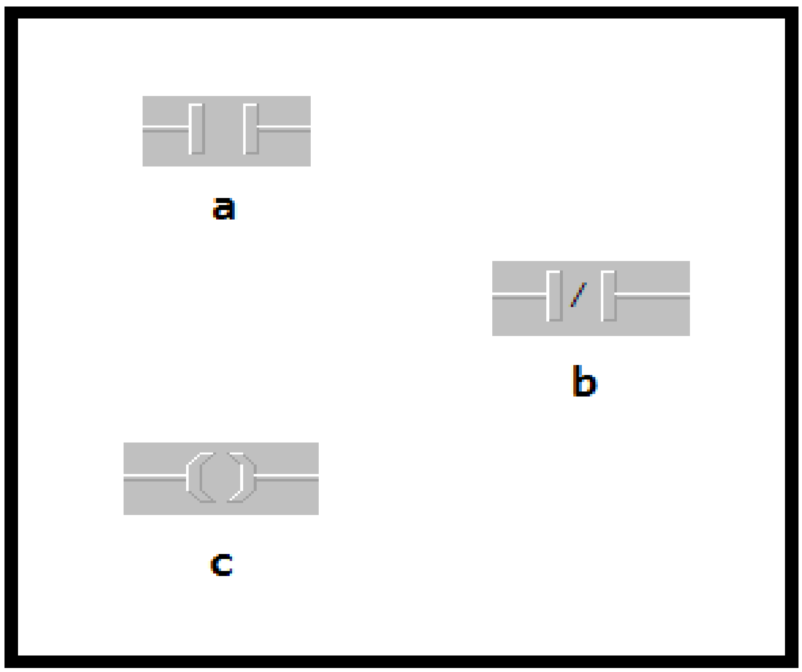


Figure 4.2 NO,NC and Coil

4.3.2 Program

The PLC used in this project is of type LG Master k-120s and the software program is KGL WIN. The Ladder diagram language is used to write the program by using computer. Where the program has been shown in Figure 4.3.

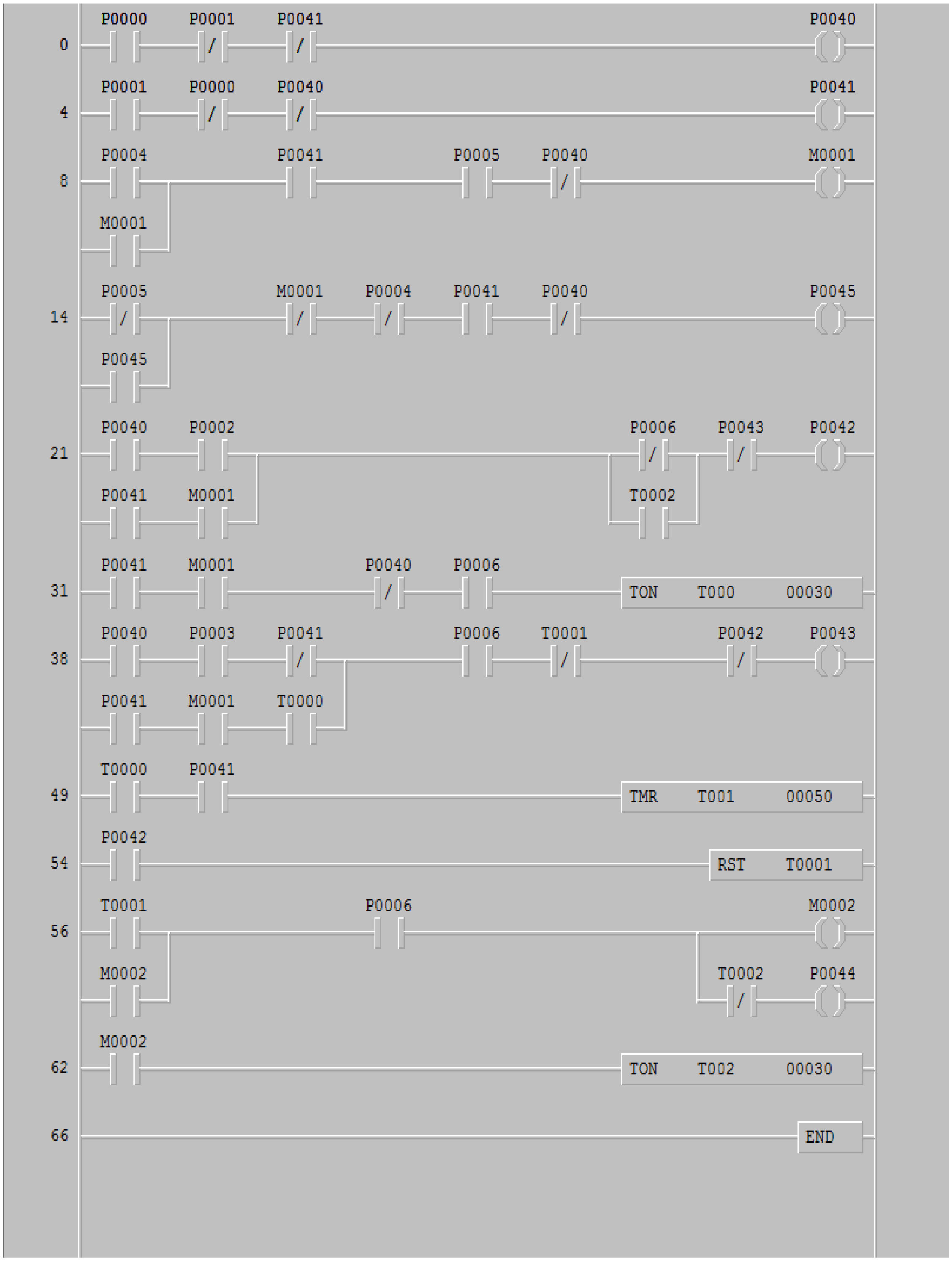


Figure 4.3: Ladder Diagram

4.3.3 Variable/comment

Table 4.1 : Variable /comment

Device	Variable
P0000	Manual selector
P0001	Auto selector
P0002	Start motor manual
P0003	Start pump
P0004	Start auto mode
P0005	Stop auto mode
P0006	Sensor
P0040	Manual lamp
P0041	Auto lamp
P0042	Motor
P0043	Pump
P0044	Full lamp
P0045	Auto stop
M0001	Start auto bit
T0000	Ready for filling
T0001	Filling time
T0002	Return move

4.4 PLC Work

Basics of a PLC function are continuous scanning of aprogram. The scanning process involves three basic steps.

Step 1: Read input status

First the PLC checks whether inputs like switches, sensors etc., is on or off state. The information is stored in memory in order to use in the following steps.

Step 2: Program execution

Here a PLC executes a program rung by rung from top to bottom and left to right. According to input status output status modifies and store in memory.

Step 3: Update output

PLC update the output signals according to change in input.

4.5 System Operation

At first, the auto selection switch is selected so that the entire system operates automatically. If the "Auto start push button" is pressed, the motor startsand the conveyor belt starts moving. The DC motor used is a DC geared type motor whose shaft is coupled directly with the shaft of the roller. This motor has an input voltage of 24v.The reason for selecting this motor is to achieve a high starting torque at a constant speed.The motor comes with a metal gearbox and centered shaft. The reason for choosing such a high torque is having such heavy rollers used on the either side of the hardware which is mounted with a conveyor belt.

Then two to three bottles is placed spontaneouslyon the conveyor belt. Now as the bottle approaches towards the photoelectric sensor, the sensor senses the bottle and the conveyor stops running.

As the conveyor stops there is low waiting time until pump gets energized and the water starts filling in the bottle. After a given time period is over, then the pump gets de energized completely and water flowing through the pump is stopped and the full lamp is on for a very short time before the conveyor belt starts moving again. The pump remains de energized until the bottle is sensed by the sensor again.

Stop Switch has also been introduced in the system which works like a circuit breaker which disconnects the entire PLC system whenever any unfavorable conditions arise. The electrical connection of the system interfacing the hardware with the PLC machine has been done.

The RS-232 cable has been used to interface the computer with the PLC machine. Ladder logic (LAD) has been implemented using theLG software.

4.6 Prototype Design

Figure 4.4 shows the prototype of conveyor and figure 4.5 shows the control panel.

Figure 4.4 Prototype conveyor

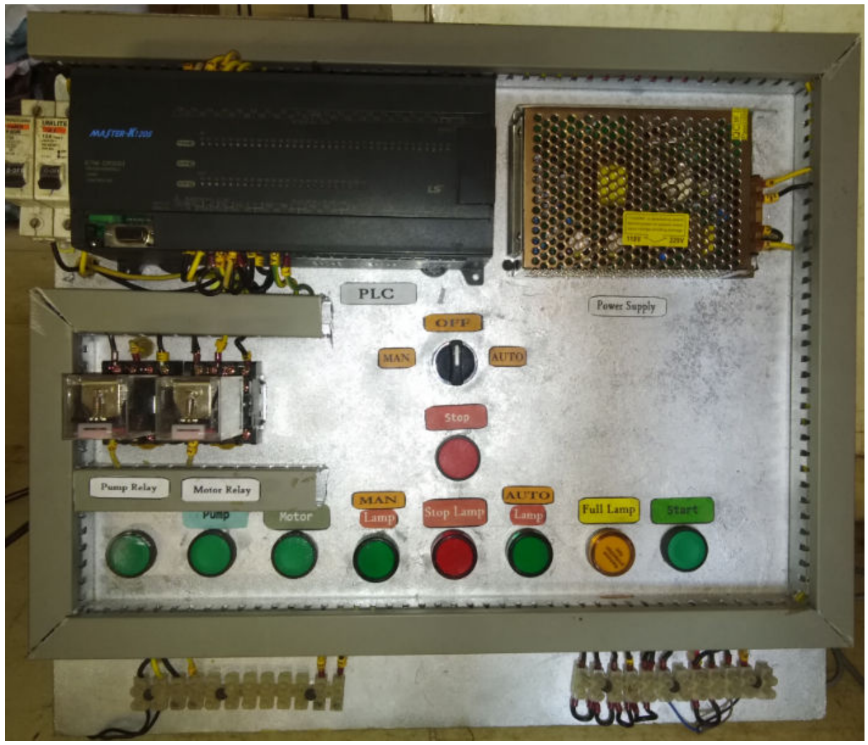


Figure 4.5: Control panel

CHAPTER FIVE

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The main objective of this project was to develop a bottle filling system based on certain specifications. The project presents an automatic filling system controlled by PLC as per the filling requirement which has simple operation. The system has the advantages as simple structure and reliable operation. The system is controlled by PLC. This was successfully implemented.

Actually this project has both mechanical and electrical part. The mechanical part of the project required welding and fabricating process. The electrical part consisted of electrical wiring, programming and some other electrical methods. It can be said that by doing this project successfully was able to understand how to the construct industrial filling systems.

5.2 Recommendations

At the end of this work, we advise the researcher to take the following points into consideration:

- Bottle capping system: This system facilitates the bottle capping after the liquid is filled. A stepper motor operated capper can be used for bottle capping.
- Monitoring system: Several monitoring systems can be placed in this project to monitor the number and sensing of bottle, quantity of liquid in the bottle etc.
- Implementing alarm systems: according to error logic conditions to display different messages at the HMI.

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