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Automatic Bottle Filling System using PLC

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ABSTRACT

Filling is a task carried out by machine that packages cold drinks and water. It also includes volume selection menu through which user can input the desired volume to be filled in bottle.

The filling operation is carried out by Programmable Logic Controller (PLC). Because PLC is cost effective, very flexible, reduce complexity, space efficient. By programming PLC we can control entire system

Keyword: *Allen Bradley PLC, solenoid valve, DC motor, float sensors, inductive proximity sensor*

I. INTRODUCTION:

Automation plays an increasingly important role in the world economy. One of the important applications of automation is in the soft drink and other beverage industries, where a particular liquid has to be filled continuously. For these kinds of applications. The trend is moving away from the individual device or machine toward continuous automation solutions. Totally 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.

Every system or machine has a controller. Depending on the technology used, the controllers can be divided into pneumatic, hydraulic and electronic controllers. Frequently, a combination of different technologies used. Furthermore, the differentiation is made between hard-wired programmable (e.g. wiring of electro-mechanical and electronic components) and programmable logic controllers. The first is used primarily in cases, where any reprogram by user is out of question and the job warrants the development of special controller. Typical application for such controllers in video cameras, automatic washing machine. However, if the job doesn't warrants the development of special controller or if the user is to have the facility of making simple or independent program changes, or of setting timers and counters, then the use of universal controller, where the program is written to an electronic memory. The PLC represents such a universal controller. It can be used for different applications and, via program installed in its memory, provides the user with a simple means of changing extending and optimizing the processes.

II. OBJECTIVE:

To develop automatic bottle filling system with user defined volume selection using sensors.

III. PLC ARCHITECTURE:

The internal architecture of a PLC is as shown in Figure.1

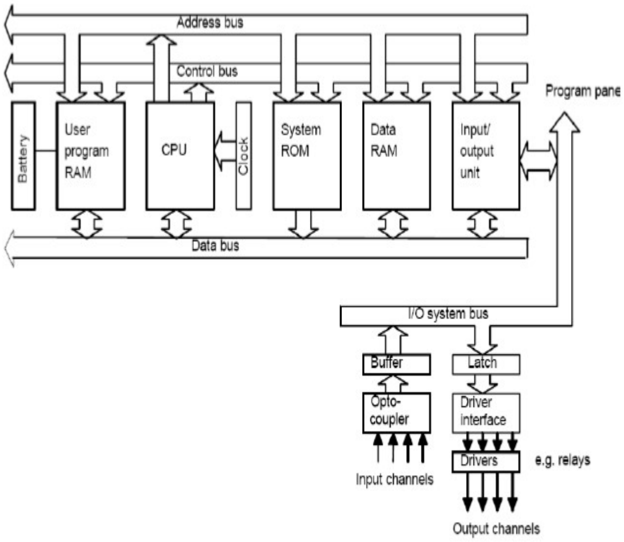

Figure 1: internal architecture of PLC

A. *Central Processing Unit :*

At the very basic, the internal architecture of a PLC consists of a central processing unit (CPU) containing the system microprocessor, memory and input/output circuitry. The CPU is supplied with a clock which determines the operating speed of the PLC and provides the timing and synchronization for all elements in the system.

The information within the PLC is carried by means of digital signals which flow along internal paths called *buses*.

B. *Memory system :*

This is the area in the PLC where all of the sequences of instructions, or *programs*, are stored and executed by the processor to provide the desired control of field devices [7]. The memory sections that contain the control programs can be reprogrammed to adapt to any changes in process control requirements.

C. *I/O Interfaces :*

An *I/O module* is a plug-in–type assembly containing circuitry that communicates between a PLC and field devices. These devices could be transmitting and/or accepting *digital* or *analog* signals.

D. *The power supply :*

The system power supply provides internal DC voltages to the system components (processor, memory, and input/output interfaces).The power supply is characterized by a maximum amount of current that it can provide at a given voltage level, depending on the type of power supply.

E. *Programming languages :*

Graphical languages:

i. Ladder diagrams (LD) - uses a standardized set of ladder programming symbols to implement control functions.
ii. Function Block Diagram (FBD) - a graphical language that allows the user to program elements in such a way that they appear to be wired together like electrical circuits.
iii. Sequential Functional Chart (SFC) - a graphical language that provides a diagrammatic representation of control sequences in a program.

Text-based languages:

i. Instruction list (IL) - a low-level language similar to the machine or assembly language used with microprocessors.
ii. Structured text (ST) - a high-level language that allows structured programming, meaning that many complex tasks can be broken down into smaller ones.

IV. *PROXIMITY SENSOR*

Proximity sensors detect the presence or absence of objects using electromagnetic fields, light, and sound. There are many types, each suited to specific applications and environments.

Inductive sensors

These non-contact proximity sensors detect ferrous targets, ideally mild steel thicker than one millimeter. They consist of four major components: a *ferrite core* with *coils*, an *oscillator*, a *Schmitt trigger*, and an *output amplifier*. The oscillator creates a symmetrical, oscillating magnetic field that radiates from the ferrite core and coil array at the sensing face. When a ferrous target enters this magnetic field, small independent electrical currents called eddy currents are induced on the metal's surface. This changes the reluctance (natural frequency) of the magnetic circuit, which in turn reduces the oscillation amplitude. As more metal enters the sensing field the oscillation amplitude shrinks, and eventually collapses. (This is the "Eddy Current Killed Oscillator" or ECKO principle.) The Schmitt trigger responds to these amplitude changes, and adjusts sensor output. When the target finally moves from the sensor's range, the circuit begins to oscillate again, and the Schmitt trigger returns the sensor to its previous output.

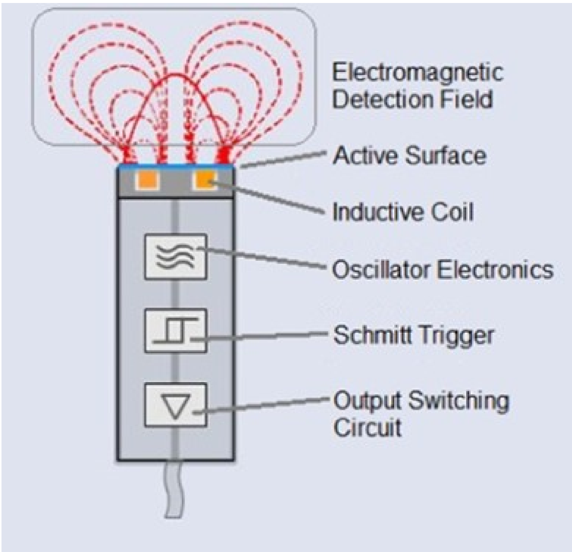

Figure 2: Internal elements of inductive proximity sensor

V. WORKING PRINCIPLE

At the input side the bottles are kept in position over the conveyor. The inductive proximity sensor is used to detect bottles without making contact. These non-contact proximity sensor detect ferrous material, ideally mild steel thicker than one millimeter. The output is then read by external control unit (e.g. PLC) that converts sensor ON and OFF state into useable information. The block diagram is shown in figure 2. Once the bottle is being detected the conveyor has to stop till the time is programmed. On the other hand, the output of the PLC enables solenoid valve in order to fill the bottle with user defined volume. This control valve is open when the bottle is detected for a time specified.

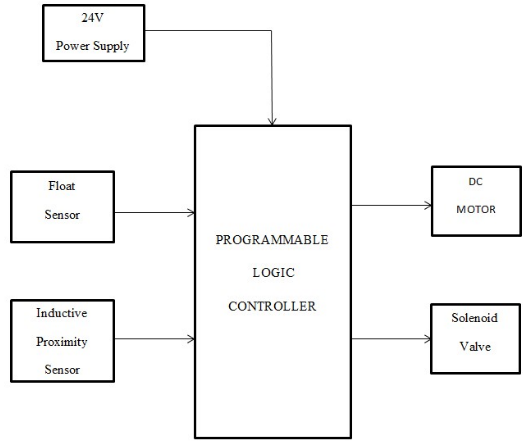

Figure 2: Block diagram

The water is pumped from reservoir tank to overhead tank and float sensors are used to detect low and high level of water of the overhead tank. The experimental setup is as shown in figure 4.

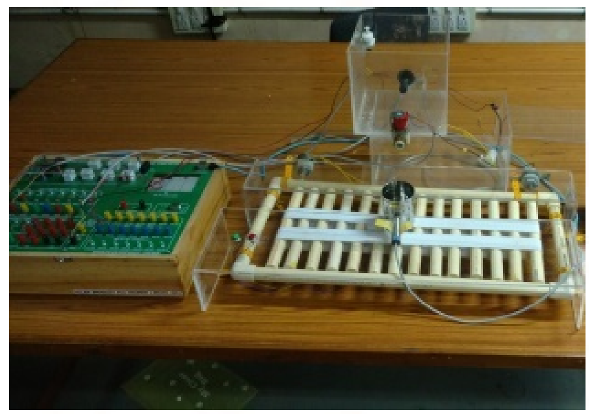

Figure 4: Automatic bottle filling system.

VI. RESULT

The device can fill up to 2 or more bottles of maximum height of 6.6'' and maximum bottle diameter of 4.6" in 1 minute. There is no need of any external pumps and only two types of sensors are used. It is a time based control by which the solenoid valve is open for a time specific and filling process is done. It can be used commercially in various coffee shops, juice shops; cold drink shops and reduce human effort. So the practical research result is much satisfactory. It also helps to understand the necessity of PLC in industrial automation and also to realize the necessity of studying it.

VII. CONCLUSION

We built a PLC controlled automatic bottle filling system. PLC based automated liquid filling and control system is a part of industrial production system. This system is suitable for liquid production where we need certain amount of liquid. The automated liquid filling process is operated in such a way that it saves both time and cost.

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