



# Multi Height Automatic Filling Station using Programmable Logic Controller

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**Abstract:** Programmable Logic Controllers (PLCs) are used in places where automatic control of the machineries is required. In the industries they are useful to run various tasks without human intervention. One of the advantage is it can work in the harsh environment of the factory floors and have greater immunity to noise and vibrations. However, to use a PLC to control the whole process, it needs to be programmed according to the requirement of the process to be controlled. In many industries such as in beverage industries, bottles are required to be filled-up with a pre-determined amount of liquid. Traditional methods of bottle filling involved placing bottles onto a conveyor and filling only one bottle at a time. This method is time consuming and expensive. The system sequence of operation is designed by ladder diagram and the plc programming software. Sensor plays its vital part as an input signal transmitter for the plc in the system. In this project photoelectric sensor used to detect the presence and the volume of the bottle that move along the conveyor belt. The input signal that has been sent from the sensor to the plc has being made as a reference to filled up the bottle. The entire system is more flexible and time saving.

**Keywords:** Programmable logic controller, Ladder diagram, Conveyor belt.

## 1.0 Introduction

The field of automation has had a notable impact in a wide range of industries beyond manufacturing. Automation is used in control system and information technologies to reduce the need for human work in production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provides human operates with machinery to assist them with the muscular requirements of work, automation will greatly decrease the need for human sensory and mental requirements as well [1].

Automation plays an increasingly important role in world economy. One of the applications of automation is in the beverage industries, where particular liquid has to be filled continuously. Totally Integrated Automation (TIA) that invented by Siemens Company puts this continuity into consistent practice. Totally Integrated Automation covers the

complete production line from the production process, filling and packaging to shipments of goods [2].

Nowadays PLC have widely used as a controller of industries. One of the application is liquid mixture control system. Previous work has reported by Rahman et. al [3], which is used two or more types of liquids with different pH values. pH sensor was used to detect pH value of the mixture, which this signal is fed to analogue input PLC terminal, that to be used for comparing pH value required as a product. It consists of six tanks, with one mixture motor and also five pumps are used to control the system via PLC [3].

Besides that, one of the application is a movable conveyor driven into and out of the trailer. This conveyor is used in distribution centers to load boxes onto trailers. It moves along a good track in the floor and can be driven in and out of the trailer. The conveyor is operated with one push button for forward and the other for reverse movement. The push button must be held down the entire time when the conveyor is

moving. Inputs of the system include the diffuse type photoelectric sensors on the front and back of the conveyor to prevent a collision, and inductive proximity switches at the bottom of the front and back to prevent over travel condition [4].

This project is also presented an application of automation wherein the development of liquid filling to bottles of different height. The operations are controlled using Programmable Logic Controller (PLC). One of the advantage using PLC are easily programmed and have an easily understood programming language. This project is aiming to control the liquid flow to fill a container. The liquid flow is monitored where it can fill an empty container with liquid automatically without human intervention. The fills of liquid are depending on the volume given by the user. Accurate flow control pump is used to accurately fill the liquid volume into the container for a specified time and filling time. In addition, this project also included a conveyor system which carries the container to the filling station and out of the filling station.



**Fig. 1 – Prototype of the System**

**2.0 Methodology**

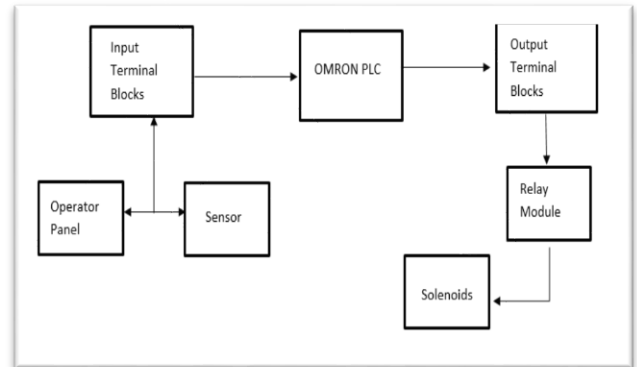
This part provides the explanation of methodology used for developing automatic filling bottles system. The purpose of this part is to provide the working principle, development and methods for the whole project to works. Table 1 shows the list of hardware used in this project. The overall prototype of the project is presented in Figure 1.

**Table 1 – List of Hardware**

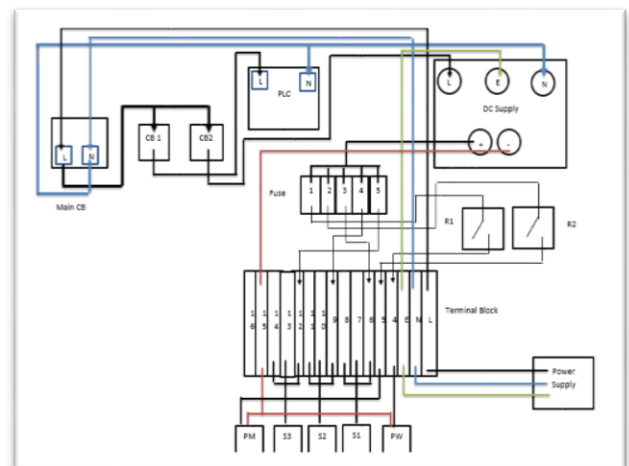
| Item   | Quantity |
|--|----------|
| PLC Module                                     | 1        |
| Conveyor Belt                                  | 1        |
| Reflective sensors                             | 3        |
| Power window motor                             | 1        |
| Dc pump motor                                  | 1        |
| Valve  | 1        |
| Tank   | 1        |
| Bottles with different size(250ml,500ml,600ml) | 1        |

The design of the system can be divided into two parts which are development of hardware and software.

In the development of software, it consists of block diagram, PLC wiring diagram and the flow chart of the whole process which are shown in Figure 2, 3 and 4 respectively.



**Fig. 2 - Block diagram of the system**



**Fig. 3 - Control Panel Wiring Diagram**

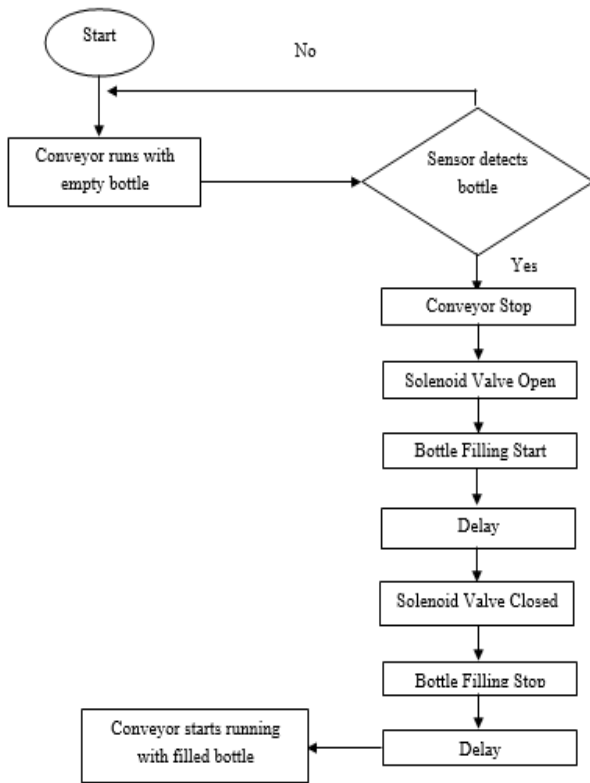


Fig. 4 - Flowchart for bottles sensing and filling system

In the development of hardware, it consists of two major parts which are bottle detection mechanism and development of conveyor belt. Figure 5 shows the schematic diagram of automatic filling bottles system of this project. The PLC will control all of the inputs and outputs operation. This machine has 3 type of power supply; 24VDC for PLC and relay, 12VDC power window motor and 12 VDC motor pump.

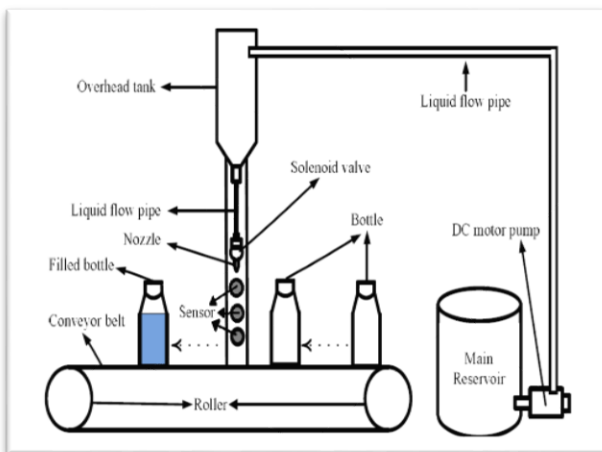


Fig. 5 - Schematic diagram of PLC controlled automatic bottle filling system

The task of bottle detection is performed using a photoelectric sensor. Photoelectric sensors are placed beside the conveyor belt at the filling station to detect the presence of

a bottle. The sensor has an infrared light transmitter and a receiver. When a bottle is brought in front of the sensor by the conveyor belt, the infrared light emitted from the emitter gets reflected from the bottle, which is then received by the receiver of the sensor. When no object is in front of the transmitter, the receiver does not receive any signal.

In order to design the conveyor belt, Solid Word 2017 are used to design the base of conveyor and roller. The length of conveyor is 1000 mm, while the height is 230 mm and the width is 100 mm. Design of conveyor are shown in Figure 6. The length of the belt is 2000mm and the diameter of roller is 50mm.

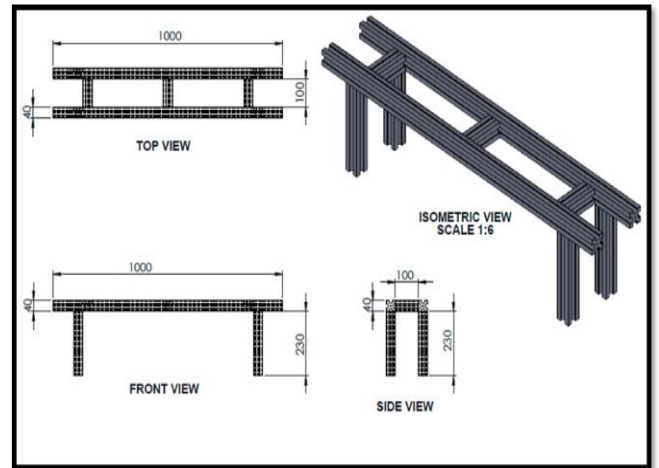


Fig. 6 - Conveyor belt design

### 3.0 Results and Discussions

After development of the system is completed, several kinds of data in this project are analyse to ensure the performance of the system. Figure 7 shows size of the bottles used. The time taken for the bottle to filled up are shown in Table 2.



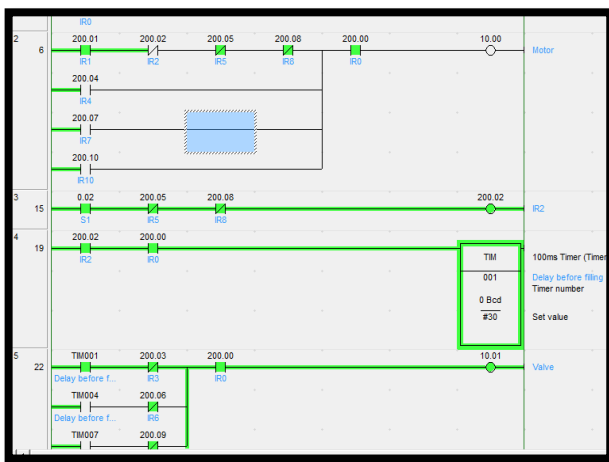
Fig. 7 - Size of the bottles, from left 250ml, 500ml, and 600ml

**Table 2 - Time taken to filled up the bottles**

| Size of the bottle | Time taken for filling up the bottle |
|--------------------|--------------------------------------|
| 250 ml             | 8 seconds                            |
| 500 ml             | 14 seconds                           |
| 600 ml             | 20 seconds                           |

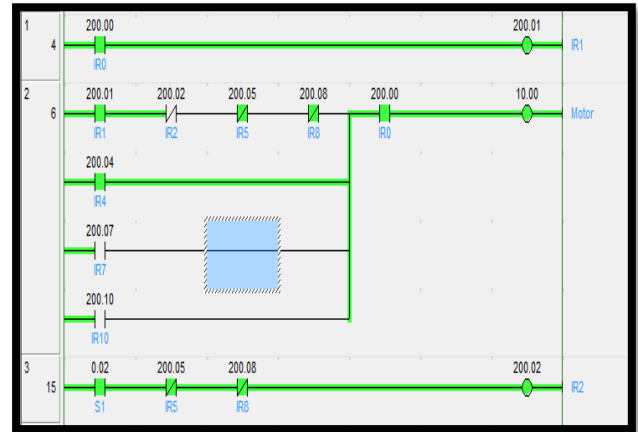
**3.1 Simulation of the Program**

The simulation program work for each of the bottle to be filled up is explained. The size of the bottle already fixed in 230 ml, 500 ml and 600 ml. The conveyor will detect one bottle at a time. The ladder diagram indicated how the program works. The following paragraph shows the program works when sensor 1 detects the 230ml bottle.



**Fig. 8 - Sensor 1 is detect the presence of the bottle**

At first, when push and reset button turn On, it will energize the internal relay of 200.00 and 200.01. After internal relay 200.01 is energized, it will turn on the power window and the conveyor belt will start running with empty bottle. As shown in Figure 8, when sensor 1 (S1) detects the presence of the bottle it will automatically turn off the power window motor. This will stop the conveyor belt. After 3 seconds delay it will open the valve for 8 seconds. This delay used to fill up the bottle with water. After finish the filling, it will delay for 3 second. This delay used to avoid the water from spill out from the bottle after finish the filling station. After 3 second, power window motor will turn on back and the conveyor belt will bring the bottle out from filling station. Figure 9 shows internal relay 200.04 energized and will turn on power window motor.



**Fig. 9 - Power window is turn on back after complete filling station**

**3.2 Sensitivity of sensor to filled up the bottle**

In this part, the sensitivity of sensor to fill up the bottle will be analysed. The analysis is divided into two which are sensitivity on the same size of the bottle and sensitivity on different size of the bottle. For the first part of sensitivity test, it records 3 same size of 250ml to determine the accuracy and the sensitivity of sensor to detect the bottle. Based on the result in Table 3, it shows that the sensor can detect all the presence of bottle.

**Table 3 - Sensitivity of sensor on same size of bottle**

| No | Size of bottle (ml) | Sensitivity of sensor to detect the presence of the bottles |        |        |
|----|---------------------|---|--------|--------|
|    |                     | Test 1  | Test 2 | Test 3 |
| 1  | 250                 | Detect  | Detect | Detect |
| 2  | 250                 | Detect  | Detect | Detect |
| 3  | 250                 | Detect  | Detect | Detect |

For the second part of sensitivity test, it will use the same method but different bottle size in order to ensure all sensor can function well. Based on result in Table 4, it shows that some of the bottle sensor cannot detect the presence of the bottle. This can be solved by setting or adjust the red line of reflective sensor so that the presence of the bottle can be detected.

**4.0 Conclusion**

In a conclusion, an automated liquid filling to bottles of different height using PLC is presented. A total control is made in a filling is achieved. The present system will provide a great deal of applications in the field of automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there is a need for increased production. The programming to this system developed is flexible, quickly and easily. This will increase the total production output; this

increase in production can yield significant financial benefits and savings. This concept can be used in beverage and food industries, milk industries, medicine industries, mineral water, chemical product industries and manufacturing industries.

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