Automatic Liquid Filling to Bottles of Different Height Using Programmable Logic Controller

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Abstract: Filling is a task carried out by a machine that packages liquid products such as cold drinks or water. 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 present work briefs about a machine that used to prepare automatic filling of liquid in to the bottle of different height is fully controlled by the PLC which acts as the heart of the system. The system sequence of operation is designed by ladder diagram and the PLC programming software. Sensor usually plays its vital part as an input signal transmitter for the PLC in the system. During this work sensor has been used to detect the bottle position that move along the conveyor belt at the low speed while the machine operates. The input signal that has been sent from the sensor to the PLC has being made as a reference. Signal in order to determine the output signal that exactly a same with the PLC programming language based on the user requirement. The entire system is more flexible and time saving.

Keywords: PLC, Sensors, Conveyor Belt

1. Introduction

Automation plays an increasingly important role in the world economy. One of the important applications of continuously. For these kinds of applications. The trend is moving away from the individual device or machine toward continuous automation solutions. Totally automation is in the soft drink and other beverage industries, where a particular liquid has to be filled Integrated Automation puts this continuity into consistent practice. Totally Integrated Automation covers the complete production line, from receipt of goods, the production process, filling and packaging, to shipment of goods. Automation is used for all control systems and the technology in programmable logic controller (PLC) is used to reduce the human work and helps in increasing the production. PLC plays an important role in the world of automation industry. It acts a major function in the automation field which tends to reduce the complexity, increases safety and cost efficient. In this system we have applied a PLC based control system in an automatic bottle filling station. Our work is also an application of automation where we have developed a liquid filling to bottles of different height. The various processes are controlled using a PLC (Programmable Logic Controller).

2. Objectives

There are four objectives to be achieved in this work. Below are the following objectives:

1. To design appropriate model for automatic mixing & filling bottle.
2. To design program using PLC for automation mixing &filling bottle.
3. To interface PLC module with the inputs and outputs component.
4. To design appropriate system for automatic mixing and filling bottle.

3. Methodology

Bottles are kept in position in a carton over a conveyor belt; they are sensed to detect their presence. Capacitive sensors are used for sensing the bottles. Depending on the output of the sensor the corresponding valve switch on and filling operation takes place. If the particular bottle is not present then the valve in that position is switched off, thereby avoiding wastage of the liquid. The filling process is done based on timing. Depending on the preset value of the timer the valve is switched on for that particular period of time and the filling is done.

4. Process Description

This chapter gives the brief description about the hardware components in this work and complete idea of the components used in the system.

A. Block Diagram

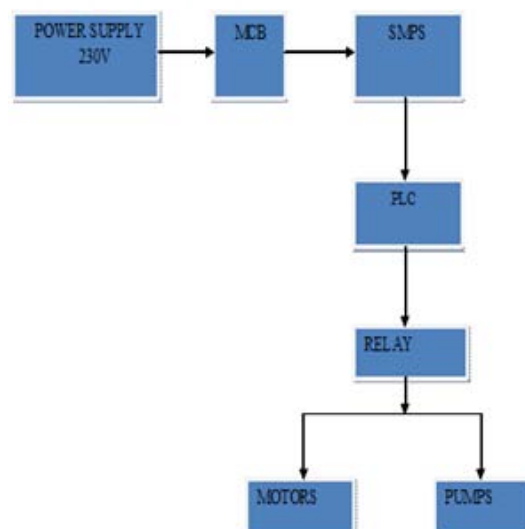The basic block diagram (as shown in FIG. I) of the process and its explanation is given as follows;

Figure 4.I: Block Diagram Of the Process

B. Input Model

The input module includes the capacitive sensors and start/stop push button. There are two capacitive sensors whose output is given as an input to the PLC. Two capacitive sensors are used to detect the bottles position. These sensors kept near the input side, where the bottles are fed into the conveyor, are called detection sensors. And one push button to start the cycle and push button to stop the cycle.

C. PLC

PLC is a solid state device. They are well-adapted to a range of automation tasks .All control operations are done using the PLC. The entire bottling process is automated by feeding the necessary conditions into the PLC using ladder logic. Ladder logic is one of the methods of programming a PLC. Thus, depending on the logic developed the filling of bottles is done. PLC consists of an I/O unit, central processing unit, and a memory unit. The input/output unit of the PLC acts as an interface to the real world. Inputs from real work are given to the input unit which is manipulated based on the programming, and the results are given back to the real world through the output unit of the PLC. All logic and control operations, data transfer and data manipulation operations are done by the central unit. The results and statuses are stored in the memory of the PLC. PLC's are used for a wide range of applications especially in the field of control and automation.

D. Output Relay Drive Unit

The operating voltage of the output devices is different when compared to that of the PLC. The output of the PLC is 24V DC whereas output devices such as pump require 230V AC for their operation. Hence the output signals from the PLC are given through a relay drive unit which drives the output devices by supplying the voltage required for their operation.

E. Output Module

The various output devices used in the bottling process are DC motors, pumps. These are connected to the output module. One DC motor is used to run the conveyor in forward direction and another one is for mixing the two solutions. Three pumps are used for pumping of liquid. These are the various output devices used in the bottling process.

Figure 4.2: Photographs of proposed work

5. Series of Operation

A. Mixing Operation

First press the start button, the valve-1 will open and liquid starts to flow into the tank-3(white) from the tank-1(green) for 6sec.After 6sec the valve-2 will open and liquid starts to flow from tank-2(red) to the tank-3(white) for 6sec.After 6sec the mixing of two liquids takes place with the help of mixing motor for 5sec.After mixing is completed the conveyor belt starts to move in forward direction.

B. Bottle Detection Using Sensors

Bottles are kept in position on the conveyor belt at the input side. Sensors are used to detect the presence of bottles. Depending on the height of the bottle the respective sensor sense the presence and height of the bottle and the filling operation takes place. A time delay is given in order to set the status of the bottles. If bottle 1 is present the corresponding status bit in PLC is set to 1 else it is set to 0. The outputs of these sensors are given to the PLC and depending on this output the filling process for the bottles takes place. When the bottles are present in the input side then the sensor gives the corresponding output to the PLC

which in turn switches ON the pump for filling operation to take place. If a particular bottle is not present the corresponding pump remains OFF.

C. Filling Operation

Once the conveyor motor switches ON and it starts moving in the forward direction. The bottles then reach the desired position for filling and the conveyor stops. The pump in tank-3 (white) switches ON and filling operation takes place.

Advantages

Very fast, Easy to change logic i.e. flexibility Reliable due to absence of moving parts, Low power consumption, Easy maintenance due to modular assembly, Facilities in fault finding and diagnostic, Capable of handling of very complicated logic operations, Good documentation facilities, Easy to couple with the process computers, Analog signal handling and close loop control programming, Counter, timer and comparator can be programmed.

Applications

Mainly used in chemical laboratories where the chemicals need to be mixed in right proportions. Hence it plays a vital role. It also plays a great role in manufacture of medicine where solutions need to be mixed at right ratios.PLC is preferred because they are more accurate and saves time. Other places where our project has got its importance are Thermal process, Milk plant, Chemical reaction, Gas process, Continuous Bottle-filling, system, Batching mixing system, Speed control of dc motor ,3-stage air conditioning system, Control of planar machine Automatic frequency control of induction heating, Detergent manufacturing companies

6. Conclusion

The automatic liquid filling to bottles of different height using DVP14SS2 programmable logic controller (PLC). The mixing & filling process is controlled by PLC. Programming the system in PLC is done by using ladder diagram. Programmable logic controller is the heart of this work. Depending upon the output of the PLC the corresponding valve or motor will energized and mixing & filling operation takes place. If the particular bottle is not present then the valve in that position is closed thereby avoiding wastage of the liquid. The present system will provides 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's 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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