Automatic Bottle Filling System Using PLC

A project report submitted in partial fulfillment

Of the requirement for the degree of B. Tech in Electrical Engineering

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Acknowledgement

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I wish to convey my gratitude to Prof. (Dr.) Alok Kole, HOD, Department of Electrical Engineering, RCCIIT and to the authority of RCCIIT for providing all kinds of infrastructural facility towards the research work.

I would also like to convey my gratitude to all the faculty members and staffs of the Department of Electrical Engineering, RCCIIT for their whole hearted cooperation to make this work turn into reality.

Name and Signature of the Student

Place:

Date:

Department of Electrical Engineering
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GROUND FLOOR, NEW BUILDING,
CANAL SOUTH ROAD, BELIAGHATA, KOLKATA – 700015, WEST BENGAL

CERTIFICATE

To whom it may concern

This is to certify that the project work entitled **Automatic Bottle Filling System Using PLC** is the bona fide work carried out by **Prithwish Das (11701614033), Krishnendu Mandal (11701614023) and Paromita Das (11701614031)**, a student of B.Tech in the Dept. of Electrical Engineering, RCC Institute of Information Technology (RCCIIT), Canal South Road, Beliaghata, Kolkata-700015, affiliated to Maulana Abul Kalam Azad University of Technology (MAKAUT), West Bengal, India, during the academic year 2017-18, in partial fulfillment of the requirements for the degree of Bachelor of Technology in Electrical Engineering and that this project has not submitted previously for the award of any other degree, diploma and fellowship.

Signature of the Guide

Name:

Designation

Signature of the HOD

Name:

Designation

Signature of the External Examiner

Name:

Designation:

Abstract

The objective of our project is to design, develop and monitor "Automatic bottle filling system using PLC". This work provides with a lot of benefits like low power consumption, low operational cost, less maintenance, accuracy and many more. This project is based on Industrial automation and is a vast application used in many industries like milk industries, chemical, food, mineral water and many industrial manufacturers. A prototype has been developed to illustrate the project.

Filling is the task that is carried out by a machine and this process is widely used in many industries. In this project, the filling of the bottle is controlled by using a controller known as PLC which is also the heart of the entire system. 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 our project we have used less number of system 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 and accepted language for the programming of the PLC. The PLC used in this system is a Siemens S7 – 1200 which makes the system more flexible and easy to operate.

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CHAPTER 1

INTRODUCTION

Overview

The project is based on industrial automation and PLC is the heart of automation. The hardware and the software are the two important areas in our project.

1) **HARDWARE DESCRIPTION**:

In this project, Siemens PLC SIMATICS S7 1200 is used for controlling the inputs and outputs. Input supply to the PLC is given through a SMPS. The rating of the SMPS is 24V DC 5Amps. The PLC used here is a compact PLC which has fixed number of inputs and outputs. In this kind of PLC model, the CPU contains 14 digital inputs and 10 digital outputs. One diffused photoelectric sensor has been used for the positioning of the bottles. A geared DC motor has been used for running the conveyor system. The ratings of the DC motor is 12V and 50 RPM speed with a high starting torque of 70 Kg-cm (at no load). Toggle switches are used to serve the purpose of some inputs to the PLC.

2) **SOFTWARE DESCRIPTION**:

There are five important languages which are used for the programming of the PLC. The list of the methods are as follows:

- Functional block diagram (FBD)
- Structure text
- Instruction list
- Flow chart
- Ladder diagram

Out of these five languages, ladder diagram is the most widely used language and is simple as compared to other languages. Ladder diagram has been used for the programming of this PLC.

Literature Review

A brief survey of technologies explored during the past decade and some of them is given below to provide an understanding of the level of research interest in this domain. In this paper, researcher outlined the various phases of operation involved in the adaptation of a manually operated boiler towards a totally automated boiler. The first part of the paper focuses on passing the inputs to the boiler at a required temperature, so as to constantly maintain a particular temperature in the boiler. The Air pre heater and Economizer helped in this method. And the paper mainly focused on level, pressure and flow control at the various stages of the boiler plant. Thus the temperature in the boiler is constantly monitored and brought to a constant temperature as required by the power plant. The automation is further improved by constant monitoring using SCADA screen which is connected to the PLC by means of communication cable. By means of tag values set to various parameters in SCADA the entire process is controlled. At the automated power plant, the boiler is controlled by Variable Frequency Drive (VFD) to put in action the required processes to be carried out at the boiler. Thus the entire cycle is carried out as a paper and at various stages each phase is detailed out. This paper has proved to be very efficient practically as the need for automation grows day by day.

This paper presented a SCADA system for a plant whose product demand is varying according to the temperature. This paper also gives an automatic method of changing a production from one mode to another. There is no manual shifting required. This paper gives a way to get rid off excess production. It also provides the facility to the user to over ride the any one of the unit hardware operation from the control room.

Researchers developed a design of re-usability using modular modeling techniques. Re-implementation of program of existing PLC program based on formulization and visualization. It is done by transformation of FSM in XML format into IEC 61131-3 POUs and project is to be creating to control machine using new controller.

Prior to the development of data acquisition and control system, collecting data from remote field instruments, distributed throughout the plant in huge manufacturing industries, was a quite challenging and multifaceted task. The team of researcher has been developed an industrial data acquisition and control systems equipped these industries with facilities to gather and process data, and perform control actions right from a centralized location, i.e. control room, without actually going to the plant. They introduction of programmable logic controllers (PLC) as a data acquisition and control hardware in these systems increased its reliability and robustness. This paper highlights the design work carried out to develop a cost efficient, simple, robust and intelligent industrial standard data acquisition and control system for two physical field plants that are 50 meters apart from the control room. This work highlights process control application and indeed is an application of industrial electronics engineering. The work carried out for this data acquisition and control system is in correlation with SCADA, DCS and totally integrated automation, which is meant to optimize processes and manufacturing procedures at the same time. At present, the PLC has been widely used in the industry area. But the shortcoming of this controller appears along with the growth of the industry equipments. Such as inferior compatibility cooperate with the new equipments, poor satisfaction of the high calculation and weak communication and so on. Thus, there need new technology to satisfy the increasing industry demands. The soft PLC comes into the world from on kind of condition. The function of PLC is imitated through software on the PC platform. But the soft PLC has shortage also. The sturdiness and instantaneity is worse than the traditional PLC. Therefore, the embedded PLC combines the advantages of traditional PLC and soft PLC, increase the computing power, express the advantages of ladder diagram and open construction to bring a universal platform to the controlled members.

In this research paper, the group of authors took efforts on the improvement of demonstrating how industrial temperature automation can be achieves using modest hardware and more refined software details. The prime concern was to generate firing pulse for an HVAC controlling actuator while displacing them at the same time to vary the magnitude of the ac voltage output. The direction of displacement of the pulse was described by the SETPOINT definition from an HMI using AT commands, and FEEDBACK from the temperature sensor installed in the industrial background. The mathematical modeling was done in LabVIEW for investigating the effect of varying firing angle on the magnitude of the ac voltage. This controlled variation of output ac voltage can be subjected to controlling temperature of the particular industrial environment.

With the help of PLC, researcher has been build and implements logic for Industrial Crane Automation & Monitoring. The soft wiring advantage provided by programmable controllers is Tremendous. In fact, it is one of the most important features of PLCs. Soft wiring makes changes in the control system easy and cheap. If it want a device in a PLC system to behave differently or to control a different process element, all have to do is change the control Program. In a traditional system, making this type of change would involve physically changing the wiring between the devices, a costly and time-consuming attempt. In future definitely PLC is dominated on all other controlling methods.

The team of authors developed ladder logic in MICROLOGIX software and is verified in Allen Bradley PLC. A ladder logic program of a typical application often results in complex software that is difficult to manage during configuration, and especially, during maintenance. The difficulty lies in a typical problem with real-time control software that is exacerbated by ladder logic. Individual components of PLC software are characteristically asynchronous, resulting in unpredictable interactions. This makes the initial configuration of the software (i.e., commissioning) extremely difficult and labour-intensive, but also makes reconfiguration risky. However the system creates a fast, real-time decision making environment. Also the use of SCADA in the industry will not only allow them to minimize the cost associated with the display and recording instruments but will also account for better quality and higher productivity. The process is adaptable to any changes in production capacity or safety requirements. In short integrated automation process produces a reliable quality hardboard production industry with the help of PLC. This paper focuses on an innovative and intelligent monitoring system of process using SCADA. The main concept of paper is data acquisition & controlling by using SCADA software with the help of PLC. Here PLC is a medium between electrical system & Personal Computer for SCADA to take input and output bits. Automating electrical distributions systems by implementing a supervisory control and data acquisition (SCADA) system is the one of the most cost-effective solutions for improving reliability, increasing utilization, increasing efficiency and saving costs.

This paper presented an automatic control of temperature and level of Continues Stirred Tank Reactor (CSTR) using PLC and SCADA. The CSTR is heated using heating-coil and its temperature and level are measured by RTD and float type level sensor respectively. The accurate control of temperature and level are the realistic feature of this system and balances the process. Automation required gaining the complete control of manufacturing process to achieve consistency in manufacturing with increased productivity by shortening manufacturing time. In this paper we consider both Batch and Continues process control using PLC and SCADA. The PLC and SCADA control the process parameters with good accuracy and results are found to be satisfactorily. This is a simple automated process and can be applied in many mixing processes used in industries. In this research paper, the device temperature parameter of different zones of furnace has been constantly monitored and hence it can be further controlled by using DAQ and control system. The constant monitoring of such different furnace zone temperature can produce data-base for scheduling of the machine servicing, troubleshooting and also for future processing. Due to use of microcontroller the computation task has been handled most effectively. Hence group of authors proposed system has been widely used in automotive engineering, instrumentation and power quality monitoring and control applications. Data acquisition system for monitoring such temperature of brazing furnace provides advantages of design simplicity, portability and less cost.

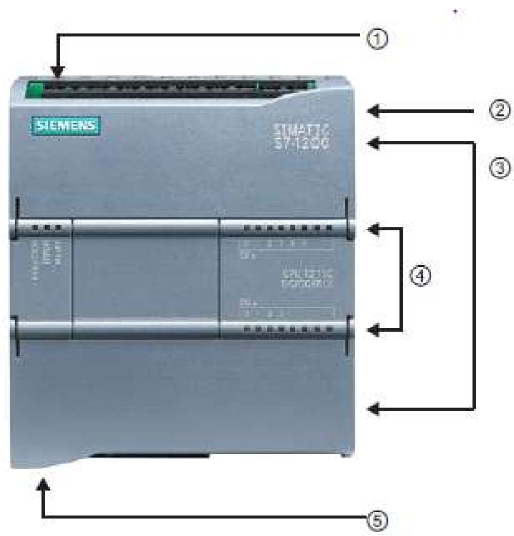
This paper reveals the design of LabVIEW based SCADA system for centralized control. It makes use of PLC as a field controller to operate the prototype design of Stenter Machine, widely used in textile industries. LabVIEW, which is a commonly accepted graphical user interface environment, also provides HMI front end. The PLC controller and the LabVIEW based SCADA are communicating through the RS-232 link. The control system is flexible and modular. Due to the intuitive programming of LabVIEW, this system is cost efficient and reliable solution for automation of small scale textile industries.

The system introduced by a group of researchers is an experimental study which helps in controlling the characteristics and ON/OFF states of a control valve. A graphical user Interface has been developed using supervisory control and data acquisition (SCADA) and the programming of the control system has been done using programmable logic control (PLC). A descriptive study has been incorporated in this paper to formulize all factors responsible for the change in valve characteristics. This system gives a clear idea about the opening and closing of three types of valves which may be present as per its requirement in an industry. The user of the system is able to supply input parameters so as to efficiently control the valve. The system is highly efficient and cost effective, as only one interfaced digital system along with a PLC can control many subsequent valves.

Chapter 2

ABOUT PLC

Technical Specification of PLC



1. Power connector
2. Memory card slot under top door
3. Removable user wiring connectors (behind the doors)
4. Status LEDs for the on-board I/O
5. PROFINET connector (on the bottom of the CPU)

The CPU combines a microprocessor, an integrated power supply, input and output circuits, built-in PROFINET, high speed motion control I/O and on board analog inputs in a compact housing to create a powerful controller. After downloading a program, the CPU contains the logic required to monitor and control the devices in the application. The CPU monitors the imputs and changes the output according to the logic of the user's program.

The CPU provides a PROFINET port for communication over a PROFINET network.

Power Budget

The CPU has an internal power supply that provides power for the CPU, the signal modules, signal board and communication modules and for other 24VDC user power requirements.

5VDC logic budget supplied by the CPU and the 5VDC power requirements of the signal modules, signal boards and communication modules.

The CPU provides a 24 VDC sensor supply that can supply 24 VDC for input points, for relay coil power on the signal modules, or for other requirements. If your 24 VDC power requirements exceed the budget of the sensor supply, then you must add an external 24 VDC power supply to your system.

Some of the 24 VDC power input ports in the S7-1200 system are interconnected, with a common logic circuit connecting multiple M terminals. For example, the following circuits are interconnected when designated as "not isolated" in the data sheets: the 24 VDC power supply of the CPU, the power input for the relay coil of an SM, or the power supply for a nonisolated analog input. All non-isolated M terminals must connect to the same external reference potential.

General Specification of CPU 1214C

CPU features:-

Technical Data	Description
User memory – • Work	 • 75 Kbytes
• Load	• 4 Mbytes internal, expandable upto SD card size
• Retentive	• 10 Kbytes
On – board digital I/O	14 inputs/ 10 outputs
On – board analog I/O	2 inputs
Process image size	1024 bytes of inputs (I)/ 1024 bytes of outputs (Q)
Bit Memory (M)	8192 bytes
Temporary (local) memory	• 16 kbytes for startup and program cycles (including associated FBs and FCs) • 4 kbytes for standard interrupt events including FBs and FCs • 4 kbytes for error interrupt events including FBs and FCs
Signal modules expansion	8 SMs max.
SB, CB, BB expansion	1 max
Communication module expansion	3 CMs max
High – speed counters	6 total • Single phase: 3 at 100kHz and 3 at 30kHz clock rate • Quadrature phase: 3 at 80kHz and 3 at 20kHz clock rate
Pulse outputs	4
Pulse catch inputs	14
Time delay/cyclic interrupts	4 total with 1ms resolution
Edge interrupts	12 rising and 12 falling (14 and 14 with optional signal board)
Memory card	SIMATIC Memory card (optional)
Real time clock accuracy	+/- 60 seconds/month
Real time clock retention time	20 days typ./12 days min. at 40ºC (maintenance free super capacitor)

Power Supply:-

Technical Data	

Voltage range	85 to 264 VAC
Line frequency	47 to 63 Hz
Input current (max. load)	• CPU only – 100 mA at 120VAC; 50mA at 240 VAC • CPU with all expansion accessories – 300mA at 120 VAC; 150mA at 240 VAC
Ground leakage, AC line to functional earth	0.5 mA max.
Hold up time (loss of power)	20ms at 120 VAC; 80ms at 240 VAC

Digital Inputs and Outputs:-

- Number of inputs: 14
- Rated voltage: 24 VDC at 4 mA, nominal
- Surge voltage: 35 VDC for 0.5 sec
- Logic 1 signal (min.): 15 VDC at 2.5 mA
- Logic 0 signal (max.): 5 VDC at 1 mA
- Number of outputs: 10
- Current (max.): 2A
- Surge current: 7A with contacts closed
- Maximum relay switching frequency: 1 Hz

PLC Concepts

Execution of the user program

The CPU supports the following types of code blocks that allow us to create an efficient structure for our user program:

- **Organization blocks** (OBs) define the structure of the program. Some OBs have predefined behavior and start events, but we can also create OBs with custom start events.
- **Functions** (FCs) and **function blocks** (FBs) contain the program code that corresponds to specific tasks or combinations of parameters. Each FC or FB provides a set of input and output parameters for sharing data with the calling block. An FB also uses an associated data block (called an instance DB) to maintain state of values between execution that can be used by other blocks in the program. Valid FC and FB numbers range from 1 to 65535.
- **Data blocks** (DBs) store data that can be used by the program blocks. Valid DB numbers range from 1 to 65535.

Execution of the user program begins with one or more optional start-up organization blocks (OBs) which are executed once upon entering RUN mode, followed by one or more program cycle OBs which are executed cyclically.

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.

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

PLC data type

The PLC data type editor lets us define data structures that we can use multiple times in our program. We create a PLC data type by opening the “PLC data types” branch of the project tree and double – clicking the "Add new data type" item. On the newly created PLC data type item, we use two single-clicks to rename the default name and double-click to open the PLC data type editor.
We create a custom PLC data type structure using the same editing methods that are used in the data block editor. We then add new rows for any data types that are necessary to create the data structure that we want.

If a new PLC data type is created, then the new PLC type name will appear in the data type selector drop drop-lists in the DB editor and code block interface editor.

Potential uses of PLC data types:

- PLC data types can be used directly as a data type in a code block interface or in data blocks.
- PLC data types can be used as a template for the creation of multiple global data blocks that use the same data structure.

Programming Concepts

Structuring the user program

When we create a user program for the automation tasks, we insert the instructions for the program into code blocks:

- An **organization block** (OB) responds to a specific event in the CPU and can interrupt the execution of the user program. The default for the cyclic execution of the user program (OB 1) provides the base structure for your user program and is the only code block required for a user program. If we include other OBs in our program, these OBs interrupt the execution of OB 1. The other OBs perform specific functions, such as for startup tasks, for handling interrupts and errors, or for executing specific program code at specific time intervals.
- A **function block** (FB) is a subroutine that is executed when called from another code block (OB, FB, or FC). The calling block passes parameters to the FB and also identifies a specific data block (DB) that stores the data for the specific call or instance of that FB. Changing the instance DB allows a generic FB to control the operation of a set of devices. For example, one FB can control several pumps or valves, with different instance DBs containing the specific operational parameters for each pump or valve.
- A **function** (FC) is a subroutine that is executed when called from another code block (OB, FB, or FC). The FC does not have an associated instance DB. The calling block passes parameters to the FC. The output values from the FC must be written to a memory address or to a global DB.

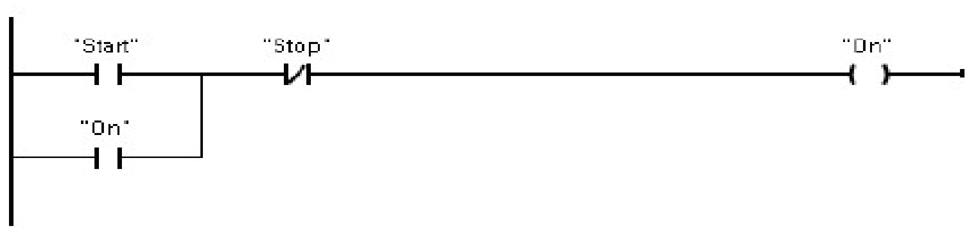
Programming Language

STEP 7 provides the following standard programming languages for S7-1200:

- LAD (ladder logic) is a graphical programming language. The representation is based on circuit diagrams.
- FBD (Function Block Diagram) is a programming language that is based on the graphical logic symbols used in Boolean algebra.
- SCL (structured control language) is a text-based, high-level programming language.

Ladder Logic (LAD)

The elements of a circuit diagram, such as normally closed and normally open contacts, and coils are linked to form networks.



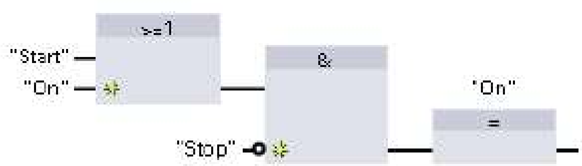
To create the logic for complex operations, you can insert branches to create the logic for parallel circuits. Parallel branches are opened downwards or are connected directly to the power rail. You terminate the branches upwards.

LAD provides "box" instructions for a variety of functions, such as math, timer, counter, and move.

STEP 7 does not limit the number of instructions (rows and columns) in a LAD network.

Function Block Diagram

Like LAD, FBD is also a graphical programming language. The representation of the logic is based on the graphical logic symbols used in Boolean algebra.



To create the logic for complex operations, insert parallel branches between the boxes.

Mathematical functions and other complex functions can be represented directly in conjunction with the logic boxes.

STEP 7 does not limit the number of instructions (rows and columns) in an FBD network.

SCL

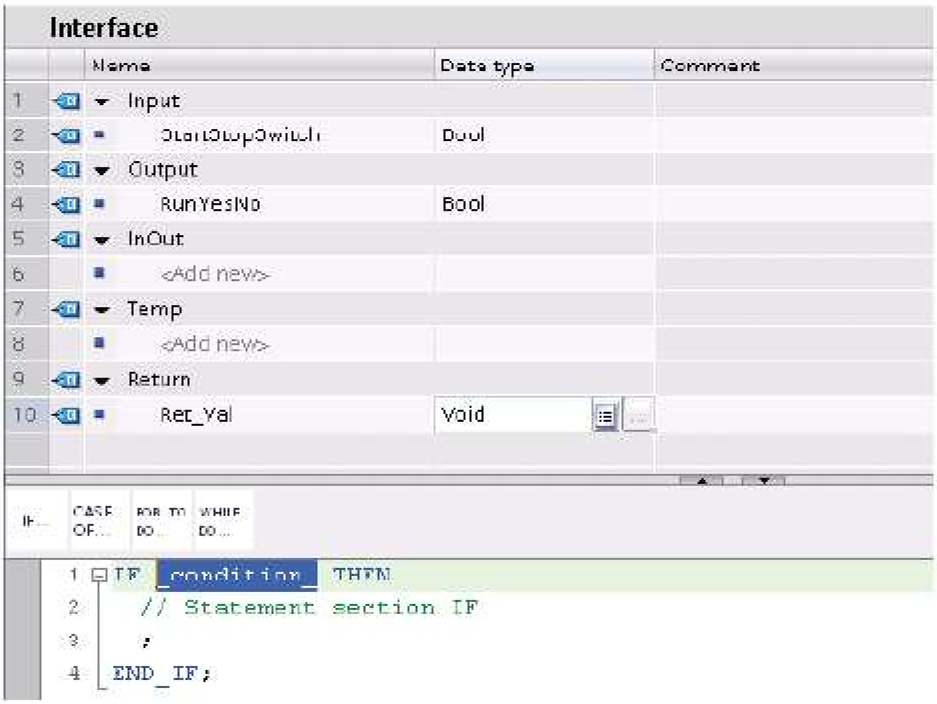
Structured Control Language (SCL) is a high-level, PASCAL-based programming language for the SIMATIC S7 CPUs. SCL supports the block structure of STEP 7.

SCL instructions use standard programming operators, such as for assignment (:=), mathematical functions (+ for addition, - for subtraction, * for multiplication, and / for division). SCL also uses standard PASCAL program control operations, such as IF-THEN-ELSE, CASE, REPEAT-UNTIL, GOTO and RETURN. We can use any PASCAL reference for syntactical elements of the SCL programming language. Many of the other instructions for SCL, such as timers and counters, match the LAD and FBD instructions.

We can designate any type of block (OB, FB, or FC) to use the SCL programming language at the time we create the block. STEP 7 provides an SCL program editor that includes the following elements:

- Interface section for defining the parameters of the code block
- Code section for the program code
- Instruction tree that contains the SCL instructions supported by the CPU

We enter the SCL code for our instruction directly in the code section. For more complex instructions, we simply drag the SCL instructions from the instruction tree and drop them into our program. We can also use any text editor to create an SCL program and then import that file into STEP 7.



Chapter 3

FEASIBILITY STUDY

Understanding feasibility

Feasibility study means the analysis of a problem to determine if it can be solved effectively. In other words it is the study of the possibilities of the proposed system. It studies the work ability, impact on the organization ability to meet user's need and efficient use of resources.

Three aspects in which the system has to be feasible are:-

Economical feasibility

The economical analysis checks for the high investment incurred on the system. It evaluates development & implementing charges for the proposed "Industrial Automation Project". The PLC used for the development is easily available at the market but they are very expensive & the software for programming comes with the PLC hence it results in high cost implementation.

Technical feasibility

This aspect concentrates on the concept of using computer meaning, "Mechanization" of human works. Thus the automated solution leads to the need for a technical feasibility study.

The focus on the platform used is the PLC based Industrial Automation.

The proposed system require an in depth technical knowledge on various electrical machines and PLC hardware as well as software. This is required to improve the technical efficiency of the design. Otherwise the system development is simple and easy to understand. The result obtained should be true in the real time conditions.

Behavioral feasibility

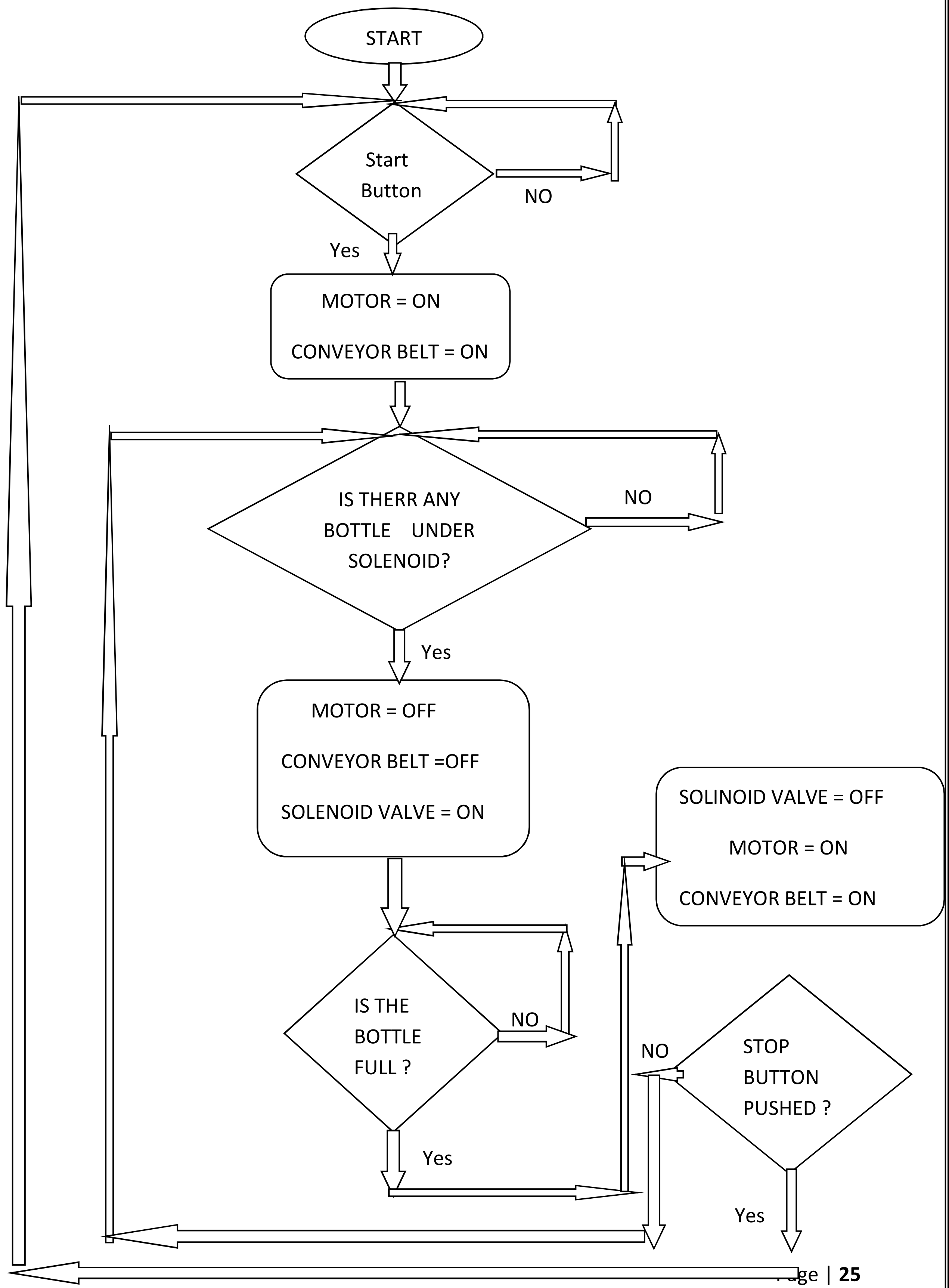
Behavioral feasibility deals with the runtime performance of the proposed system. It must score higher than the present in the behavioral study. The project should have end user when the system is designed while designing. The programmer should be aware of the condition's user's knowledge input, output, calculations etc.

Care should be taken to avoid non-working means & buttons.

Chapter 4

SOFTWARE IMPLEMENTATION

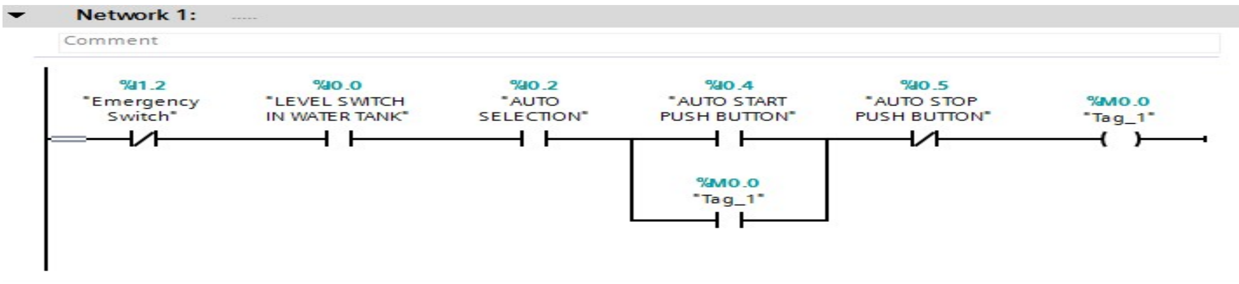
Flowchart

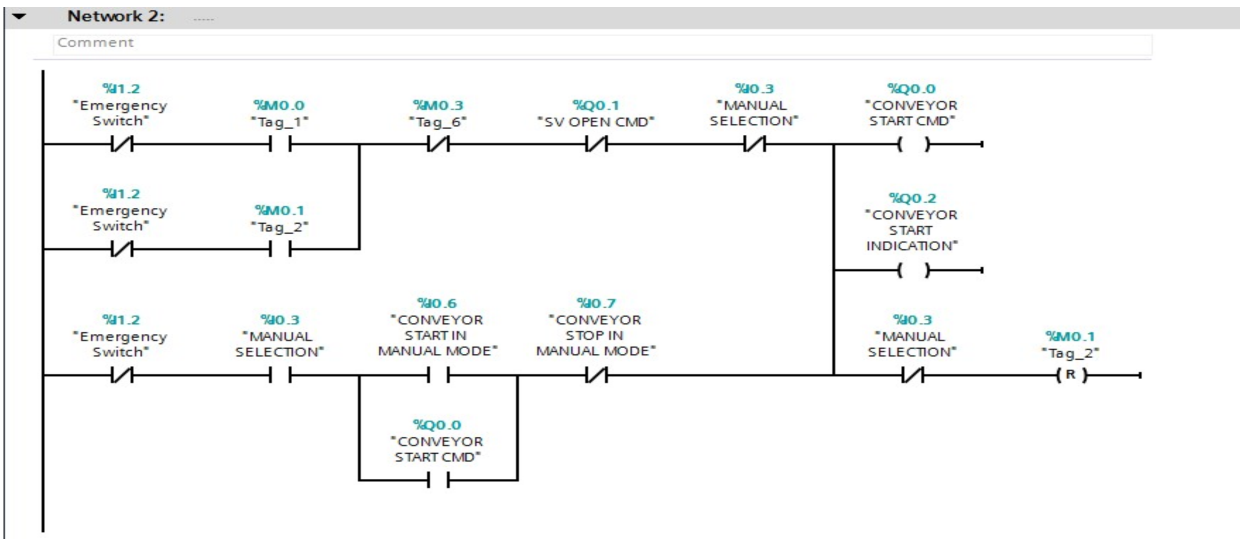

START
Start
Button
NO
Yes
MOTOR = ON
CONVEYOR BELT = ON
IS THERR ANY
BOTTLE UNDER
SOLENOID?
NO
Yes
MOTOR = OFF
CONVEYOR BELT =OFF
SOLENOID VALVE = ON
SOLINOID VALVE = OFF
MOTOR = ON
CONVEYOR BELT = ON
IS THE
BOTTLE
FULL ?
NO
Yes
NO
STOP
BUTTON
PUSHED ?
Yes

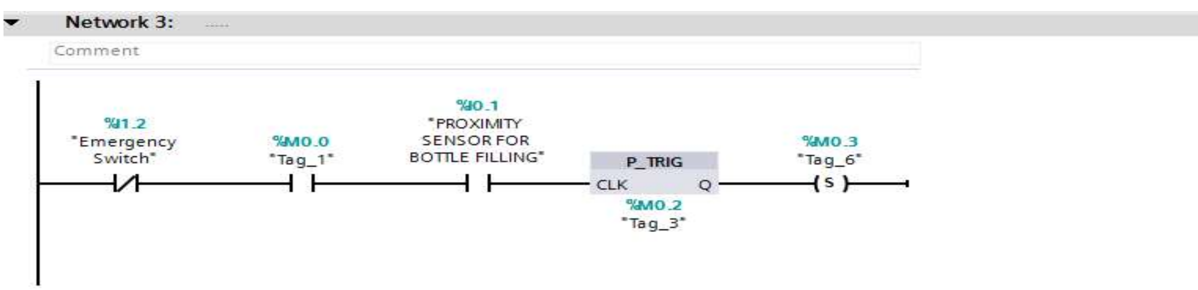
Algorithm

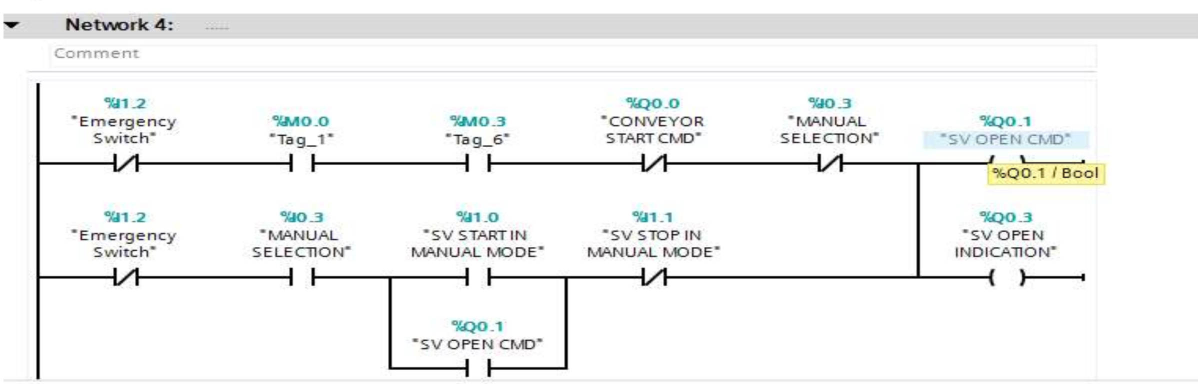
STEP 1	:	Press the "START" Push Button.
STEP 2	:	Then the "MOTOR" starts and the conveyor moves forward.
STEP 3	:	If the sensor detects the presence of bottle which is in position with the solenoid valve, then the conveyor will stop.
STEP 4	:	If the sensor does not detects any presence of the bottle, the conveyor keeps on moving.
STEP 5	:	After some delay the valve turn "ON" and the bottle will get filled till the timer gets off.
STEP 6	:	After the bottle is filler , a d3elay is provide and then after the delay the motor starts running.
STEP 7	:	And the process respects itself repeats itself from step 3

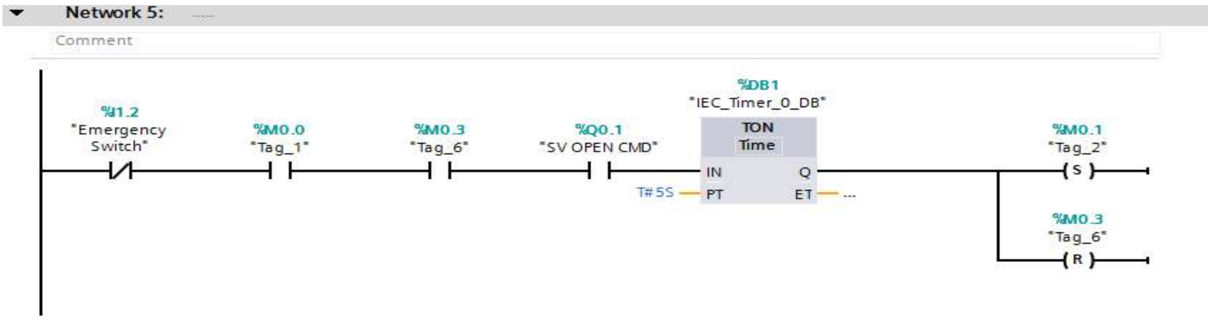
Ladder Logic (LAD)



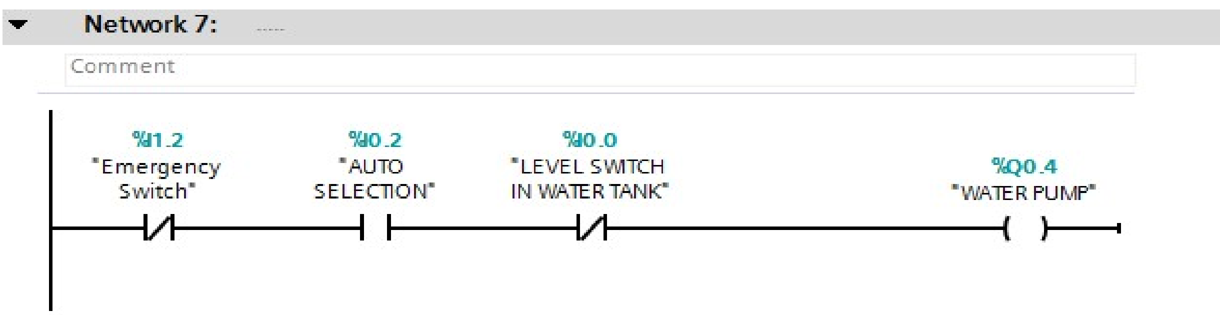







Network 5:
Comment
%DB1
"IEC_Timer_0_DB"
TON
Time
%I1.2
"Emergency Switch"
%M0.0
"Tag_1"
%M0.3
"Tag_6"
%Q0.1
"SV OPEN CMD"
IN
Q
T#5S
PT
ET
%M0.1
"Tag_2"
S
%M0.3
"Tag_6"
R


Network 6:
Comment
%I1.2
"Emergency Switch"
%I0.5
"AUTO STOP PUSH BUTTON"
%M0.3
"Tag_6"
R
%M0.1
"Tag_2"
R


Network 7:
Comment
%I1.2
"Emergency Switch"
%I0.2
"AUTO SELECTION"
%I0.0
"LEVEL SWITCH IN WATER TANK"
%Q0.4
"WATER PUMP"

Chapter 5

HARDWARE REQUIREMENT SPECIFICATION

Water Float Switch

[*Fig: Water float Sensor switch*]

The entire length of the equipment is 2m. It has an input voltage of 250V A.C with an input current of 15A. It has a square shape. It is designed to withstand a temperature of 80 degree Celsius. It has both NO & NC contacts and a cfls 2m cable length. It's working mechanism is very simple. When the tank is filled up with water then the float switch "normally opens" (NO) the circuit and when the tank is empty the float switch "normally closes" (NC) the circuit and energizes the hardware connected with it (mostly water pump is connected).

In this project, It is dipped into the tank filled with water so it floats over the water and on decrease in water level the float switch falls down completely towards the ground due to low level of water which then closes the circuit connection with the water float sensor. As a result, the pump that is interfaced with the entire system then gets completely energized and the water from the reservoir is pumped directly to the water tank and it is filled with water and gradually the water level starts rising and the float switch gradually starts to float over water. After the water is filled up to a certain level and the float switch starts floating over water, then the circuit breaks and the pump gets de energized simultaneously.

Photoelectric Sensor

[*Fig: Diffused photoelectric Sensor*]

Operating voltage is 6 – 36 VDC and its output current is 300 mA. It’s response frequency is 0.5 kHz. It’s output type is n – p – n 3 wire (Black, Blue and Brown). It is made of brass or plastic.

In this project, It is used to sense the position of the bottles. A round shaped sensor is used which can detect opaque, transparent or any other kinds of objects. In this case it is detecting different plastic bottles. The sensor used here is a diffused reflective type sensor. The range of sensing the objects are 100 mm.

DC Geared Motor

[*12V DC geared Motor*]

The DC motor used is a DC geared type motor whose shaft is interconnected with the shaft of the roller. This motor has an input voltage of 12v with an input current of 600mA to 14A. It's no load speed is 50 RPM. The reason for selecting this motor is to achieve high torque at a constant speed. It has a torque of 70kgcm which provides sufficient amount of torque for our load.The motor comes with a metal gearbox and centered shaft. Shaft is loaded with bearing for wear resistance. 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.

Water Pump

[*Fig: 12V DC submersible water pump*]

The net weight of the pump is 150 gm. Its dimensions of inlet and outlet are 15 mm O. D. and 5 mm O. D. Its working voltage is 12 V DC and working current is 0.1 – 0.5 A. Its lift is 130 cm at 12 V DC and flow rate is 300L/H.

In this project, the water pump is submerged in the reservoir from where the water will be pumped up to the main tank if it gets empty.

SMPS (Switched Mode Power Supply)

[*Fig: 24V SMPS*]

A **switched-mode power supply** is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. Like other power supplies, an SMPS transfers power from a DC or AC source (often mains power) to DC loads, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. Ideally, a switched-mode power supply dissipates no power. Voltage regulation is achieved by varying the ratio of on-to-off time. In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply. Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.

In this project, 24 V DC and 12 V DC SMPS had been used for the power supply of the different components used. For example, 12 V DC is used to supply power to water pump, DC geared motor and 24 V DC is used to supply power to the solenoid valve, water float switch and photoelectric sensor.

Solenoid Valve

[*Fig: 24V DC Solenoid valve*]

Qualified application voltages as following description:

AC 110V AC 380V ; AC 220V DC 24V ±10% ; AC 36V DC 12V

Induction coil insulation has qualities of high moistureproof, heat-resistance and succeeded water immersed handling function. Capacity of induction coil sequent electric current and maximum temperature up to 90ºC.

In this project, It is normally used to automatically control the flow of the water that shall fill the water bottle. When the water bottle placed over the conveyor belt, which is initially at motion, is sensed by the Photoelectric sensor, the conveyor stops running and at the same time the solenoid valve gets energized and water starts flowing through the valve for a certain time period (depending on the time we set on the timer in the PLC programming).As the time period is over then the solenoid valve gets de energized and water stops flowing through the valve. The conveyor belt starts moving again and the valve remains de energized until and unless the bottle is sensed by the sensor again.

Water Tank

The function of the water tank is to store the water which is to be filled in the water bottle via solenoid valve whenever required. The water tank contains a float switch which is normally used to determine the level of water and whenever the water level in the tank falls it is restored by the water stored into the reservoir with the help of the pump through a narrow pipe which is connected with the tank.

Switches

[*Fig: Toggle switches of the PLC*]

The type of switches we used in our project are the toggle switches. Two toggle switches are used to change the mode: Manual and Auto. Two toggle switches are used for “Auto Start” and “Auto Stop”. For manual mode, Two toggle switches are used for “Conveyor Start” and

“Conveyor Stop” and two toggle switches are used for “Solenoid valve Open” and “Solenoid valve close”.

And lastly, one toggle switch is dedicated for the “Emergency” Switch.

Relays

[*Fig: Two NO-NC contacts relay*]

[*Fig: Four NO-NC contact relay*]

Coil Rating:

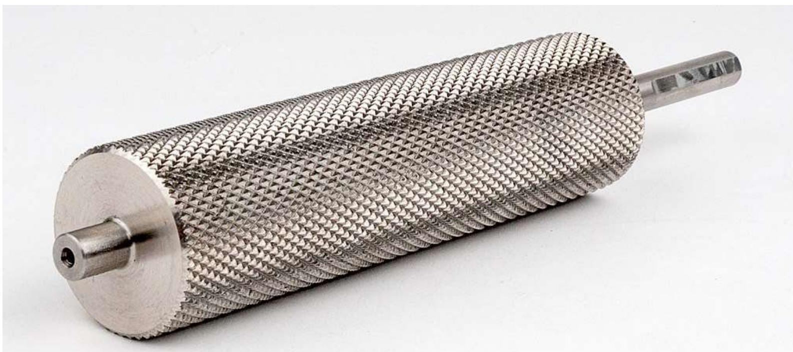
Rated voltage		Rated current		Coil resistance	Must operate voltage	Must release voltage	Max. voltage	Power consumption
		50 Hz	60 Hz					
AC	6 V	443 mA	385 mA	3.1 Ω	80% max. of rated voltage	30% min. of rated voltage at 60 Hz 25% min. of rated voltage at 50 Hz	110% of rated voltage	Approx. 2.3 VA at 60 Hz Approx. 2.7 VA at 50 Hz
	12 V	221 mA	193 mA	13.7 Ω				
	24 V	110 mA	96.3 mA	48.4 Ω				
	100 V	26.6 mA	23.1 mA	760 Ω				
	110 V	24.2 mA	21.0 mA	932 Ω				
	200 V	13.3 mA	11.6 mA	3,160 Ω				
	220 V	12.1 mA	10.5 mA	3,550 Ω				
	230 V	10.0 mA	11.5 mA	4,250 Ω				
	240 V	11.0 mA	9.6 mA	4,480 Ω				
DC	6 V	224 mA		26.7 Ω		15% min. of rated voltage		Approx. 1.4 W
	12 V	112 mA		107 Ω				
	24 V	55.8 mA		430 Ω				
	48 V	28.1 mA		1,710 Ω				
	100 V	13.5 mA		7,390 Ω				
	110 V	12.3 mA		8,960 Ω				

Load		Resistive load (cosϕ = 1)	Inductive load (cosϕ = 0.4)
Contact mechanism		Single	
Contact material		AgSnIn	
Rated load	**NO**	10 A, 250 VAC 10A, 30 VDC	7 A, 250 VAC
	NC	5 A, 250 VAC 5 A, 30 VDC	
Rated carry current		10 A	
Max. switching voltage		250 VAC, 250 VDC	
Max. switching current		10 A	
Max. switching power	**NO**	2,500 VA/300 W	
	NC	1,250 VA/150 W	

Contact resistance	100 mΩ max.
Operate time	AC: 20 ms max. DC: 30 ms max.
Release time	20 ms max.(40 ms max. for built-in Diode Relays)
Max. operating frequency	Mechanical: 18,000 operations/h Electrical: 1,800 operations/h (under rated load)
Insulation resistance	100 MΩ min. (at 500 VDC)
Dielectric strength	2,500 VAC 50/60 Hz for 1 min between coil and contacts 1,000 VAC 50/60 Hz for 1 min between contacts of same polarity and terminals of the same polarity 2,500 VAC 50/60 Hz for 1 min between current-carrying parts, non-current-carrying parts, and opposite polarity
Insulation method	Basic insulation
Impulse withstand voltage	4.5 kV between coil and contacts (with 1.2 × 50 µs impulse wave) 3.0 kV between contacts of different polarity (with 1.2 × 50 µs impulse wave)
Pollution degree	3
Rated insulation voltage	250 V
Vibration resistance	Destruction: 10 to 55 to 10 Hz, 0.75-mm single amplitude (1.5-mm double amplitude) Malfunction: 10 to 55 to 10 Hz, 0.5-mm single amplitude (1.0-mm double amplitude)
Shock resistance	Destruction: 1,000 m/s^2 (approx. 100 G) Malfunction: 100 m/s^2 (approx. 10 G)
Endurance	Mechanical: 5,000,000 operations min. (at 18,000 operations/h under rated load) Electrical: 100,000 operations h. (at 1,800 operations/h under rated load)
Failure rate P level (reference value)	10 mA at 1 VDC
Ambient temperature	Operating: –40 to 60°C (with no icing or condensation)
Ambient humidity	Operating: 5% to 85%
Weight	Approx. 90 g

Conveyor System

- Conveyor belt: A belt of length 2*(3ft.2inches) and width is 3.9 inches. The material used is PVC. Reason for choosing this belt is has low friction and oil resistant.
- Drive roller:

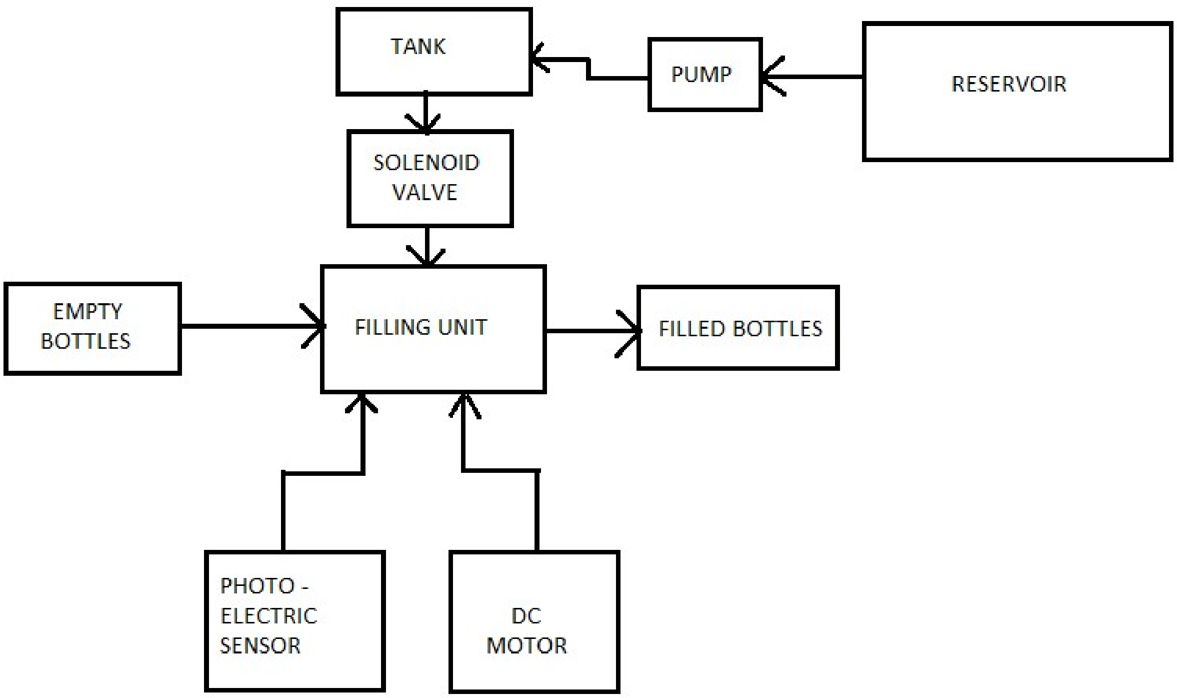


Total net weight of the rollers are 5 Kg. The diameter of the shaft of the roller is taken 1 inch whereas the diameter of the rollers are 3.5 inches. The length of the shaft whose one side is elongated for coupling with the motor is 3 inches. The length of the roller is taken 4 inches.

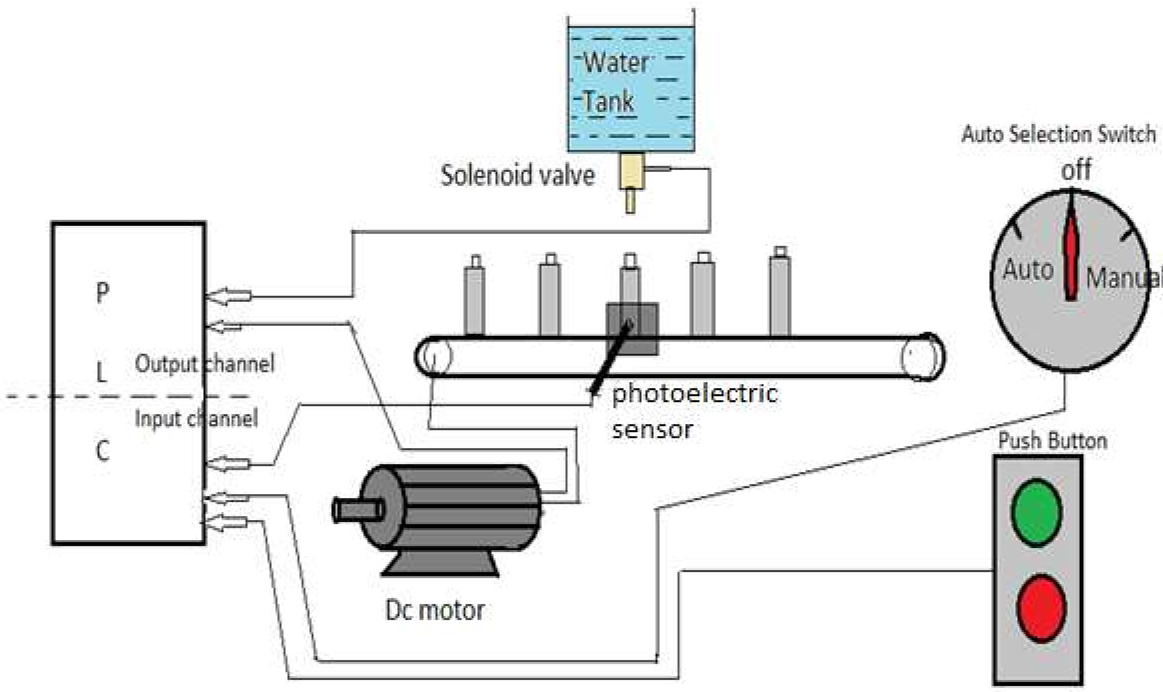
Chapter 6

SYSTEM DESIGN

Block Diagram



Schematic Diagram



Methodology

At first, the auto selection switch is selected so that the entire system operates automatically.

Then the "Auto start push button" (toggle switch is used here) is selected and the motor starts and 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 12v with an input current of 600mA to 14A.The reason for selecting this motor is to achieve a high starting torque at a constant speed. It has a torque of 70kgcm.The motor comes with a metal gearbox and centered shaft. Shaft is loaded with bearing for wear resistance. 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 simuntaneously on 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 the solenoid valve gets energized and the water starts filling in the bottle. After a given time period is over, then the solenoid valve gets de energized completely and water flowing through the valve is stopped and the conveyor belt starts moving. The valve remains de energized until the bottle is sensed by the sensor again.

Then as this process is continued the water level in the tank keeps on decreasing with course of time. A water float switch is used which is dipped into the tank filled with water. The entire length of the equipment is 2m. It has an input voltage of 250V A.C with an input current of 15A. It has a squarez shape. It is designed to withstand a temperature of 80degree Celsius. It has both NO & NC contacts and a cfls 2m cable length.

It is dipped into the tank filled with water so it floats over the water and on decrease in water level the float switch falls down completely towards the ground due to low level of water which then closes the circuit connection with the relay. As a result, the pump that is interfaced with the entire system then gets completely energized and the water from the reservoir is pumped directly to the water tank and it is filled with water and gradually the water level starts rising and the float switch gradually starts to float over water. After the water is filled up to a certain level and the float switch starts floating over water, then the circuit breaks and the pump gets de energized simultaneously.

As this process takes place the entire system is turned OFF automatically. It remains in the OFF mode till the tank is refilled with water up to a certain level where the float switch comes to a completely horizontal position. After the tank is completely filled with water the activity of the motor as well as the belt is resumed respectively.

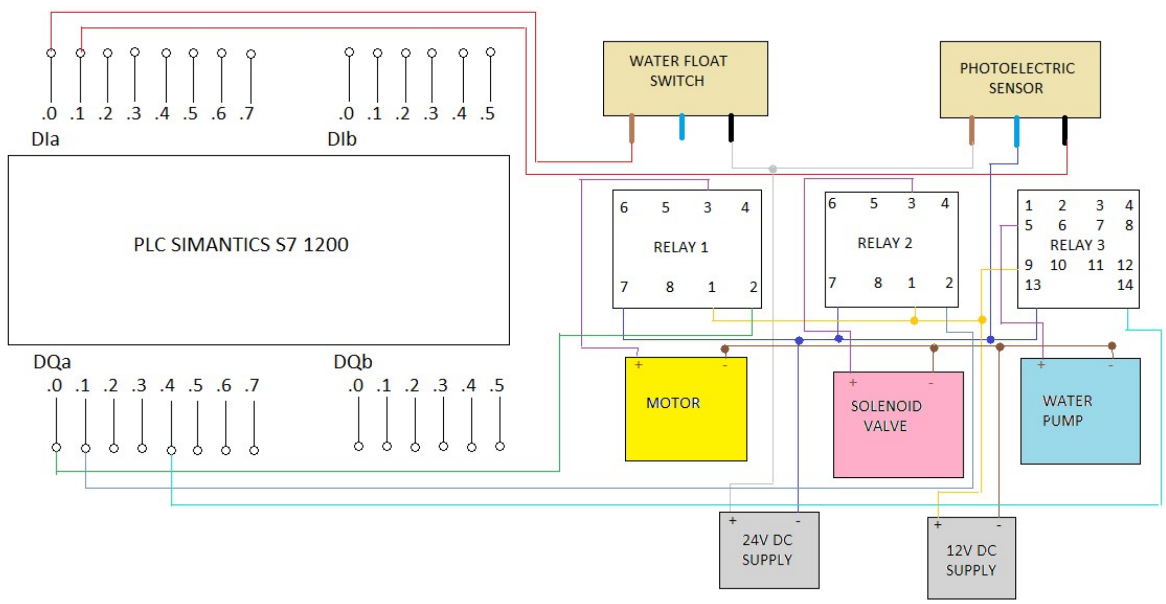
Then the system starts working as mentioned above.

EMERGENCY 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.

An Ethernet cable has been used to interface the computer with the PLC machine. A ladder logic (LAD) has been implemented using the SIEMENS software in order for the better understanding of the system, so that when the machine is online we can keep record of which part of the machine is online as per as requirement.

Connection Diagram



Our Prototype Design

Chapter 7

RESULT AND DISCUSSION

Software Test:

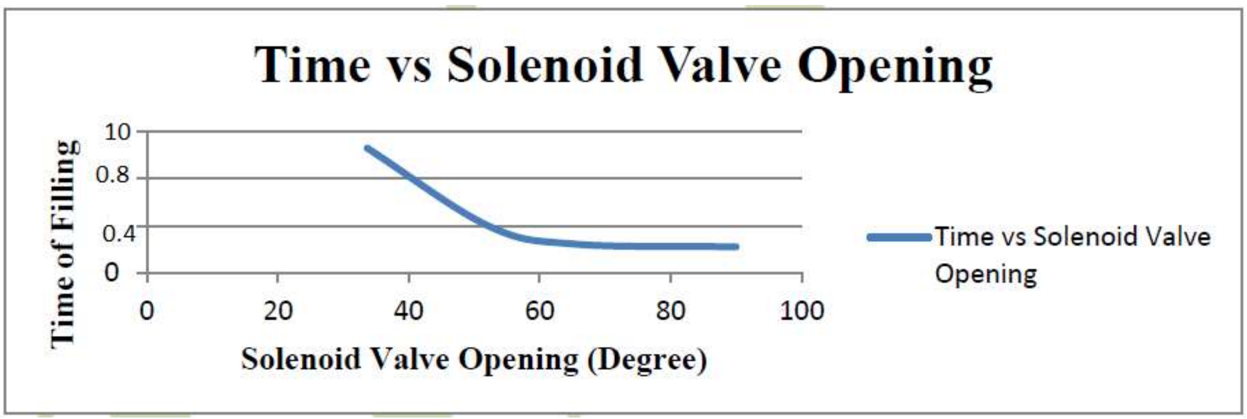
According to the working process of the system PLC programming, Ladder logic (LAD) simulation software TIA V12 is used. PLC programming in the form of Ladder diagram.

Pump Control:

Control of pump to start and stop to fill the liquid tank to run complete system.

Filling process:

As the empty bottle sent in to filling area the position sensor and proximity sensor confirmed the perfect position of bottle for filling. Solenoid valve open for particular time to fill required amount of liquid in bottle. After filling the bottle sent for next operation.



From the fig. above shows that as the solenoid valve opening increases the time required to fill 200 ml liquid in bottle decreases. As the valve angle increases the flow rate increases.
So for filling different amount of liquid in to the bottle the filling time should be constant but the flow rate will be different.

Chapter 8

CONCLUSION AND FURTHER SCOPE FOR DEVELOPMENT

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. We consider this project as a journey where we acquired knowledge and also gained some insights into the subject which we have shared in this report.

By the installation of jet nozzle and strong solenoid valve can reduce the time to fill bottles and can efficiently increase productivity. A guide way could be used in case of vibration.

A capping section could also be introduced. The nozzle positioning must be given more care and concenteration. The system could be redesigned for increased bottle size and productivity.

References

[1] **"PLC Based Automatic Bottle Filling and Capping System With User Defined Volume Selection "** T.Kalaiselvi , R.Praveena, Assistant professor, Easwari Engineering College, Chennai. **International Journal of Emerging Technology and Advanced Engineering (ISSN 2250-2459)2012.**

[2] **"Implementation and performance analysis of bottle filling plant using ladder language"** 1 SavitaM.tech,R.N College of Engineering & Management,Rohtak,India.2 Lokeshwar Assistant Prof, R.N College of Engineering & management,Rohtak,India. **International Journal of Science and Research (ISSN 2319-7064) 2012.**

[3] **"Industrial Application of PLCs In Bangaladesh"** 1 Ahmed Ullah AbuSaeed,2 Md.Al-Mamun,3 A.H.M.ZadidulKarim, Department of EEE, University of Pacific,Dhanmondi,Dhaka. **International Journal of Scientific & Engineering Research (ISSN 2229-5518)2012.**

[4] Arif Ozkan, Kerim Cetinkaya, '*Process Automation and Mixture Filling System Design', Journal of Engineering Research and Applied Science, Volume 1(2), December 2012, pp 98-106*

[5] D. Baladhandabany, S. Gowtham, T. Kowsikkumar, P. Gomathi, '*PLC Based Automatic Liquid Filling System', International Journal of Computer Science and Mobile Computing, Vol. 4, Issue 3, March 2015, pg.684-692*

[6**] "Programmable Logic Controller"** D.Ahuja1, N.Chaudhary 2 Department of Electrical and Electronics Engineering, YMCA University of Science and Technology, Faridabad, 121006, India. **International Journal of Information and Computer Science, 2012, 1: 115-120 - 104 - Published Online August 2012.**

[7] "The Principle of Programmable Logic Controller and its role in Automation", Avvaru Ravi Kiran#1, B.VenkatSundeep*2, Ch. SreeVardhan #3, Neel Mathews!4#Electronics and Communications, KL University, Guntur, Andhra Pradesh, India**,***Assistant Professor, Electronics and Communications, KL University, Guntur, Andhra Pradesh, India. General Manager Mobility Solutions, Mahindra Reva Electric Vehicles Pvt Ltd, Bangalore, India. **International Journal of Engineering Trends and Technology- Volume4 Issue3(ISSN: 2231-538) 2013.**

[8] "Application of PLC for Arranging Bottle in Beer Filling Production Line" ZHANG Tianxia, DONG Feng , YUAN Hao Tianjin Key Laboratory of Process Measurement and Control, School of Electrical Engineering and AutomationTianjin University, Tianjin 300072, China.

[9] Petruzella, Frank D. (2010) - 'Programmable logic Controllers' - Tata McGraw Hill Education, pp.6-12.