Bottle Filling Simulation System Using Programmable Logic Control

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Abstract. The use of manual systems in the process of bottle filling is still often used, when using the manual process, then make the production is not maximal, and the volume is often different. The process is also done of course repeatedly, of course, takes a long time. The proposed tools are used to make bottle filling automatically to make the work faster and more efficient. In the process of filling the bottle on this prototype, the user can choose the option to fill the bottle. This prototype is PLC-based, PLC is considered capable to replace hundreds of relays, time etc., then PLC is considered mostly for the automation process. In this research, the method used is direct experimental method, which is done by research planning, control design, circuit, tool design, up to test phase, when tested in experiment 1 for 7 times experiment, with 1 second filling time, bottles have not been consistent, if averaged the result is 39,571 ml. then in the second experiment for 7 experiments, with a 2 second filling time, the water that filled the bottle has not been consistent, if the average yield is 108 ml.

1. Introduction
Technological developments are increasingly advanced. Industry changes its system from manual to automatic. Currently charging bottle in the industry are in desperate need of automation so that when charging can be faster and more efficient. Automation is the use of control systems that can reduce human needs in terms of work [1]. Automating tasks in the industry will increase productivity and reduce the possibility of errors in the system [2]. Some automatic bottle fill prototypes have many features already in use, such as a number of volumes and user-defined volume selection [3]. To make a process or a good system can use a variety of applied bias automation techniques [4]. Current automation techniques are used to improve systems, most industries use PLCs for industrial automation [4]. PLC is the easiest solution for the process automation system because of its less complexity than the relay logic system [4]. PLC is widely used in the automation industry because its functionality is able to replace hundreds of relays, time etc. [2]. With the automatic system all the process runs well, we just monitor whether the poses run in accordance with the desired. The prototype made is very suitable for home industry, and easy when in operation. The purpose of making this prototype is:
   1. To help manual process be automatic
   2. Help overcome the problem of the household industry to produce more products.
   3. Helping the home industry to be able to compete with large industry.
2. Method

2.1. Research Planning

Based on some problems in the conventional industry regarding the bottle filling still using the manual system, it takes a tool that can simplify the work process in the bottle filling. In addition, there are several things to note namely, the estimation of needs, price estimates, then the application of the tool.

2.2. Program Design

At this stage, the software used to create the program on this prototype is Cx - Programmer, with programming languages using ladder diagrams.

![Flowchart Process Control](image)

**Figure 1.** Flowchart Process Control

The process is done the selection of electrical components, the function of each component affects the working system of the control circuit used to operate this prototype.

- Electrical component working system
- The working capability of electrical components

  From the figure 1 shows that the input section that is using push button and proximity sensor and for the processing is done by PLC, then at the output of the indicator light as indicator standby state, where this situation PLC get voltage source, then there is indicator light ready, this condition indicate that motor, and pump.

2.3. Tool Design

At this stage the process is to determine the components of equipment needed to form this prototype, at this stage, there are some things in a note such as:

- The working function of each tool
- Tool Characteristics

2.3.1. A subsubsection. In designing this prototype used a conveyor as shown in figure 2 is able to move the bottle to the place of charging, this conveyor is driven by motor 12 VDC, while the direction of this conveyor motion is horizontal. In order to move this dc motor in supply with a voltage of 12 VDC connected to the relay is set by the PLC to ON / OFF it.

![Conveyor](image)

**Figure 2.** Conveyor
2.3.2. **Push Button.** The push button is functioning as a circuit breaker or electric current from the power source, in this prototype, there is 3 push button function that is the first function as a stop button, where this button serves to stop the system being worked. Then the "A" and "B" buttons, these two buttons are the work command buttons for the system to run, only that distinguishes that when the bottle filling.

2.3.3. **PLC (Programmable Logic Control).** The PLC used in this study is the Omron CP1L - L20DR - A PLC, with 12 inputs and 8 outputs, where the voltage source can be 220 VAC and 24VDC. Omron type PLC is able to communicate with the program CX-Programmer.

2.3.4. **Photoelectric Sensor.** Photoelectric sensors as shown in figure 3 work based on the presence or absence of objects by using their capacitance change values. Sensors are used is able to detect objects both types of metals and non-metallic type, the working voltage of this sensor ranges from 10 VDC - 30 VDC.

![Figure 3. Photoelectric Sensor](image)

2.3.5. **DC Motor.** DC motor as shown in figure 4 is an electrical machine that requires electrical energy to work, where electrical energy is converted into mechanical energy. This mechanical energy can be used to rotate the fan, and also the conveyor.

![Figure 4. DC Motor](image)

2.3.6. **Brushless DC Pump.** This type of pump must be installed in the exposed state of water in the suction. This motor works at a voltage of 12 VDC, then the positive cable is marked in red and the negative cable is marked in blue as shown in figure 5.

![Figure 5. Brushless DC Pump](image)
2.3.7. **MCB (Mini Circuit Breaker).** MCB is used as a security when there is a short from the outside that can endanger PLC. MCB working principle that if getting excessive heat then bimetal in MCB will expand and break MCB. On this prototype used MCB 2 A.

2.3.8. **Relay.** The relay used is the type of Omron type MY2N - J, where the working voltage of the coil is used 24 VDC, which is capable of passing current 5A at 220 VAC relay working voltage, and 5A at a working voltage of 28 VDC.

2.3.9. **Functional Test.** This process is an early stage test process, where testing is done from every design that has been created and synchronizes with controls and tools that have been made. This is necessary to reduce the occurrence of errors, from the side of the program, system control and tools.

2.3.10. **Testing Tool.** This whole test process is a process whereby the incorporation of a program that has been designed in the application cx - programmer, then connected to the CP1L PLC that has been connected with the circuit controls and tools that have been made, below is a flow diagram of the work process of the tool made.

![Flowchart Process](image)

Figure 6. Flowchart Process

In Figure 6 it is explained that the bottle filling process takes place, where when starting the filling process, the bottle already placed on the conveyor will go to the charging area, when the photoelectric sensor detects an object then the conveyor will stop, then the pump will fill the bottle during the period which is set, when it is finished filling, the conveyor will re-run, this system uses a system loop (continuous).

This tool is designed to be able to perform two types of charging process, in process 1 working time bottle filling is set for 1 second, then for process 2 working time bottle filling is set for 2 seconds. As for the steps-steps to perform testing tools as follows:

**Step 1:** Connect the required supply voltage already installed either for PLC, or other equipment.
Step 2: Connect the input and output parts with PLC, other hardware must also be connected with PLC such as dc motor, sensors and brushless DC Pump.

Step 3: Select the option to adjust how much water will fill into the bottle. Make a selection by pressing a button that has been labelled.

Step 4: After we press the button then the conveyor will run, where on the top of the conveyor there is an empty bottle.

Step 5: When the bottle covers the proximity sensor the dc motor will stop. Then brushless DC Pump will work and fill the water for the time already set in the program.

Step 6: When the brushless working time of DC Pump is complete, Brushless DC Pump will stop then the dc motor will move back and rotate the conveyor belt.

Step 7: To stop the tool press the stop button.

3. Result and Discussion

From the design of the automatic bottle filling device, the tool works well, the system works in accordance with the already designed. This tool has 2 processes where the first process of the bottle runs over the conveyor, then after about the dead conveyor sensor and brushless DC pump will work and fill the bottle that is right under the charger.

Figure 7. Bottle Filling In Process 2

Figure 8. Bottle Filling In Process 1

Figure 7 explains that a bottle filling process is taking place, in this process the time spent to fill the bottle for 1 second. Figure 8 shows the test in process 2 where the time used to fill the bottle for 2 seconds.

Figure 9. Control Circuit

Figure 10. Look At the Bottle Filling Tool
Figure 9 is a control set made in accordance with the plan, while figure 10 is a top view of a tool already made. After the finished tool is made, it is done several times experiments on 2 charging process system. The following table results from experiment 1:

| No Experience | Volume |
|---------------|--------|
| 1             | 40 ml  |
| 2             | 40 ml  |
| 3             | 39 ml  |
| 4             | 40 ml  |
| 5             | 39 ml  |
| 6             | 39 ml  |
| 7             | 40 ml  |

In table 1 is done 7 times, with charging time for 1 second. Seen from the existing data that there is volume inequality during charging, for experiments 1 and 2 volumes obtained that is 40 ml, then in 3 volumes experiments obtained by 39 ml, then in experiment 4 volumes obtained for 40 ml, then on experiments 5 and 6 volumes obtained 39 ml, and in the 7th experiment again get a volume of 40 ml. From the data obtained also that the volume produced during the 7 experiments ranged from 39 ml - 40 ml. If averaged - average during the experimental process then the average is 39.571 ml.

In Figure 11 showed that in glass experiment 1 and 2 were obtained the same data that were as much as 40 ml. Then, in glass experiment 3 underwent a decreasing amount of volume that was only about 39 ml. Then on glass experiment 4 had increased again that was equal to 40 ml, then at experiment of glass number 5 and 6 again got the decreasing result about 39 ml, and for the last data taken the volume of water obtained in glass 7 that is equal to 40 ml.

Then at the time of the experiment, there were several bottles not detected by the sensor just because the bottle was far out of the distance range of the sensor. Furthermore, when a bottle had a larger size, many times the sensor read out the object 2 times. So that for 1 bottle, can charge 2 times. In addition the photoelectric sensor, the test also uses a capacitive probe type, when the experiment is often filling failure due to the distance of the bottle with the sensor far enough, the ability of the sensor to detect the object only about 4mm, therefore the sensor selection is needed to be able to fill the bottle with maximum.

4. **Conclusion**

Based on the experiments conducted and from the data obtained, in experiment 1 where this experiment was conducted at the time of filling the bottle for 1 second, that the data obtained was inconsistent, where the data ranged in the number 39 ml - 40 ml. then in go back to experiment 2 where the setting
time for the process of bottle filling for 2 seconds is also obtained result so variation, that is 105 ml range. 109 ml, and 110 ml.

In the experimental execution several times there is an error where the sensor does not detect the coming of the bottle, so there is a bottle that is not filled with water, this proves that the photoelectric sensor used during the manufacture of this tool is still experiencing miss in its use. For that better sensor selection is needed, in order to reduce the error rate and every bottle that passes can be filled.

The results of the reading in this experiment can be in some inequality, this is because when testing the bottle that has been filled with water, the reading using measuring glass as a measure, thus causing inaccuracies in the reading. Therefore, the use of digital measuring instruments is necessary to reduce the error rate when reading the results of each time the experiment. Overall the tool works well, the system control works well, and for the components used

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