PLC Based Liquid Mixing and Filling System

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Abstract— The aim of this paper is to describe the method for mixing and filling more than one bottle at a time. This method includes of placing bottles onto a conveyor belt and filling bottles one at a time. In a conveyor system, the stepper motor is used for its efficiency. It includes the user defined volume selection at the desired level. Our system includes less number of sensors, so it is less expensive. Mixing and filling is controlled by PLC (Programmable Logic Controller) using ladder logic method. During filling of bottle the PLC system obtained feedback from the sensor to control the valve through with conveyer. So, with help of PLC programming whole system can be controlled. Sensor stands as the most important part for bottle filling. Normally in all automation industries, PLC is considered as the heart of any system. The whole processing system can be flexible, efficient. Every result reveals that the operation of PLC is very inspiring for liquid mixing and filling system.

Keywords: PLC, Metallic Sensor, Solenoid Valves, DC Motor

I. INTRODUCTION

This system is designed and developed for "automatic mixing and filling of the liquid into bottles using PLC. PLC was invented to replace the sequential relay machine control. PLC works at its input and depending upon their state turning on off its output. Automation is control system an equivalent such machinery processes in factory with minimum human interface. PLC is a important part in automation. Today the industrial computer is available to carry out plc programming in some places takes place of plc. The computer must be able to run plc software that allows it to operate PLC. PLC software gives user to program and document of plc program using ladder logic or another programming language. PLC provides many other benefits including increases reliability and flexibility, lesser cost, capability of communication, quick response type is easier. Generally there are five classes of PLC micro small, medium and large. The criteria used in categorizing plc include functionality no of inputs and outputs cost and physical size.

A. Methodology-1

This paper consist of three containers first container contains chemical A and second container consist of chemical B with respect to solenoid valve connected only. Middle container is a mixing and filling container .Mixing container connected with solenoid valve and level sensor to sense the chemical level in it .When the press the start pushbutton fill container 1 and container 2 manually container 3starts filling when low level is detected valve 1 and valve 2 will be open .Then container 3 will fill high level sensor detect the liquid level .Then both valve V1 and V2 will be close .After the water level sensor sense the high level container 3 mixing motor turns in for few second. The mixing motor turns off conveyor belts starts moving and bottles move on the conveyor belt. Bottle is sensed by proximity sensor solenoid valve will be open and bottle will be fill for the set time duration. The bottle is filled V3 will be closed and motor start again after some delay .The process is continues until the stop button is press.

B. Methodology-2

In this method, we are fixing the web camera at an optimum location. Where the camera captures the images of logo on the bottle, then logo of the bottle is compared with the reference logo by cross correlation method to classify image. If it is matched, then conveyor starts and by interfacing the MATLAB with arduino, where arduino gets the signal and it sends the signal to the PLC program. After that, PLC allocates time for positioning the bottle to the corresponding valve position. If bottle is positioned at particular valve, then the valve opens for given specified time based on user defined volume selection, to fill the liquid in the bottle.

II. SYSTEM ARCHITECTURE

The system architecture shown in figure 1 is the automated bottle filling system. This System consists of three reservoirs; Reservoir Tank-1and; Reservoir Tank-2 and; Reservoir Tank-3 each containing the constituent liquids components of the mixture required to be produce; which are to be mixed in pre-determined proportion. Reservoir Tank -1 and tank 2 is connected to a Pump and Pump for transferring the liquids to the Overhead Mixing Tank 3 through the solenoid valve. The Overhead Mixing Tank contains programming of PLC the liquid level is fixed. This additional safety has been incorporated to ensure that the automated system works safely even in the case of failure of the high level sensor. The other end of the conveyor belt is connected to dc motor.

Fig. 1: System Architecture

A. Hardware Description

PLC is used for performing input and output operation and ladder program is used for controlling input and outputs. The modeled components include pumps, sensors, solenoid valve, the electric motor, the indicators and the liquids. SMPS is

used for giving input supply to the PLC.SMPS used is a compact type PLC with ratings 24V. Positioning of the bottles various proximity sensors are used and for conveyor system DC motor is used which results in high torque. Input to the PLC is push button and solenoid valve is used for filling up the bottles. [1]

B. Software Description

In software description there are four important languages are used for the PLC programming listed below

1) Functional block diagram (FBD)
2) Sequential flow chart (SFC).
3) Ladder diagram.
4) Structure text (ST)

Ladder diagram is most widely used out of these four languages as compared to the other languages and programming languages method based on mimic relay logic.[1]

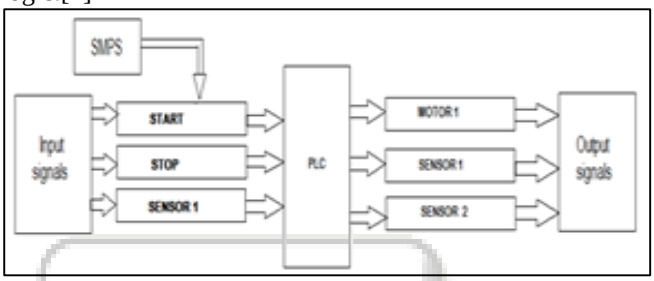

Fig. 2: Functional block diagram (FBD)

III. PLC (PROGRAMMABLE LOGIC CONTROLLER)

A programmable logic controller (PLC) or programmable controller is an industrial digital computer which has been ruggedized and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and ease of programming and process fault diagnosis.

Fig. 3: PLC

A. Working of PLC

It is a continuous scanning process of a program. There are three steps in this:

1) Step 1: Read input status .It checks whether the input to each if it is on or off. Sensor is connected to the first input, then to second input, last to third input and so on. In next step data is recorded into its memory which to be used
2) Step 2: To execute program which depends on reading executes. Proceedings of the 2nd International Conference on Inventive Communication and Computational Technologies On single instruction PLC executes program. The program is executed when the first input is on then it should turn on the first output which is based on the state of the first input. As it already knows which inputs are on/off from the previous step it will be able to decide the first output should be turned on .For the next step it will store the execution results.
3) Step 3 Update Output Status which return to values of the output. PLC gives the status of the outputs. It states the outputs based on which inputs were on during the first step thereafter executes the program. The common basic elements of a PLC include input modules a central processing unit (CPU), output modules or points, and a programming device. In next step it would 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. In last step the PLC goes back to step first and the steps are repeated continuously. The type of input modules used by a PLC depends upon the types of input devices used. [3]

B. Solenoid Valve

A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thereby operate a mechanism which regulates the opening of fluid flow in a valve.

Fig. 4: Solenoid valve

C. Working of Solenoid Valve

The magnetic field exerts a force on the plunger. As a result, the plunger is pulled toward the centre of the coil so that the orifice opens. This is the basic principle that is used to open and close solenoid valves. A solenoid valve is an electromechanical actuated valve to control the flow of liquids and gases.

D. Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch. Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized.

Fig. 5: Relay

E. Ladder Logic

Ladder logic is the main programming method used in PLC. Ladder logic is based on mimic relay logic. The relay logic diagrams are difficult; hence we have selected ladder logic as main programming method. In modern control systems they used relay but these are not used for logic. A relay is a device that controls a switch using magnetic field. Relays are used as one power source close a switch for another power source, while keeping isolated. A simple ladder logic diagram is shown below.

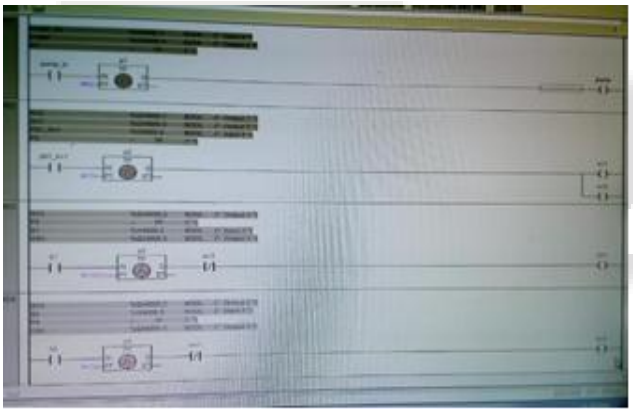

Fig. 6: Ladder logic

F. Used and Run

A PLC is primarily used to control machinery. A program written for a PLC consists basically of instructions to turn on and off outputs based on input conditions and the internal program. In this respect, it is similar to how a standard computer application is used.

Ladder diagrams are specialized schematics commonly used to document industrial control logic systems. They are called ladder diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent.

Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware. The name is based on the observation that programs in this language resemble ladders, with two vertical rails and a series of horizontal rungs between them.

G. Conveyor Belt

A conveyor belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both of the pulleys are 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. There are two main industrial classes of belt conveyors; those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, overburden and more.

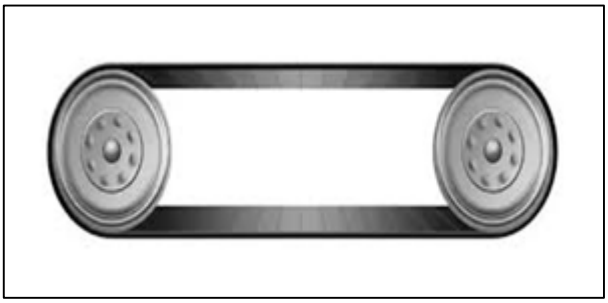

Fig. 7: Conveyor Belt

H. Metal Sensor

A metal detector is an electronic instrument which detects the presence of metal nearby. Metal detectors are useful for finding metal inclusions hidden within objects, or metal objects buried underground. They often consist of a handheld unit with a sensor probe which can be swept over the ground or other objects. If the sensor comes near a piece of metal this is indicated by a changing tone in earphones, or a needle moving on an indicator.

IV. Future Work

With the help of our project we can extend the process for the packing with the help of "Pick and Drop Robot". In this project we can also use the multiple colors to mix the color and fill it in the bottle.

V. Result

The device can fill up to 2 types of liquid by intermixing using solenoid valve switch in just few seconds. System doesn't require no any external pumps and only two metallic sensors are used. It is a time based control by which the pulse is generated in flow sensor and filling process is done. It is used commercially in various coffee shops, juice shops, cold drink shops and reduces human effort. So the practical research result is much satisfactory. It shows the necessity of PLC in industrial automation and also to realize the necessity of studying it.

VI. Conclusion

The main aim of this paper is to develop a PLC based automatic liquid mixing system for filling bottles. We acquire more knowledge for better and advancement of the project in

future. Also knows how PLC systems are essential for advancements in electronic gadgets like automatic liquid mixing systems etc.

REFERENCES

[1] PLC based Automated Liquid Mixing and Bottle Filling System, Mini Sreejethl and Shilpa Chouhan2, 1st IEEE International Conference on Power Electronics. Intelligent Control and Energy Systems (ICPEICES-2016)
[2] Vision based Bottle classification and Automatic Bottle Filling System, K. Thyagarajan, Meenakshi. R,Suganya .P, International Conference on Advances in Human Machine Interaction (HMI - 2016), March 03-05, 2016
[3] Designing and Implementation of Chemical Mixing and Filling Bottles Using PLC, Prasad Birmole, Madhushri Kamble, Sayali Naik, Anjali Sadamate, Prof.Heenali.V.Korgaonkar, 2nd International Conference on Inventive Communication and Computational Technologies (ICICCT 2018)
[4] Subhankar Chattoraj, Subhro Mukherjee, Rahul Mallick, Ankit Parashar4, Sayandeep Sen, Karan Vishwakarma "Automatic Bottle Filling System Using PLC and SCADA", International Journal of Engineering Research and Development, Volume 12,Issue 10 (October 2016)
[5] Yazdi L, Prabuwono AS, Golkar E. "Feature Extraction Algorithm for Fill Level and Cap Inspection in Bottling Machine". International Conference on Pattern Analysis and Intelligent Robotics, 28-29 June 2011, Putrajaya, Malaysia
[6] Kunal Uttekar; Rahul Gosavi; Sarthak Lad; Jagruti Kamat; "Implementation of Sensor Network for Automation of Bottle Capping Assembly Station Using IEEE 802.15.4"; 2nd International Conference on Instrumentation Control and Automation; 15-17 November 2011; Bandung; Indonesia.

