Chapter 1

1. Introduction

1.1 General Concept

The industrial world is facing many technological changes which increased the urgent demand for the premium quality products and services that can only be supplied by a high level of productivity. This requirement needs process engineering systems, automated manufacturing, and industrial automation.It’s necessary in order to streamline operations in terms of acceleration, reliability and system output. So the automation plays gradually important role.

This Project is a complete application of automation in industrial line. The various process of this system is controlled by PLC. PLC is heart of the system and the system is controlled according to the programmed PLC. And in this project the main steps of production are combined in one machine which will supply the operator by a lot of benefits and solve many production problems. It’s controlling and indicating makes the system easily accessible and alert the operator in the case of any fault or errors. It is one of the major applications of automation in the liquid industries where a specific amount of liquids has to be filled continuously into the container and mixing this liquid substance to specific degree then fill it into bottles.

1.2 Problem Statement

Higher costs in operation and maintenance for each separated system of filling and mixing increased downtime and operation steps in the production line also limited flexibility and efficiency of system with non-homogeneous products and hardness control at various temperature and environmental conditions.

1.3 Proposed Solution

Design system which used an integrated process of two production steps (filling and mixing) in one automated machine by using PLC.

1.4 Aim and Objectives

The Aim of this project is to automate the production line using PLC. Themain objectives are:

1- To design appropriate model for automatic mixing & filling system.

2- To program PLC for automate the system.

3- To design a prototype system for automatic mixing & filling bottle.

1.5 Methodology

Firstly select the components (Siemens PLC, Sensors, Pumps, Valves, Leds, Mixer, Tanks, DC motor) .The PLC used is CPU 314C-2 DP as it has (24I/16O) digital module and (15I/2O) analog module and has an interface for MPI+DP. The programming software is SIMATIC S7-300. Only control the time of the flow by using the pumps. Level of the liquids in the tank is sensed by the level sensor switches. The ratio of different liquids will decided as per the required mixed liquid that we needed. After that the mixer will start to mix the liquids till make them homogenous as a new substance, Then open the filling valve to fill the bottle by pump for a period of time and pause the filling valve to run the motor which controlled the movement of conveying belt and start filling bottle again when the proximity sensor active. Now the operation is finish but we will add level sensor in the main tank at low level to run the system continuously in the same steps and same quality of new liquid. Each step has a led. The purpose of leds to indicate the operator in which step. After run and check the system in simulator the project will be ready for design.

From above project is divided into three sections, the first one is filling section from sub tanks, the second one is mixing section and the last one is refill section. The whole sections are controlled by the PLC which is include input and output channels.

1.6 Thesis Outline

The thesis is written in five chapters:

Chapter 1 : Introduction, Which include problem statement with proposed solution.

Chapter 2 : Literature review, Highlights the previous studies and explain different parts of the proposed system.

Chapter 3 : Methodology, Explain the method used to design the system.

Chapter 4 : Simulation result and discussion, Highlight simulation result with different and discuss the result.

Chapter 5 : Conclusion and recommendation, Summarize the work done and highlight several point for future work

Chapter 2

2. Literature review and component

2.1 Previous studies

In May 2011 Azman Bin Abdul Rahman shared his research in university of Tun Hussein On Malaysia in a title ’Liquid Mixture Control System using PLC’ to mix two or more types of liquids with different valuesin one container, in order to acquire new homogenous liquid value with correct composition.[1]

In October 2013 Prof. S.T.Sanamdikar shared his own paper in IJETTCS in title ‘Color making and mixing process using PLC’.In this paper he explained that the main colors will come from the main tanks and flow into mixing tanks all colors coming from the process will be mixed in required proportion[2]

In July 2013 the Research Paper by researcher MALLARADHYA H M, K R PRAKASH have design and Develop an ‘Automated liquid filling to bottles of different height using microcontroller’ . A total control is made in a filling is achieved. The programming to this system developed to be flexible, quickly and easily.[3]

In October 2015 Bipin Mashilkar, Pallavi Khaire and Girish Dalvi made study mainly that design, fabricating and controlling system for ‘Automated bottle filling system’. The main part is the control system which includes C programming in Arduino microcontroller to control various components in system. A conveyor system with sensors and electromagnetic valve is fabricated for this purpose. The entire sequence of operation is controlled by Arduino microcontroller. It mains purpose avoiding the manual filling process. since it has many shortcomings like spilling of water while filling it in bottle, equal quantity of water may not be filled, delay due to natural activities of human etc.[4]

In January 2016 Prof. Swapnil R. Kurkute, Mr. Akshay S. Kulkarni, Mr. Mahesh V. Gare, Mr. Soham S. Mundada shared in IJIREEICE their paper in title 'Automatic Liquid Mixing and Bottle Filling'.The system is controlled using programmable logic controller (PLC) and SCADA is used for visualizing the system. Their paper proposes a mixing and filling management system for industries which is complete application of automation. It's controlling and monitoring makes the system easily accessible and alert the operator in the case of any fault or errors. It is one of the major applications of automation in the soft drink and other beverage industries, where a specific amount of liquid has to be filled continuously into the bottles.[5]

In January 2015 Mihir Panchal, Aashish Panaskar and Prof. Lalit Kumar shared the paper in IEEE in a title "PLC Based Liquid Filling and Mixing system" to make fully automatic untouched liquid filling and mixing system. The system meet the demand of high-speed production using the least mechanism requirements, and low cost of operation.[6]

2.2 Programmable Logic Controller (PLC)

Programmable logic controllers (PLCs) have been an integral part of factory automation and industrial process control for decades. PLCs control a wide array of applications from simple lighting functions to environmental systems to chemical processing plants. These systems perform many functions, providing a variety of analog and digital input and output interfaces; signal processing; data conversion; and various communication protocols. All of the PLC's components and functions are centered around the controller, which is programmed for a specific task.[7]

2.2.1 History of PLC

In the late 1960's PLCs were first introduced. The primary reason for designing such a device was eliminating the large cost involved in replacing the complicated relay based machine control systems. Bedford Associates (Bedford, MA) proposed something called a Modular Digital Controller (MODICON) to a major US car manufacturer. Other companies at the time proposed computer based schemes, one of which was based upon the PDP-8. The MODICON 084 brought the world's first PLC into commercial production. When production requirements changed so did the control system. This becomes very expensive when the change is frequent. Since relays are mechanical devices they also have a limited lifetime which required strict adhesion to maintenance schedules.[8]

Troubleshooting was also quite tedious when so many relays are involved. Now picture a machine control panel that included many, possibly hundreds or thousands, of individual relays. The size could be mind boggling. How about the complicated initial wiring of so many individual devices, These relays would be individually wired together in a manner that would yield the desired outcome. As can be seen, there were many problems with this relay based design.

These "new controllers" also had to be easily programmed by maintenance and plant engineers. The lifetime had to be long and programming changes easily performed. They also had to survive the harsh industrial environment. That's a lot to ask! The answers were to use a programming technique most people were already familiar with and replace mechanical parts with solid-state ones.[8]

In the mid70's the dominant PLC technologies were sequencer state-machines and the bit-slice based CPU. The AMD 2901 and 2903 were quite popular in Modicon and A-B PLCs. Conventional microprocessors lacked the power to quickly solve

PLC logic in all but the smallest PLCs. As conventional microprocessors evolved, larger and larger PLCs were being based upon them. However, even today some are still based upon the 2903. (Ref A-B's PLC-3) Modicon has yet to build a faster PLC than their 984A/B/X which was based upon the 2901.6 Communications abilities began to appear in approximately 1973. The first such system was Modicon's Modbus.

The PLC could now talk to other PLCs and they could be far away from the actual machine they were controlling. They could also now be used to send and receive varying voltages to allow them to enter the analog world. Unfortunately, the lack of standardization coupled with continually changing technology has made PLC communications a nightmare of incompatible protocols and physical networks. Still, it was a great decade for the PLC.

The 80's saw an attempt to standardize communications with General Motor's manufacturing automation protocol (MAP). It was also a time for reducing the size of the PLC and making them software programmable through symbolic programming on personal computers instead of dedicated programming terminals or handheld programmers. Today the world's smallest PLC is about the size of a single control relay. The 90's have seen a gradual reduction in the introduction of new protocols, and the modernization of the physical layers of some of the more popular protocols that survived the 1980's.

The latest standard (IEC 1131-3) has tried to merge PLC programming languages under one international standard. Now PLCs are programmable in function block diagrams, instruction lists and structured text all at the same time! PC's are also being used to replace PLCs in some applications. The original company who commissioned the MODICON 084 has actually switched to a PC based control system.[8]

2.2.2 Advantages of PLC

1.Less wiring.

2.Wiring between devices and relay contacts are done in the PLC program.

3.Easier and faster to make changes.

4.Trouble shooting aids make programming easier and reduce downtime.

5.Reliable components make these likely to operate for years before failure.

2.2.3 Disadvantages of PLC

1.PLC was designed for relay logic ladder and has difficulty with some smart devices.

2.To maximize, PLC performance and flexibility, a number of option modulus must be added.

2.2.4 Applications of PLC

1.It is used in process automation

2.It is used to optimize the process.

3.It is used to integrate the different processing levels.

4.By using PLCs quality of production is possible.

5.System accuracy is increased by using PLCs.

6.Automatic traffic control system is possible.

7.It is used in twisting machines, automatic suspension of rotary system

8.Numerous applications are possible by using PLCs in the industry.

9.After wiring of relay panel if the event sequence is to be changed, it is necessary to rewire all or part of the panel.

10.Many of the control relay of the ladder diagram can be replaced by software which means less hardware failure.

11.It is easy to make change in programmed sequence of events when it is only in software.

2.2.5 PLC compared with other control system

Allen-Bradley PLC installed in a control panel. PLCs are well-adapted to a range of automation tasks. These are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life.

PLCs contain input and output devices compatible with industrial pilot devices and controls; little electrical design is required, and the design problem centers on expressing the desired sequence of operations. PLC applications are typically highly customized systems so the cost of a packaged PLC is low compared to the cost of a specific custom-built controller design. On the other hand, in the case of mass-produced goods, customized control systems are economic due to the lower cost of the components, which can be optimally chosen instead of a "generic" solution, and where the non-recurring engineering charges are spread over thousands or millions of units. For high volume or very simple fixed automation tasks, different techniques are used. [9]

Very complex process control, such as used in the chemical industry, may require algorithms and performance beyond the capability of even high-performance PLCs. Very high-speed or precision controls may also require customize solutions hardware may be chosen for very demanding control applications where the high development and maintenance cost can be supported. "Soft PLCs" running on desktop-type computers can interface with industrial I/O hardware while executing programs within a version of commercial operating systems adapted for process control needs. [9]

Programmable controllers are widely used in motion control, positioning control and torque control. Some manufacturers produce motion control units to be integrated with PLC so that G-code (involving a CNC machine) can be used to instruct machine movements. PLCs may include logic for single-variable feedback analog control loop.

Historically PLCs were usually configured with only a few analog control loops; where processes required hundreds or thousands of loops, a distributed control system (DCS) would instead be used. As PLCs have become more powerful, the boundary between DCS and PLC applications has become less distinct. PLCs have similar functionality as Remote Terminal Units. An RTU, however, usually does not support control algorithms or control loops. As hardware rapidly becomes more powerful and cheaper, RTUs, PLCs and DCSs are increasingly beginning to overlap in responsibilities, and many vendors sell RTUs with PLC-like features and vice versa.

The industry has standardized on the IEC 61131-3 functional block language for creating programs to run on RTUs and PLCs, although nearly all vendors also offer proprietary alternatives and associated development environments. In recent years "Safety" PLCs have started to become popular,as functionality and safety-rated hardware added to existing controller architectures (Allen Bradley,Guardlogix, Siemens F-series etc). These PLC types as being suitable for use in safety critical applications for which PLCs have traditionally been supplemented with hard-wired safety relays.

Such PLCs typically have a restricted regular instruction set augmented with safety-specific instructions designed to interface to emergency stops, light screens and so forth. The flexibility that such systems offer has resulted in rapid growth of demand for these controllers.

2.2.6 PLC structure

PLC consist of several parts:

- Input module
- CPU (central process unit)
- Program memory
- Output module
- Power supply

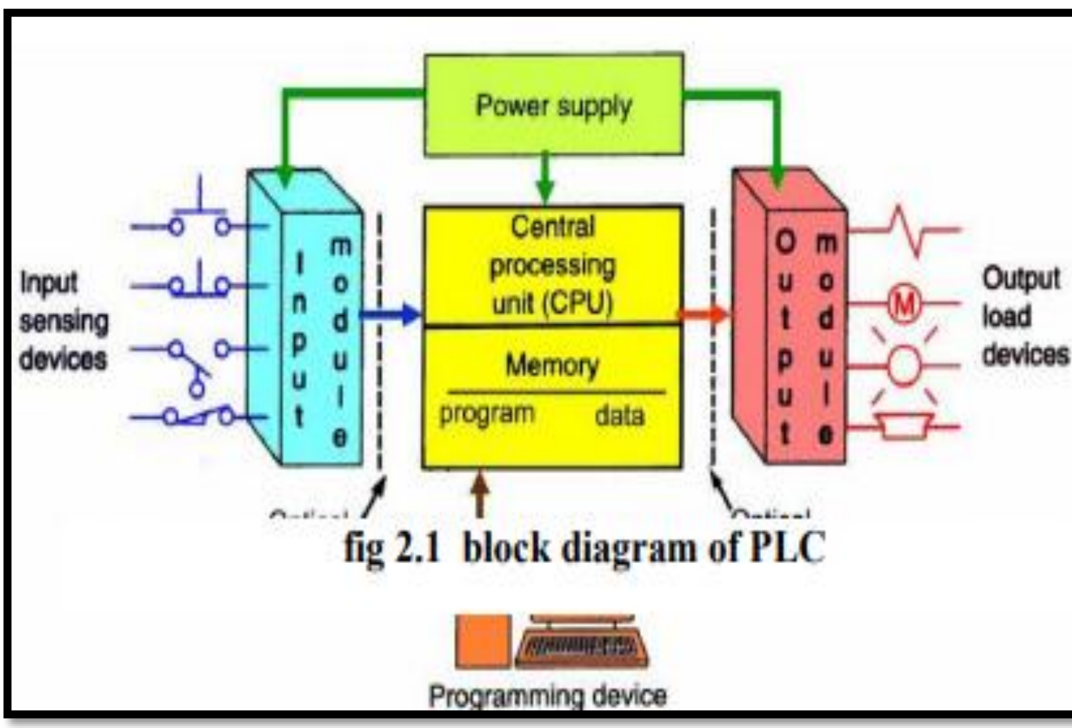

Figure 2.1 Block diagram of PLC

2.2.6.1 Input module

There are two types of input modules:

1.Digital inputs

These convert the external binary signal from the process to the internal digital signal level of programmable controller.

Digital Input devices such as Push buttons, Switches, Limit switch, Proximity sensor and Photo sensor.

2.Analog inputs

Analog inputs cards converts' continuous signal via analog to digital converter into discrete values for the PLC such as Pressure transmitter, Flow transmitter, Level transmitter, Load cell and Thermo couples.

2.2.6.2 CPU (Central Processing Unit)

The CPU is the brain of the system. The CPU is a very microprocessor based system that replaces control relays, counter, timers and sequencers. A processor appears only once in a PLC and it can be either a one bit (or) a word logic operation. PLCs with word processors are used when processing text and numerical data, calculations, gauging, controlling and recording as well as the simple processing of signals in binary code are required. The CPU accepts (reads) input data from various sensing devices, executes the stored user program from memory and sends appropriate commands to control device. A direct current (dc) source is required to produce the flow level voltage used by the processor and the inputs and outputs modules. This power supply can be housed in the CPU unit (or) may be a separately mounted unit depending on the PLC system manufacturer. Most of the CPUs contain the backup batteries that keep the operating program in storage in the event of a plant power failure. The processor memory module is a major part of the CPU housing. Memory is where the control plan or program is held or stored in the controller the information stored in the memory relates to the way the input and output data should be processed. The amount of memory required is based on the complexity of the program. Memory elements store individual pieces of information called bits (for binary digits). The main purpose of the CPU is “scanning”. It performs the three main functions like:

- Read the inputs
- Depends up on reading executes
- Return to the values of the output

These three functions done simultaneously by the CPU called CPU scan cycle. The time required to complete the only one cycle is called “CPU scan time”. The CPU scan time depends upon our logic. If the scan time is increase the PLC speed decreases. If the scan time is decreases the PLC speed increases

a. CHECK INPUT STATUS (read the inputs)
   First the PLC takes a look at each input to determine if it is on or off. In other words, is the sensor connected to the first input on, Then the second input, Then the third and so on… It records this data into its memory to be used during the next step.[8]
b. EXECUTE PROGRAM (depends up on reading executes)
   Next the PLC executes your program one instruction at a time. Maybe the program says that if the first input was on then it should turn on the first output. Since it already knows which inputs are on/off from the previous step it will be able to decide whether the first output should be turned on based on the state of

the first input. It will store the execution results for use later during the next step.[8]

c. UPDATE OUTPUT STATUS (return to values of the output)

Finally the PLC updates the status of the outputs. It updates the outputs based on which inputs were on during the first step and the results of executing your program during the second step. Based on the example in step 2 it would now turn on the first output because the first input was on and your program said to turn on the first output when this condition is true. After the third step the PLC goes back to step one and repeats the steps continuously. One scan time is defined as the time it takes to execute the 3 steps listed above.[8]

The basic elements of a PLC include input modules or points, a central processing unit (CPU), output modules or points, and a programming device. The type of input modules or points used by a PLC depends upon the types of input devices used. Some input modules or points respond to digital inputs, also called discrete inputs, which are either on or off. Other modules or inputs respond to analog signals. These analog signals represent machine or process conditions as a range of voltage or current values. The primary function of a PLC's input circuitry is to convert the signals provided by these various switches and sensors into logic signals that can be used by the CPU.

The CPU evaluates the status of inputs, outputs, and other variables as it executes a stored program. The CPU then sends signals to update the status of outputs. Output modules convert control signals from the CPU into digital or analog values that can be used to control various output devices. The programming device is used to enter or change the PLC's program or to monitor or change stored values. Once entered, the program and associated variables are stored in the CPU. In addition to these basic elements, a PLC system may also incorporate an operator interface device to simplify monitoring of the machine or process.

In our case the input module will be composed of an array of switches that help us to input Logic ones or Logic zeros to the PLC; the output module is made of LEDs to display the status of the system; our programming device is the SIEMENS provided STEP 7 MicroWin and the operator interface is STEP 7 Simulator.

2.2.6.3 Output modules

There are two types of output modules

1. Digital outputs

These convert the internal signal level of the programmable controller into the binary signal level required externally by the process, such as Relays, Contactor, Values, Leds, Solenoid value, Coilers.

2. Analog outputs

Analog outputs cards converts' digital values in the PLC to converts continuous signals via a digital to analog converts, such as, Flow control values, Pressure control values, Drive inputs, Values, Analog ports.

2.2.6.4 Program memory

In program memory is classified into three types:

I. System memory.

II. Load memory.

III. Work memory.

System memory

In system memory contain all hardware configuration details Load memory Each CPU has an internal load memory. The size of this internal load memory depends on the CPU used.

This internal load memory can be replaced by using external memory cards. If there is no memory card inserted, the CPU uses the internal load memory; if a memory card is inserted, the CPU uses the memory card as load memory.

The size of the usable external load memory cannot, however, be greater than the internal load memory even if the inserted SD card has more free space. Work memory.

Work memory is a non-retentive memory area for storing elements of the user program that are relevant for program execution. The user program is executed exclusively in work memory and system memory.

It divided into two:

I.Run mode.

II.Stop mode.

2.2.6.5 Power supply

Here the power supply is separately mention because for plc to power up it requires only 24v dc so, to convert 230v ac to 24vdc one converter is used called SMPS(switch mode power supply).

2.2.7 PLC Memory organization

Memory can be categorized into voltaic and and nonvolatile memory. Volatile memory will lose its stored information if all operating power is lost. Volatile memory is easily altered and quite suitable for most applications when supported by battery backup. Nonvolatile memory can retain stored information when power is removed accidentally or intentionally. Plc makes use of many different types of volatile and nonvolatile memory devices. The common memory types description:

1. RAM: Random access memory (RAM) is designed so that information can be written into (or) read from the memory today's controllers use the CMOS-RAM with battery support for user program memory. RAM provides an excellent means for easily creating and altering a problem.

2. ROM: Read- only memory (ROM) is designed so that information stored in memory can be read and cannot be changed under ordinary circumstances.

3. EPROM: Erasable programmed read only memory (EPROM) is designed so that it can be reprogrammed after being entirely erased with the use of an ultraviolet light source.

4. EEPROM: Electrically erasable programmed read- only memory. (EEPROM) is a nonvolatile memory that offers the same programmed flexibility as does RAM. It provides permanent storage of the program but can be easily changed using standard programming devices.

2.3 Centrifugal pump

A centrifugal pump operates through the transfer of rotational energy from one or more driven rotors, called impellers. The action of the impeller increase the fluid velocity and pressure and directs it towards the pump outlet. With its simple design the centrifugal pump is well understood and easy to operate and maintain.

Centrifugal pump designs offer simple and low cost solutions to most low pressure, high capacity pumping applications involving low viscosity fluids such as water, solvents, chemicals and light oil.

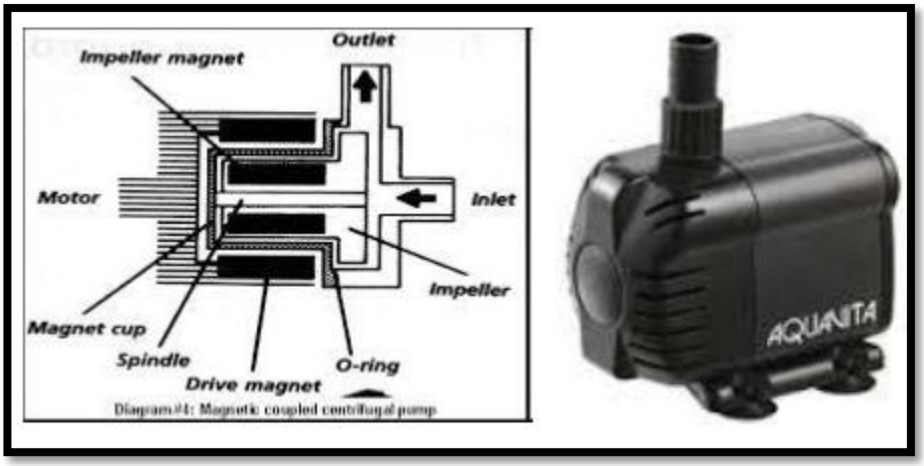

Figure 2.2 Centrifugal pump

2.4 Conveyor system

A conveyor belt is the carrying medium of a belt conveyor system. A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of pulleys, with an endless loop of carrying medium the conveyor belt that rotates about them. One of the pulleys is powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

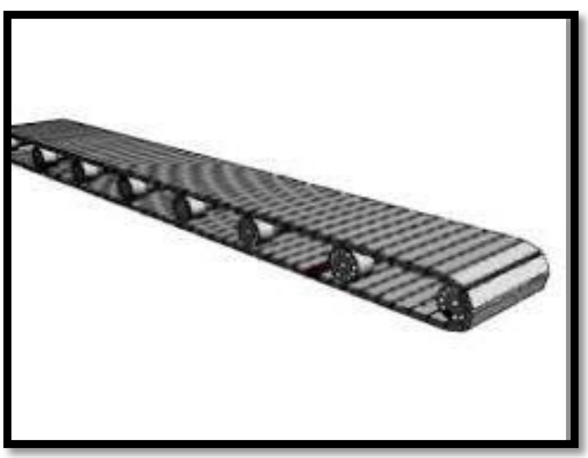

Figure 2.3 Conveyor belt

2.5 Proximity Sensor

The proximity sensor or photoelectric sensor is another type of position sensing device. Photoelectric sensors use a modulated light beam that is either broken or reflected by the target. The control consists of an emitter (light source), a receiver to detect the emitted light, and associated electronics that evaluate and amplify the detected signal causing the photo electric's output switch to change state. There are three major types of photoelectric sensor:

1. Reflective model

   Both the light emitting and light receiving elements are contained in a single housing. The sensor receives the light reflected from the target, This is the type which used in project.

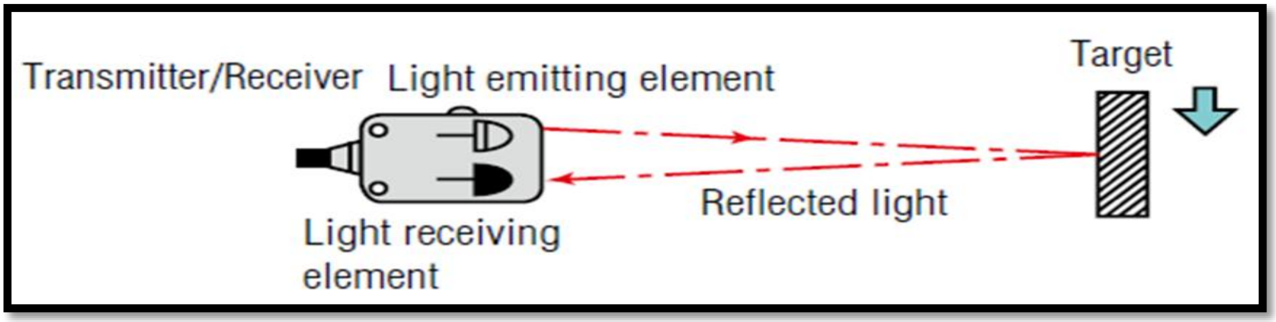

Figure 2.4 Reflective photoelectric sensor

2. Thrubeam model

   The transmitter and receiver are separated. When the target is between the transmitter and receiver, the light is interrupted.

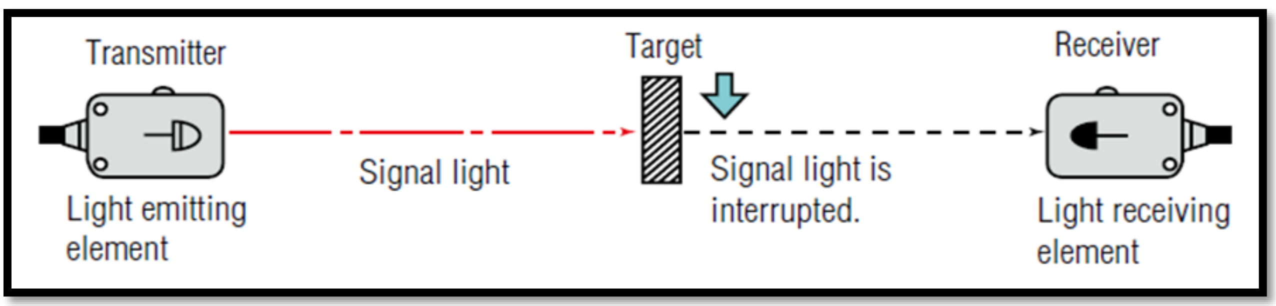

Figure 2.5 Thrubeam photoelectric sensor

3. Retroreflective model

   Both the light emitting and light receiving elements are contained in same housing. The light from the emitting element hits the reflector and returns to the light receiving element. When a target is present, the light is interrupted.

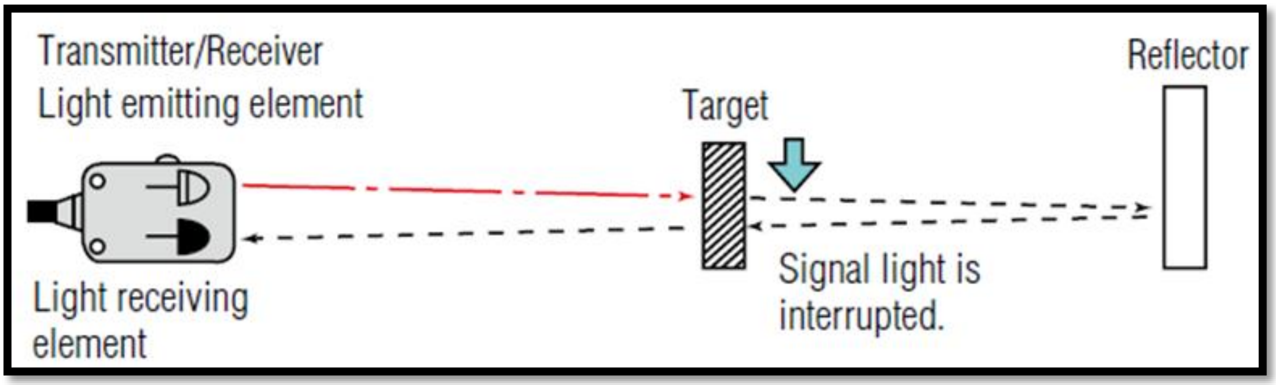

Figure 2.6 Retoreflective photoelectric sensor

2.5.1 Advantages

1- Senses all kinds of Materials.

2- Long Life.

3- Longest sensing range.

4- Very fast response time.

2.5.2 Disadvantages

1- Lens Subject to Contamination.

2- Sensing Range Affected by color and reflectivity of target.

2.5.3 Applications

1- Packaging.

2- Material handling.

3- Parts detection.

2.6 Solenoid Valve

A solenoid valve is an electromechanical device used for controlling liquid or gas flow. The solenoid valve is controlled by electrical current, which is run through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move. Depending on the design of the valve, the plunger will either open or close the valve. When electrical current is removed from the coil, the valve will return to its de-energized state.

In direct-acting solenoid valves, the plunger directly opens and closes an orifice inside the valve. In pilot-operated valves (also called the servo-type), the plunger opens and closes a pilot orifice. The inlet line pressure, which is led through the pilot orifice, opens and closes the valve seal.

The most common solenoid valve has two ports: an inlet port and an outlet port.

Solenoid valves make automation of fluid and gas control possible. Modern solenoid valves offer fast operation, high reliability, long service life, and compact design.

The parts of solenoid valve are:

1. Valve Body
2. Inlet port
3. Outlet port
4. Coil/solenoid
5. Coil windings
6. Lead wire
7. Plunger
8. Spring
9. Orifice

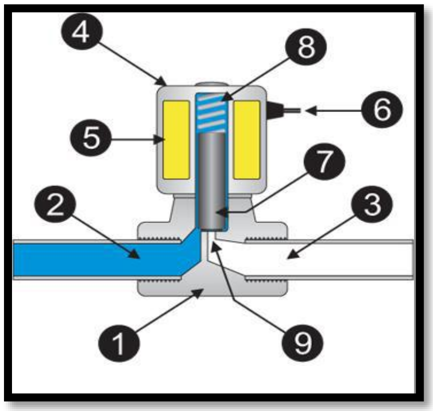

Figure 2.7 Solenoid valve parts

Figure 2.8 Solenoid valve

2.7 Gear Motor

The motor used to drive the conveying belt with High torque and work with power Supply voltage 12v.

Figure 2.9 Gear Motor

CHAPTER THREE

3. Methodology

3.1 Overview

This chapter describes, discusses and justifies the research approach, methods and techniques used in this research work. General methodology frameworks followed by specific sub framework of all phases and way forward to achieve research objectives are presented and explained in details and show signal movement.

3.2 Research activities

Research activities began with a comprehensive literature review that shows how research related to previous studies. Analyses requirement that is followed by studying and analyze the theoretical and practical requirements needed to complete the search. The next step was a phase of circuit design where an online of components of the circuit is drawn and linked. Then, a simulation of the designed circuit is done with a test code in simulator. This is followed by the practical hardwiring of circuit components and burning the application code on the memory. Finally comes to the step of testing the practical circuit and recording the results and compare it with the theoretical result.

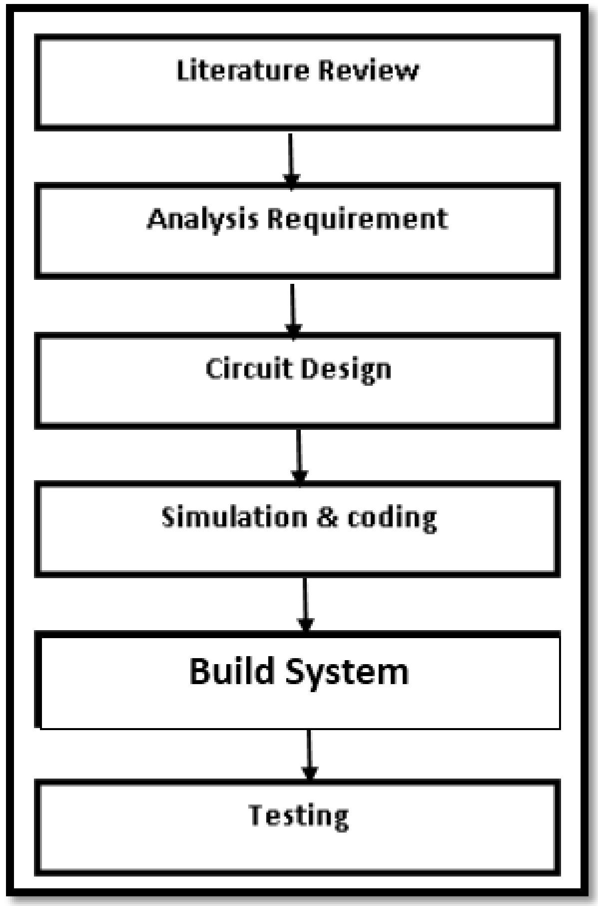

Figure 3.1 Research activities

3.3 System block diagram

The block diagram consists of PLC, Pumps, Switches, mixer, Conveying belt, Proximity sensor and solenoid valve. All these contents connected to the PLC which serves as a client and server of the system. When the user press start switch the pumps start filling from the tanks to the mixer after that the mixer start mixing the liquids until make it homogeneous at that time the bottle press the proximity sensor at the position then the solenoid valve is opened to fill the product into the bottle .

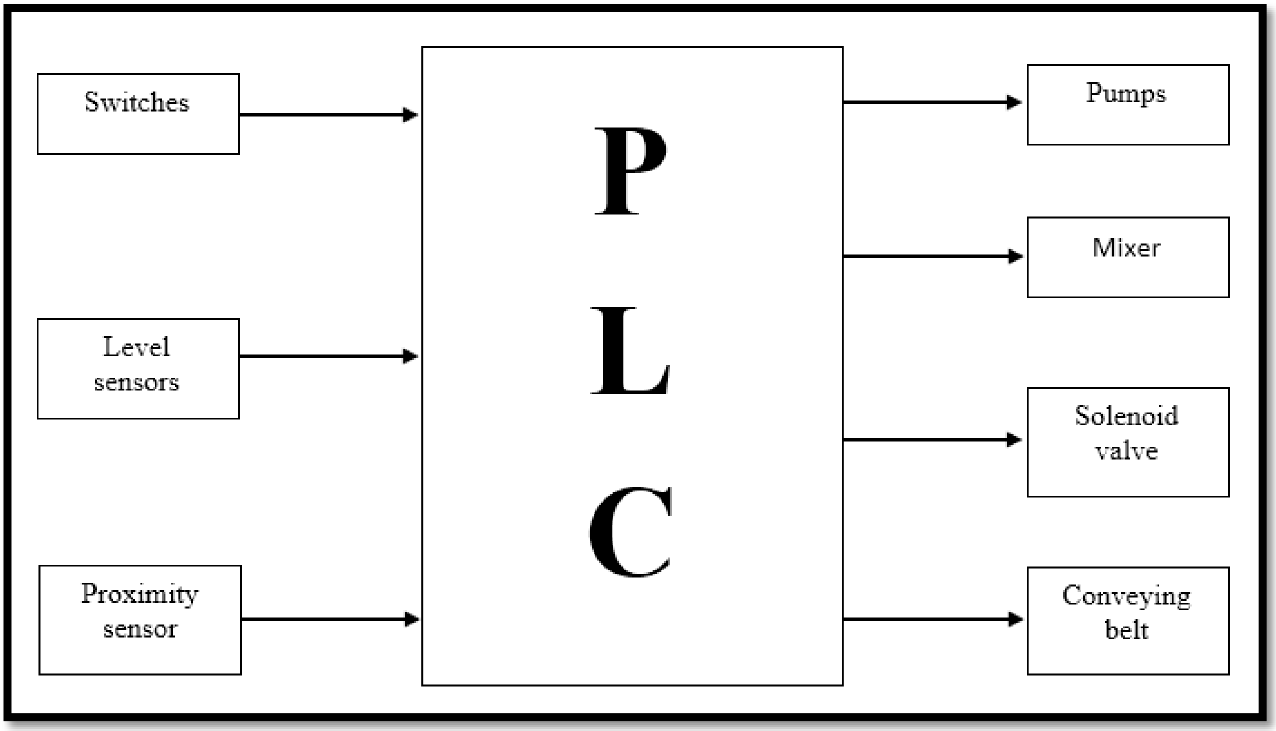

Figure 3.2 Block diagram

3.4 Connections with PLC

The inputs of PLC are:

1. Start switch which is connected with the first input of PLC (I0.0).
2. Emergency stop which is connected with the second input of PLC (I0.1).
3. Low level sensor which is connected with the third input of PLC (I0.2).
4. high level for pump1 sensor which is connected with the fourth input of PLC (I0.3).
5. high level for pump2 sensor which is connected with the fifth input of PLC (I0.4).
6. Photoelectric sensor which is connected with the sixth input of PLC (I0.5).

And the output of PLC are:

1. Pump1 which is connected with the first output of PLC (Q0.0).
2. Pump2 which is connected with the second output of PLC (Q0.1).
3. The mixer motor which is connected with the third output of PLC (Q0.2).

4. The solenoid valve which is connected with the fourth output of PLC (Q0.3).
5. The conveying belt motor which is connected with the fifth output of PLC (Q0.4).

As shown in connection diagram.

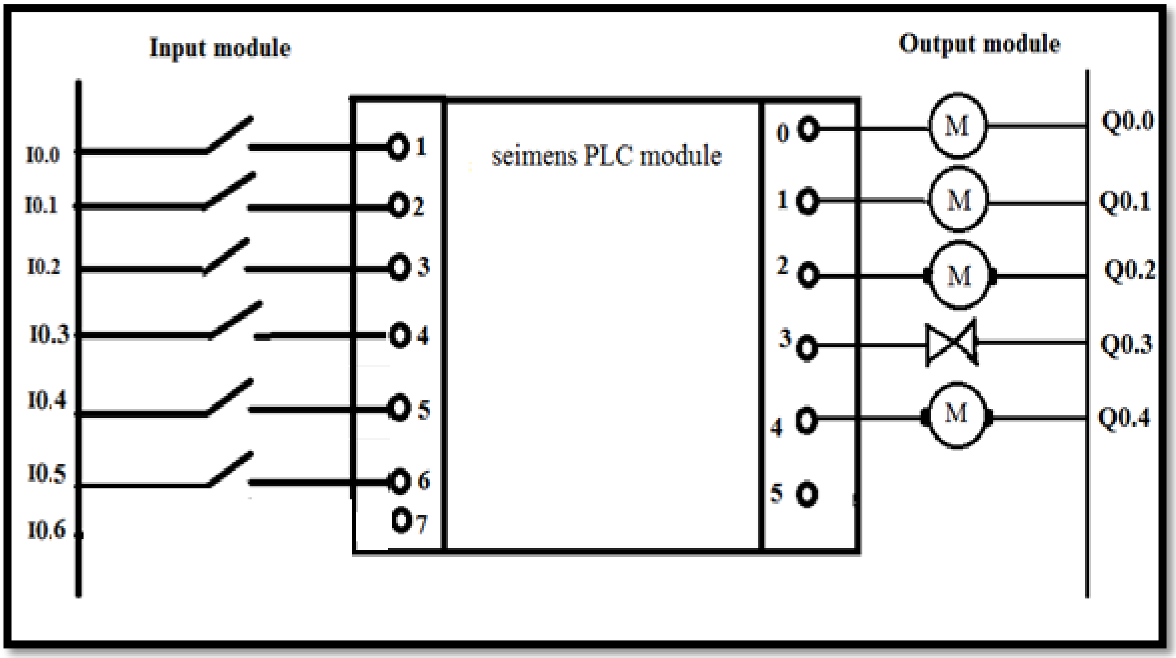

Figure 3.3 Connection with PLC

3.5 System description

The system has being installed using the following components:

- PLC
- Pumps
- Level sensors
- Mixing motor
- Proximity sensor
- Solenoid valve
- Motor to drive conveying belt

3.6 Signal movement

The system is designed as follow:

1-The user run the PLC and select system from selector switch. The controller check the low level of the liquid in mixing tank by the level sensor if it isn't low the controller will run the conveying belt until the proximity sensor activated then the solenoid valve is opened to fill the homogenous liquid into the bottle for a period of time and the system will repeat this operation until the low level sensor of the liquid in mixing tank is deactivated.

2-When the low level sensor of mixing tank is deactivated the controller will activate pump 1 till activate pump's1 level sensor after that run pump2 till activate pump's2 level sensor.

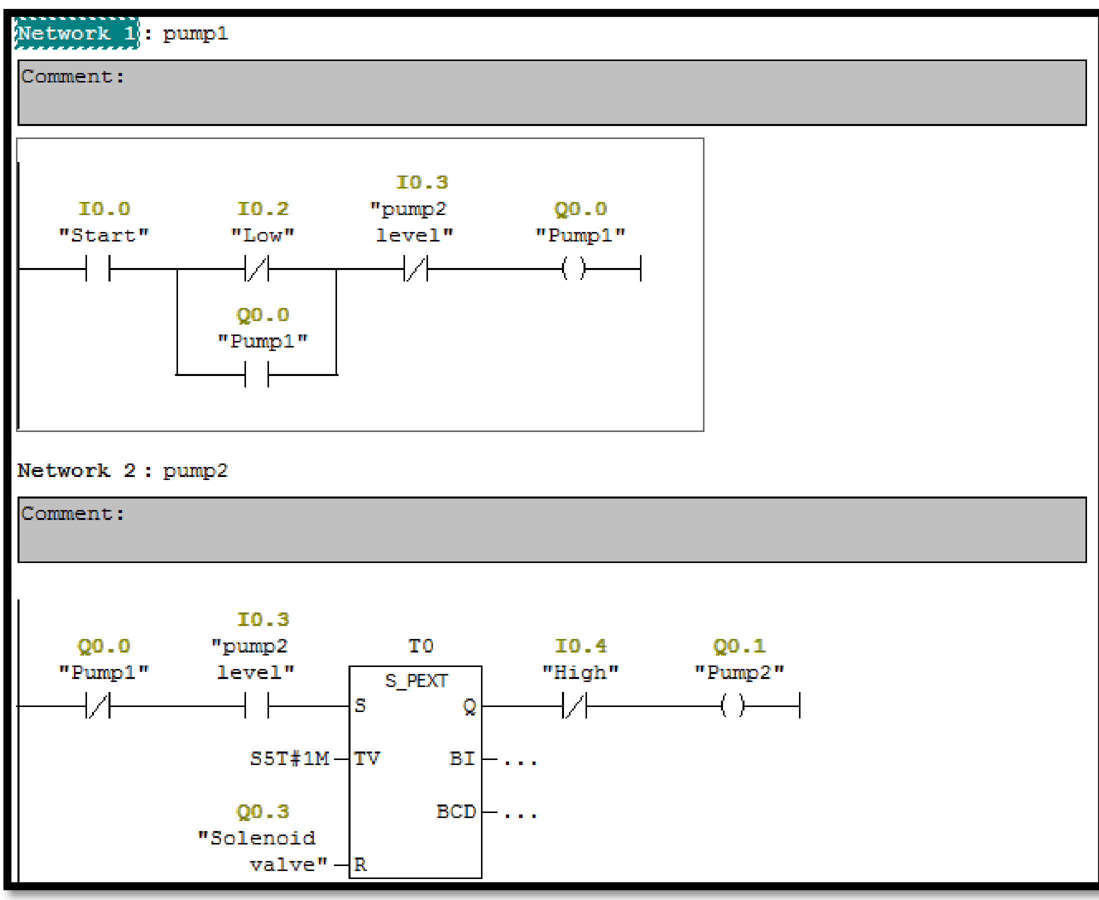

Figure 3.4 Filling pumps

3-Then the mixer motor will be activated for a period of time to mix the liquids until make it homogenous.

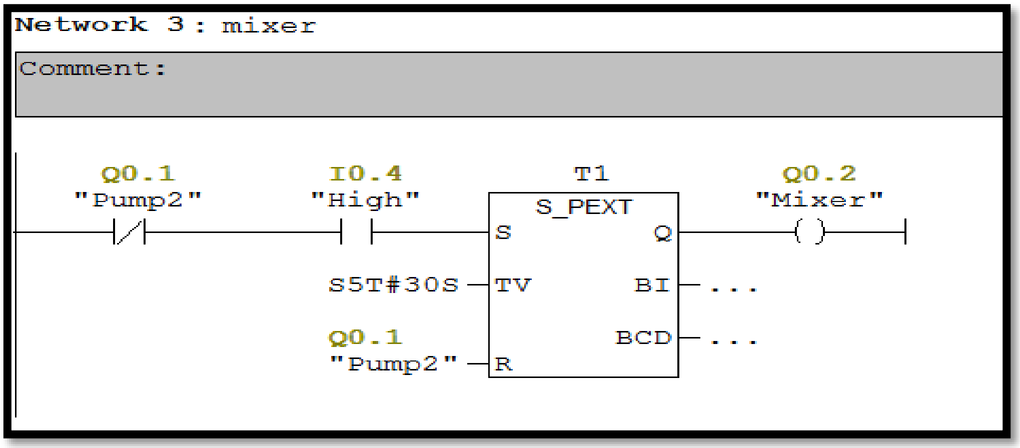

Figure 3.5 Mixer

4-After step3 is done the controller will check the proximity sensor if it is activated or deactivated, if its deactivated the controller will run the conveying belt motor until make the proximity sensor active. and if its activated the controller will open the solenoid valve and filling pump at the same time for a period of time to fill the bottle with the product.

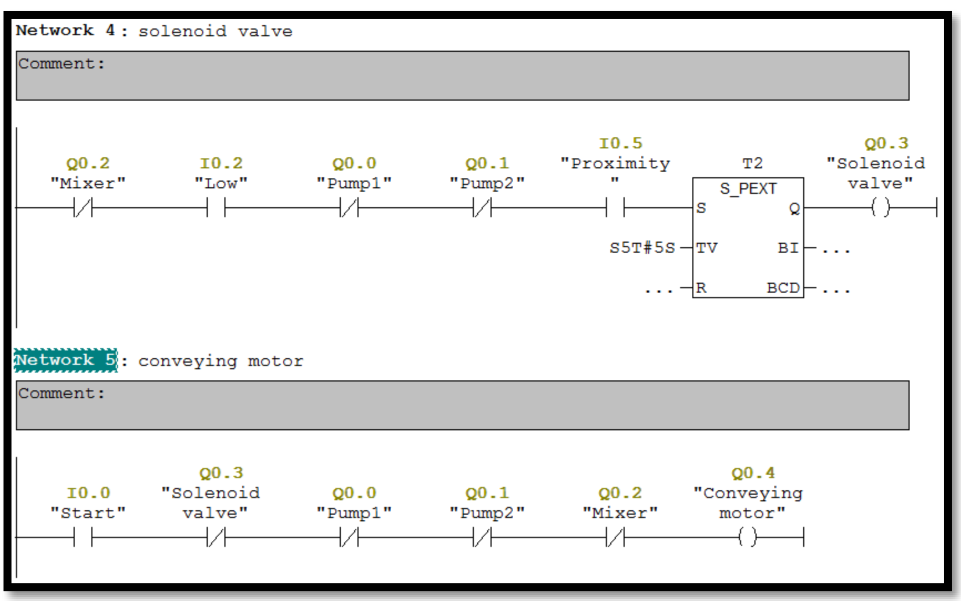

Figure 3.6 Solenoid valve and conveying belt

5-The PLC will repeat step 4 until the low level sensor of mixer being low.

6-If the condition in step 5 is true, the system will repeat the procedure from step2.

3.7 Simulator

SIMATIC S7-PLCSIM V5.4 is software test without controller for STEP 7 V5.x, and its provide effective support with the development of programs and following actual application in the automation environment, a simulated test environment including PLC and process reduces startup times and cost.

S7-PLCSIM executes the user program just like a real controller during program execution, different process values can be monitored and change via a simple user interface.

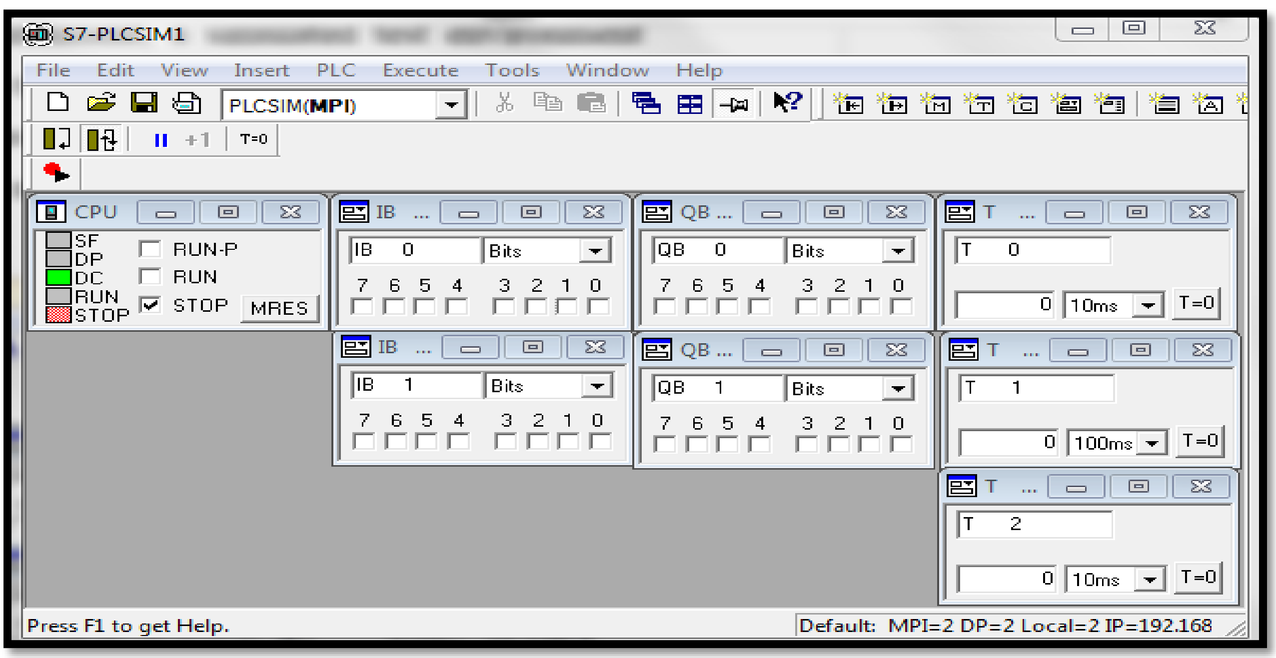

Figure 3.7 S7-PLC Simulator

3.8 Flow chart

This type of diagram is represents an algorithm, workflow or process. Also its shows the steps of the orders and priority of each command in the system which is controlling by PLC.

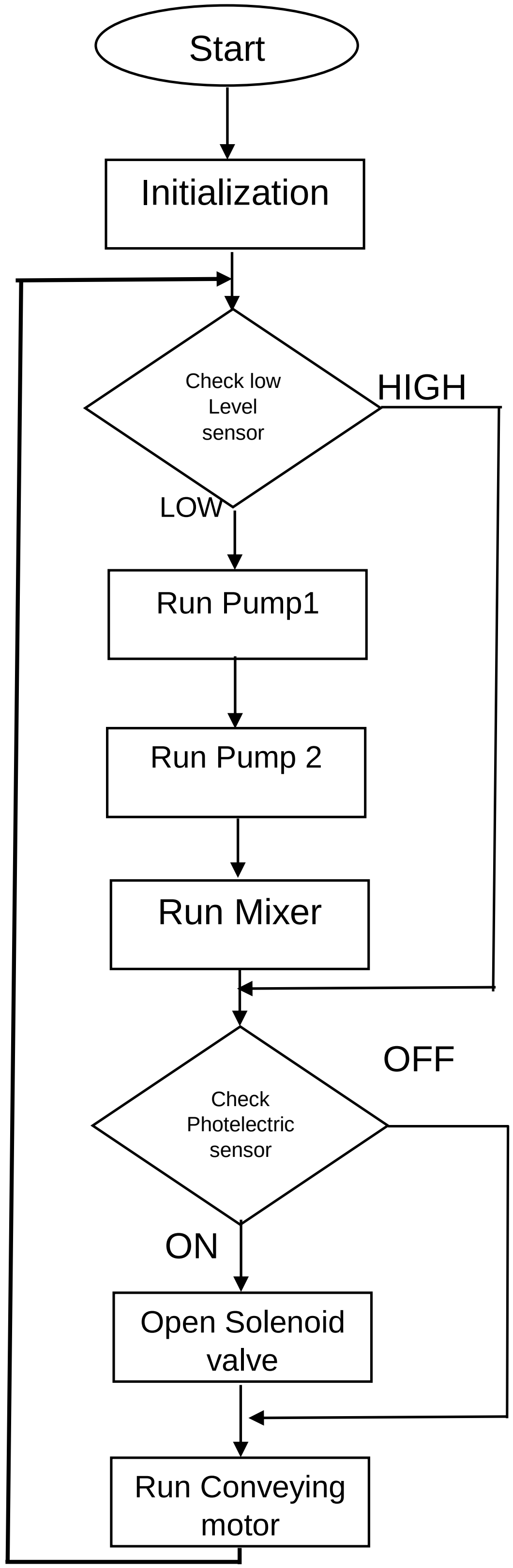

Figure 3.8 Flow chart

CHAPTER FOUR

4. Simulation result and discussion

4.1 System Connection

The diagram bellow shows the connection of the components with each others.

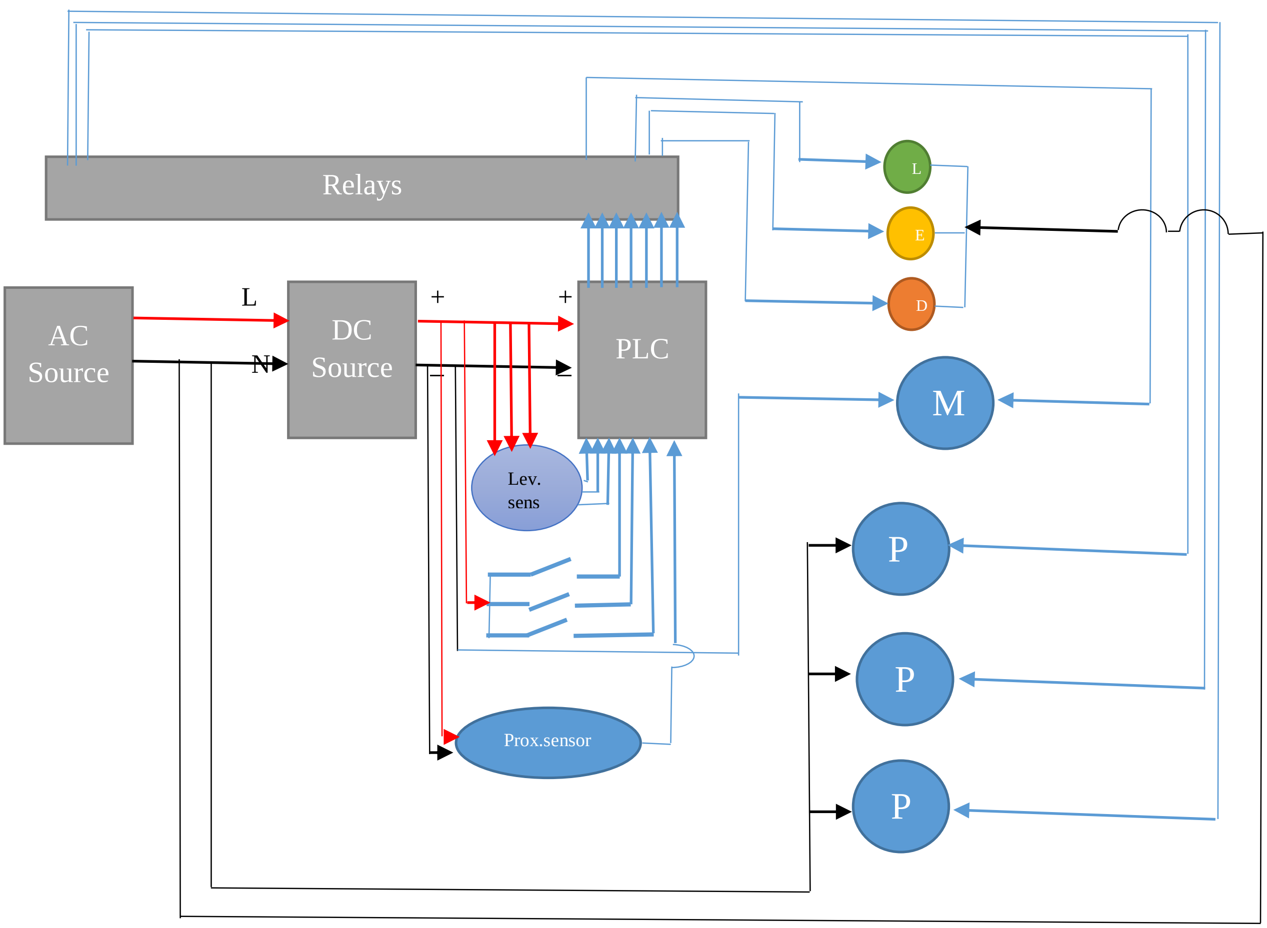

Figure 4.1 System connection diagram

In details:

The line in start, stop and emergency switches are connected with the positive wire of dc supply 24v. and the the neutral of them connected with the plc inputs.

The neutral in leds are connected with the negative wire of AC power supply 220v. and the line of them are connected with relays.

Figure 4.2 Switches and LEDs

The neutral in pumps are connected with the negative wire of AC power supply 220v. and the line of them are connected with relays.

Figure 4.3 Pump

The inputs of proximity sensor are connected with special D.C power supply 24v which is connected with the main D.C power supply to get more stability in voltage. and the output of sensor is connected with the input of plc.

Figure 4.4 Proximity sensor

The neutral of conveying belt motor is connected with the negative of DC power supply and the line of the motor is connected with the PLC output.

4.2 System Testing

The figure below shows when the system is in complete stopping.

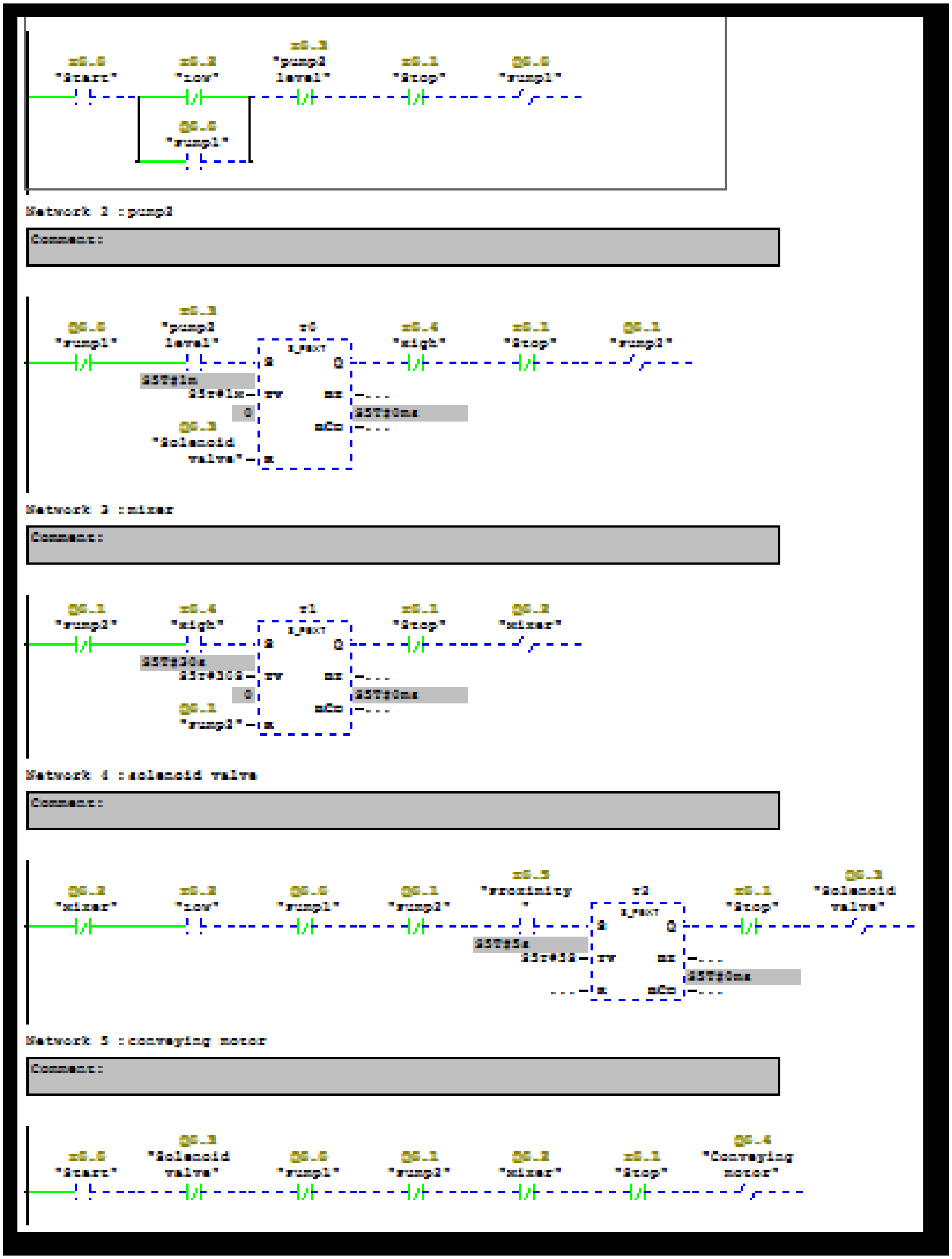

Figure 4.5 System is stopped

4.2.1 Case (1)

When the simulation is run and the user has started the system the signal will check the level of the liquid in main tank if its low the signal will run the pump1 in sub tanks till reach the the high level of pump1.

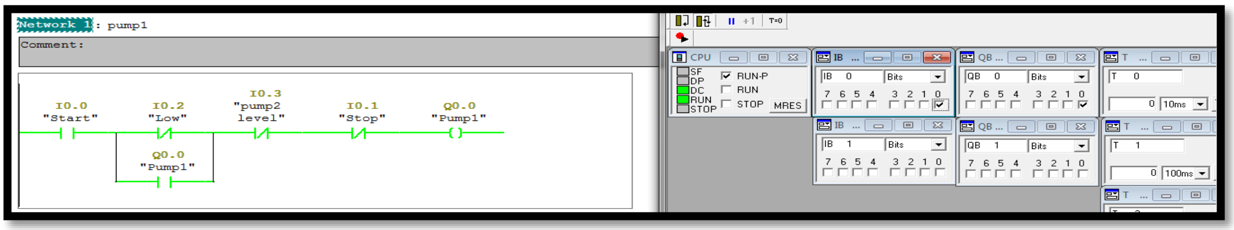

Figure 4.6 Pump1 is running

After pump1 stop.pump2 will start running till reach the high level of pump2.

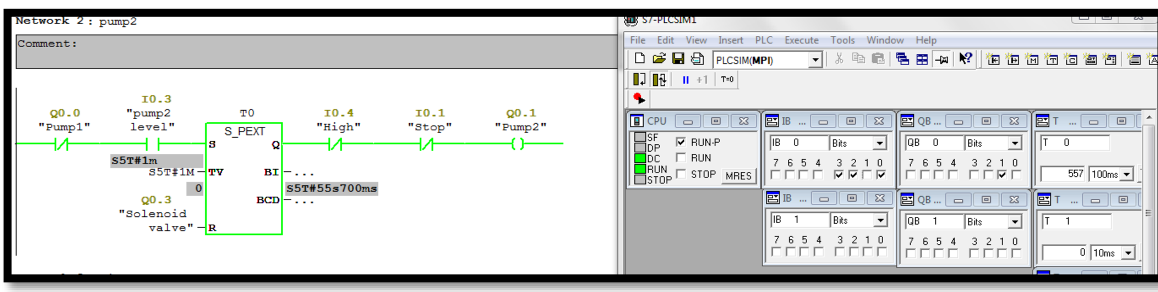

Figure 4.7 Pump2 is running

After the pump2 stop. The high level sensor will be in a high level after that the mixer will start mixing for specific time.

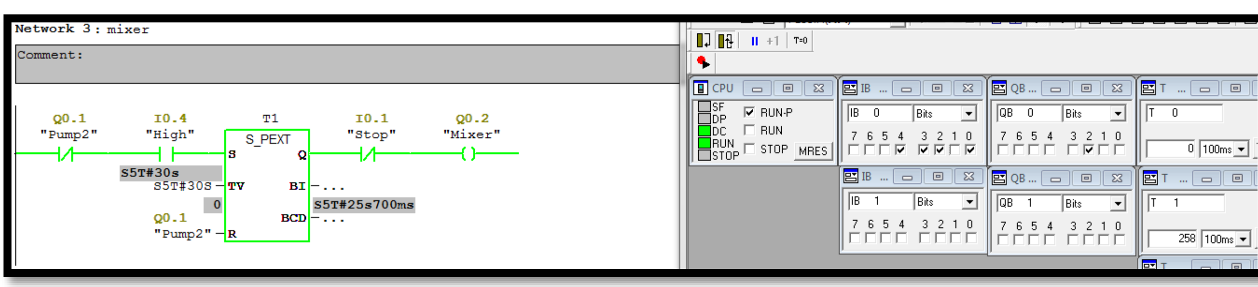

Figure 4.8 Mixer is running

When the liquid is homogenous and the proximity sensor is on. The solenoid valve will open for a time.

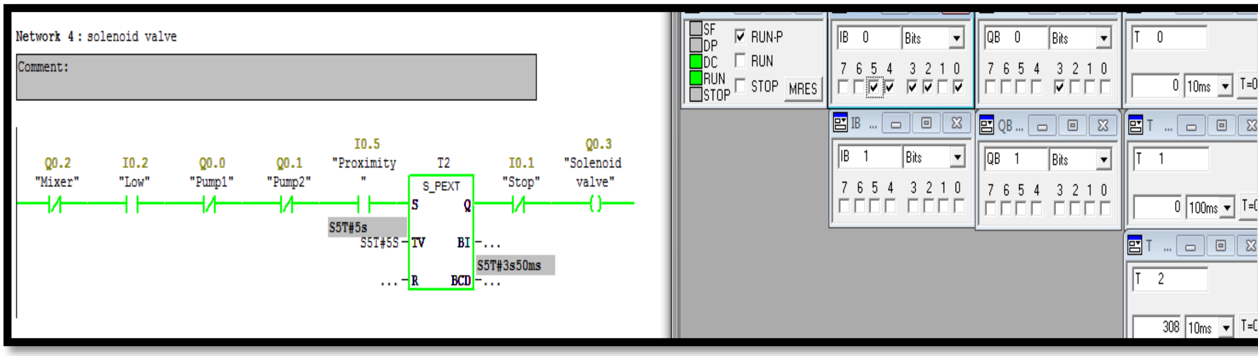

Figure 4.9 Solenoid valve is opened

Then the conveying belt will start moving the bottle. This stage repeat until the low level sensor in main tank is activated.

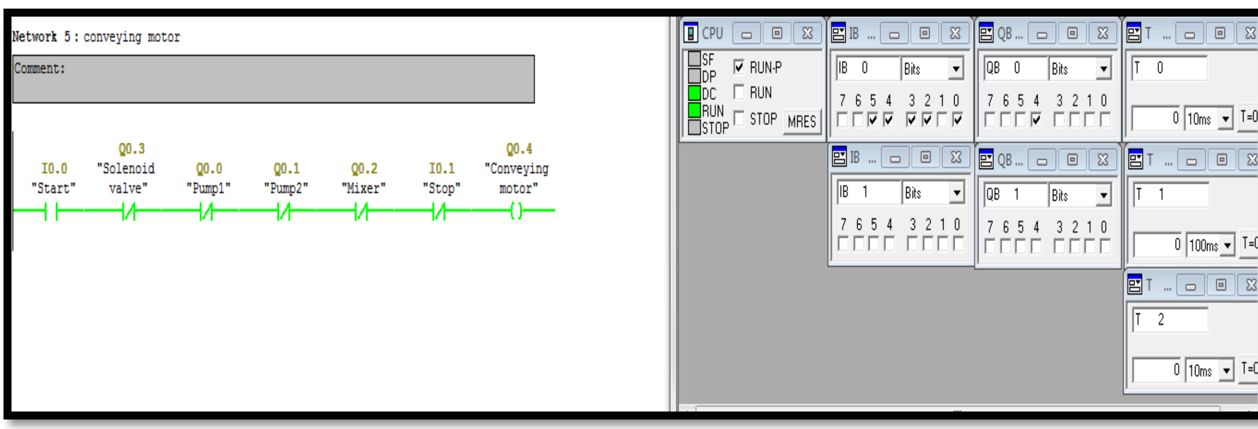

Figure 4.10 Conveying motor is activated

4.2.2 Case (2)

If the low level of the liquid in main tank isn't activated the controller will run the conveying motor to detect a bottle by the proximity sensor and continue the process as normal without run the pumps in sub tanks and mixer.

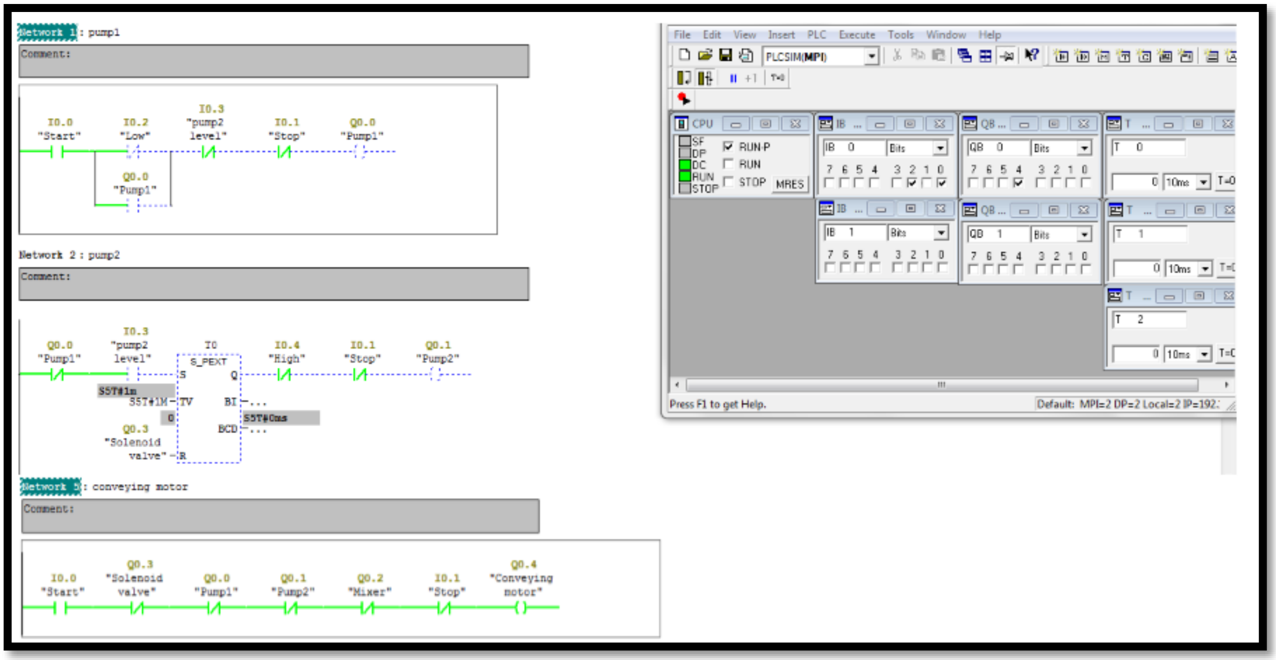

Figure 4.11 Run the conveying motor after starting

4.2.3 Case (3)

If the proximity sensor doesn't detect the bottle on conveyor the solenoid valve will never open and the controller will run the conveying motor.

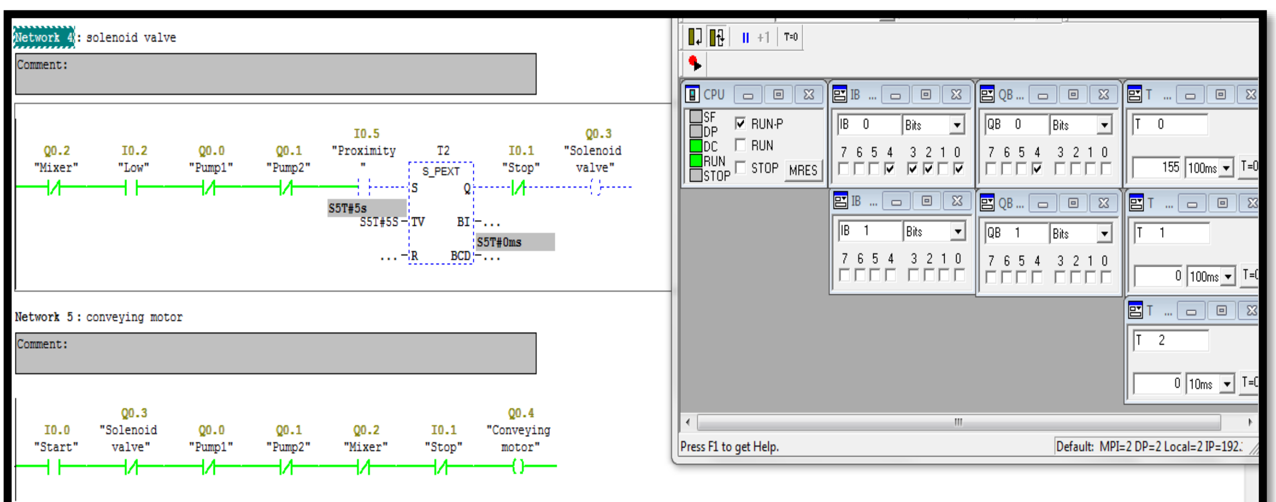

Figure 4.12 No bottle on conveying belt

4.2.4 Case (4)

If the user run the system and decide to stop the system at any time, the user should press the emergency switch to stop all the process in different stages without waiting the timers.

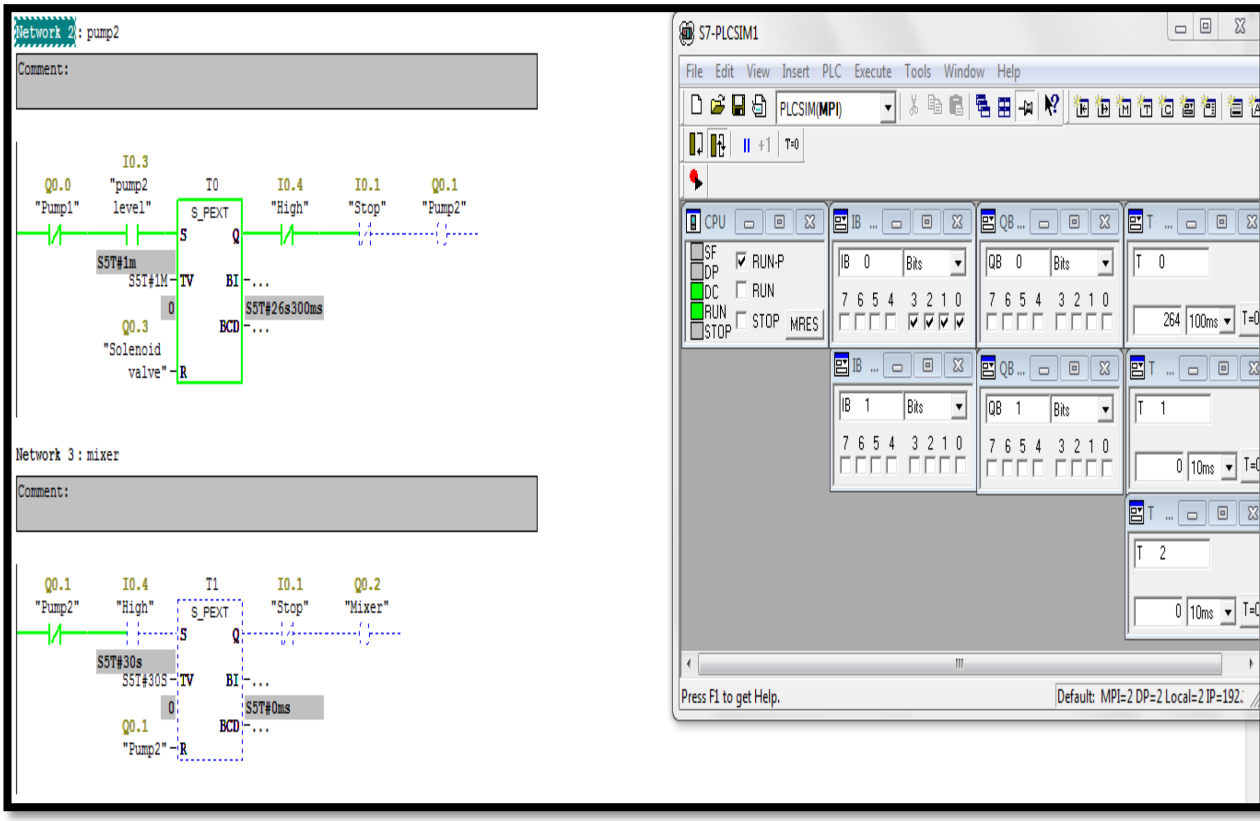

Figure 4.13 Emergency stop

4.2.5 Case (5)

If the low level sensor is active at any time the controller will stop any process and run pump1 till reach pump1 level and then run pump2 till activate the high level sensor and mix it by the mixer and start filling it by solenoid valve after detecting the bottle by the proximity sensor.

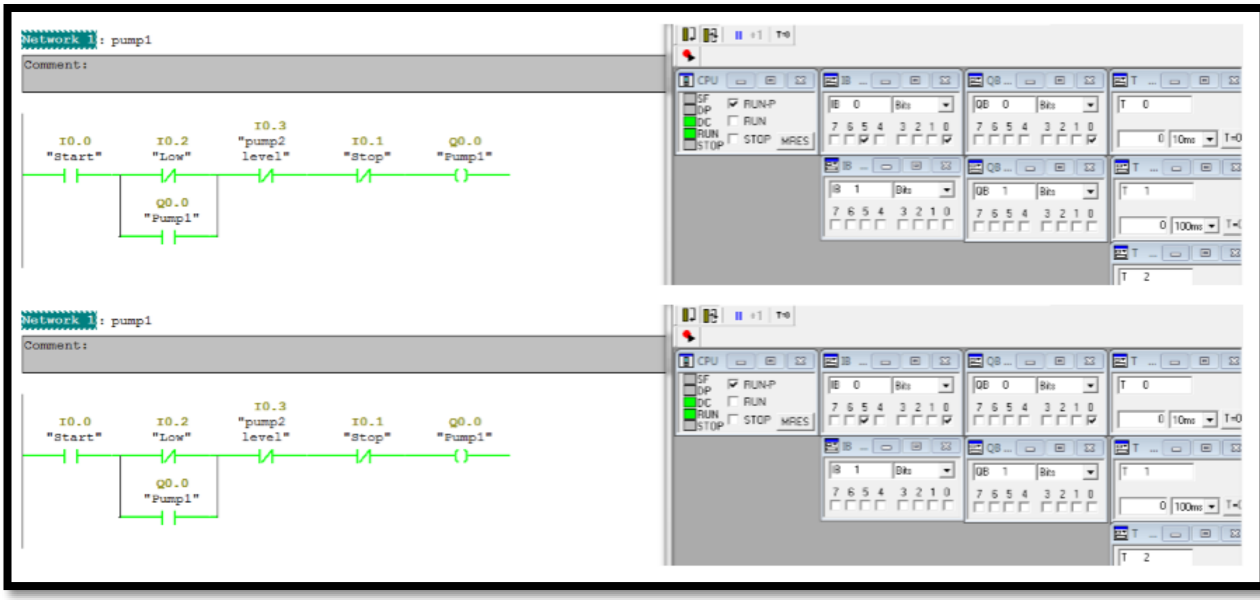

Figure 4.14 Refill the tank mixer

4.2.6 Case (6)

The pump2 timer rest by solenoid valve, so if there is any leakage on main tank pump2 will never work till solenoid valve open again.

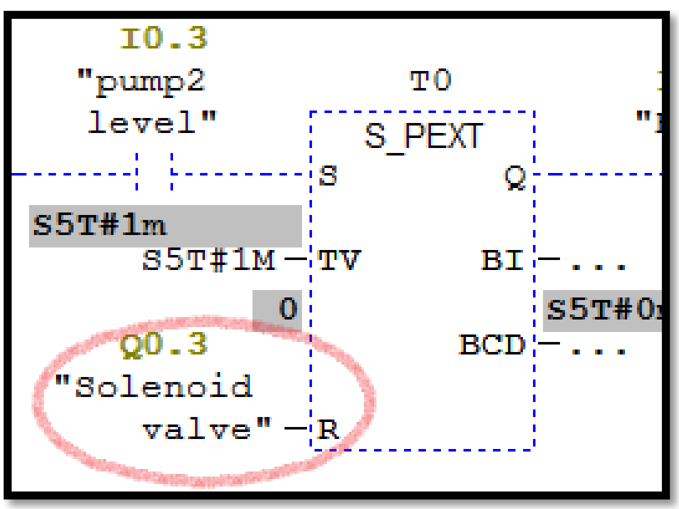

Figure 4.15 pump2 timer reset

4.3 Practical Result

The system can fill the liquid substances from sub tanks to the main tank (Mixture) with varying properties and fill it again into bottles after mix the substances to generate a new homogenous substance. There are only three pumps and only two types of sensors are used. It is a time based control by which the user condition. It can be used commercially in various applications such as coffee shops, juice shops, cold drink shops and medicine factory.

This system reduce human effort, Low operational cost, low power consumption, accuracy and flexibility to the system and at the same time it will provide accurate volume of liquid in bottle by saving operational time. In this work, a prototype has been designed. So the practical research result is much satisfactory. It also helps to understand the necessity of PLC in industrial automation and also to realize the necessity of studying it.

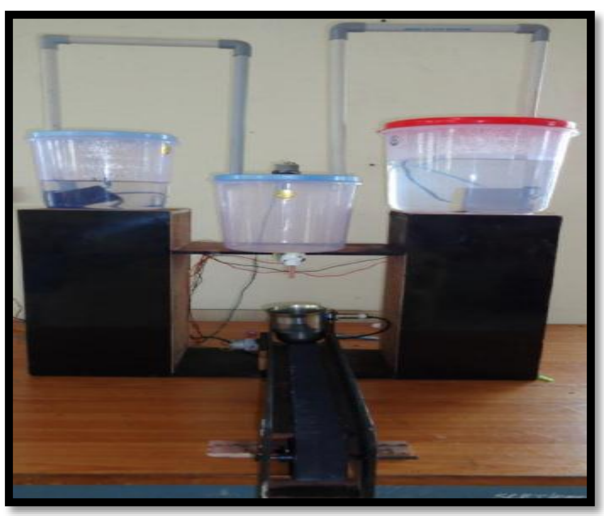

Figure 4.16 Practical System

CHAPTER FIVE

5. Conclusion &recommendations

This chapter describes the conclusion of the research and the recommendations that we want the next researchers to do.

5.1 Conclusions

The project ‘Automatic mixing and filling bottle using PLC” has been successfully designed and executed.

This Project has proposed an application of automation illustrating a PLC based fully automatic untouched liquid filling and mixing system. The system meets the demand of high-speed production using the least mechanism requirements.

The system has proved to work effectively avoiding unnecessary spill or wastage of liquids. The system also provides high accuracy and precision in proportion of liquid filling and mixing. Although proposed system illustrates the mixing process of two liquids, any number of liquids may be mixed in varying proportions. It is true that the use of PLC is a costly affair particularly for small industries but it offers many advantages that overcome its cost.

5.2 Recommendations

- Increase number of sensors for more accuracy.
- Include monitoring process.
- Include fuzzy control alogarithm.

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