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Design and Fabrication of an Automated Carousel Bottling System Controlled by Allen Bradley Software

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ABSTRACT: *The designed low cost industrial automation process is best suitable for small scale industries to increase the production rate of manufacturing the bottles filling the liquid and relative operations on bottles. Automation plays an increasingly important role in the world economy and in daily experience . 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 into the given container or bottle. This paper showcases the design and fabrication of an automated bottling system with carousel. This system makes use of sensors for detecting the bottle position moving along the carousel system or rotary path at a particular speed. The liquid filling operation takes place using a solenoid valve. The amount of liquid filled in bottle is verified using load sensors. The input signal to the sensor and supporting components in the system is controlled through programming logic written using Allen Bradley software. The fabricated automated bottling system with carousel performed satisfactorily during the trial runs.*

Keywords: *Bottling system, Allen Bradley software, IR Sensors, Level switch, Programmable Logical Controller (PLC)*

I. INTRODUCTION

The field of automation has made greater impact on the wide variety of industries beyond manufacturing [1]. The pressure to continually increase production volumes has stressed older systems and has increased maintenance requirements. For manufacturers, this creates two problems: higher costs and increased downtime [2]. Automation has the capabilities of using the control systems and information technologies to reduce the need for human work in the production of goods and services [3].

Use of sensors and PLC software in automated system has been greatly decreased the need for human sensory and mental requirements as well. 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. Totally integrated automation covers the complete production line, from receipt of goods, the production process, filling and packing, to shipment of goods [3]. Many areas of manufacturing and processing are currently focusing on optimization and control technologies in order to improve performance and efficiency. In an increasingly competitive market, the industries are showing a clear need and strong desire to improve in the field of beverages [4].

II. OBJECTIVE

The main objective of the project is to design and fabricate an automated bottling system of rotary type, where by desired indexing slots allots bottles to position in line with filling point at filling station is operated by the DC motor. The weights of the water filled bottles are then verified using the load cell. Since filling is done on carousel system and other relative operations on conveyor system, thus making the system more effective to approach on bottling. So that to avoid overlapping of processes. This system can provide simultaneous operations by just interfacing with I/O modules.

III. METHODOLOGY

Depending on the output of the sensor, the corresponding solenoid valve switches on and filling operation takes place. If bottle is not present on the indexing system, then position of solenoid valve is switched off, where by avoiding wastage of the liquid. The filling process is done based on timing given in program. Depending on the preset value of the timer the solenoid valve is switched on for that particular period of time and the filling is done. After the filling of liquid is done a load sensor checks the correct amounts for verification.

IV. PROCESS DESCRIPTION

The 3D model for automated bottling system is designed using the CATIA software and is shown in Fig. 1. The approach to fabricated model is done with guidance of references below.

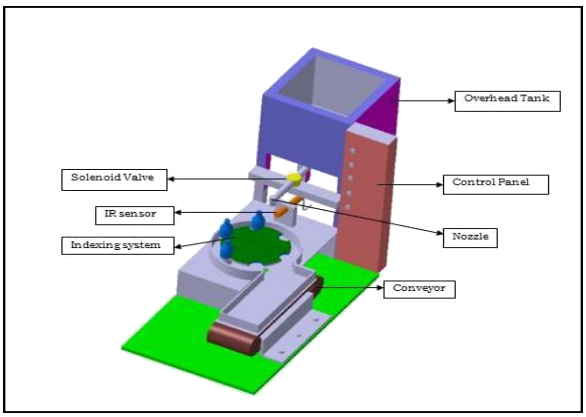

Figure 1 CAD model of automated bottling system

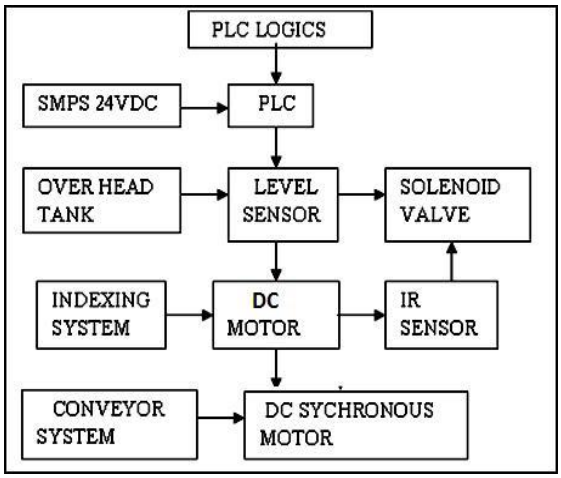

Figure 2 Process flowchart

Fig. 2 illustrates the process flow chart which describes about the system analysis with each component interaction irrespective to its process function. It also shows the PLC which interconnect each of the modules to run an effective operation of liquid filling in each incoming empty bottles. The process flowchart emphasizes on the looping ability of the system and its various units.

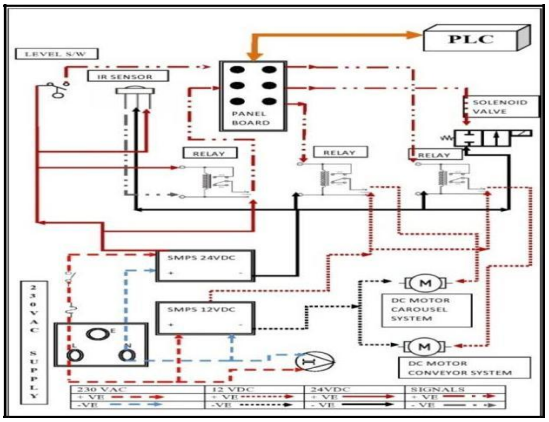

Figure 3 Circuit diagram of automated bottling system

Circuit diagram of the automated bottling system is shown in Fig. 3. The circuit diagram is like a nervous system which helps in connecting to the brain. The nervous system is referred to as the

available wireframe connect of different units and its components connected with PLC as its brain so as to controls all the elements of the system as per the ladder logics.

4.1 Automated Bottling System Units

4.1.1 Overhead tank

Table 1 Details of overhead tank

Overhead tank	Specification	Material	Usage/ Purpose
Leak proof Tank	10 *liters* capacity	Stainless steel	Storage
Level sensor	Float type	Fiber	Sensing
Constant height gauge	500*ml* capacity	Galvanized Iron	Pressure constant
Submergible pump	230 *VAC*	Fiber	Pumping

Table 1 displays the details of overhead tank used in the automatic bottling system. It is of 10 liter capacity leak proof tank. The level sensor present in tank at particular designed point to check the constant minimum level of liquid, so as to make filling unit active in the system. The use of submerge pump in the tank is to draws liquid from tank to constant head gauge, so as to maintain constant pressure of liquid at any given time in the tank at all levels.

4.1.2 Carousel unit

Table 2 Details of carousel unit

Carousel unit	Specification	Material	Usage/ Purpose
Rotating disc	6 slot indexing	Wood	Rotary guidance
DC motor	gear motor	Metal	Revolves indexed disc
Guides	1*mm* sheet	GI steel	Support guide to bottles

Details of the carousel unit used in the automatic bottling system are shown in Table 2. The system consists of a rotating disc made attached to DC motor. The speed of the DC motor is adjustable with variable load current where by making easy for filling process.

4.1.3 Filling unit

Table 3 Details of filling unit

Filling unit	Specification	Material	Usage/ Purpose
IR sensor	Sensing range 10*cm*	Fiber	Detecting empty bottles
Solenoid valve	24 *VDC*	Brass	Filling empty bottles
Empty bottles	80 *ml* capacity	Plastic	To be filled

Filling unit consists of IR sensor and solenoid valve. Specifications of the filling unit are given in Table 3. This unit needs to be synchronized with the above units. The empty bottles arrive at from carousel unit and liquid to be filled from overhead tank. The IR sensor detects the empty bottles and solenoid valve fills liquid of relative quantity into empty bottles.

4.1.4 Conveyor unit

The conveyor unit consists of nylon rollers with leather belt about 3 inches width size. To revolve this conveyor unit a DC motor is used. Conveyor unit collects the filled bottles from the filling unit to do remaining further

process in bottling plant.

Table 4 Details of conveyor unit

Conveyor unit	Specification	Material	Usage/ Purpose
Nylon rollers	6" long with 3" slot	Nylon	support belt
Belt	3" wide	woolen	Transport filled bottles
DC motor	gear motor	Metal	Revolves belt

4.1.5 Control panel

Table 5 Details of control panel

Control panel	Specification	Material	Usage/ Purpose
Inputs	Yellow slots	Plastic	Signal to PLC
Outputs	Green slots	Plastic	Signal from PLC
LED lights	Y-G-B-R	Glass	visual Indications
Wire probes	Single studded	PVC cables	Communication

Control panel is where all the system components are interfaced with each other to get desired output results. Details of the control panel are shown in Table 5. The probes are used for interfacing with each of the input or Output module to PLC. The LED lights gives the indication for programmer for the activation of pulsating signal given to the module by PLC programming and logics.

V. PLC

Programmable logic controller is a digital computer used for automation of industrial process, such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output unlike general purpose computers. Arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to controlled machine operations are typically stored in the battery backed or non –volatile memory [4]. The PLC performs the logic functions of relays, timers, counters and sequencers. The PLC scans its inputs and, depending on the program, switches on or off various combinations of outputs. The logic state of the output depends on the input conditions and so the term conditional logic is used [1]. They are well-adapted to a range of automation tasks. All control operations (filling and capping) are done using the PLC. The entire bottling process is automated from the feeding of empty bottles into the system till all the other operations are happening simultaneously using ladder logic. Ladder logic is one of the methods of programming a PLC. 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. PLC's are used for a wide range of applications especially in the field of control and automation [5].

VI. INPUT SIGNALS

Sensors: The input module includes the level sensors/switch and IR sensor; outputs are given as an input to the PLC. Level switch are used to detect the minimum liquid present in the overhead tank, and IR sensor is used to detect the incoming empty bottles into the system for positioning those at filling station. These sensors output signals are the inputs to DC motor and the solenoid valve in next unit stations.

VII. OUTPUT SIGNALS

DC motors: The rotor of the motor produces torque from the interaction between the magnetic field in the stator and rotor. The strength of the magnetic fields is proportional to the amount of current sent to the stator. The RPM is variable to current supply. Here in ABS DC motors are used in both carousel and conveyor system.

Solenoid valve: Solenoid Valves are used in the industry where we need to control the flow of all sorts of fluids. A solenoid valve is an electromagnetic valve for use with liquid or gas controlled by running or stopping an electrical current through a solenoid, which is a coil of wire, thus changing the state of the valve to open or close.

VIII. LADDER LOGIC

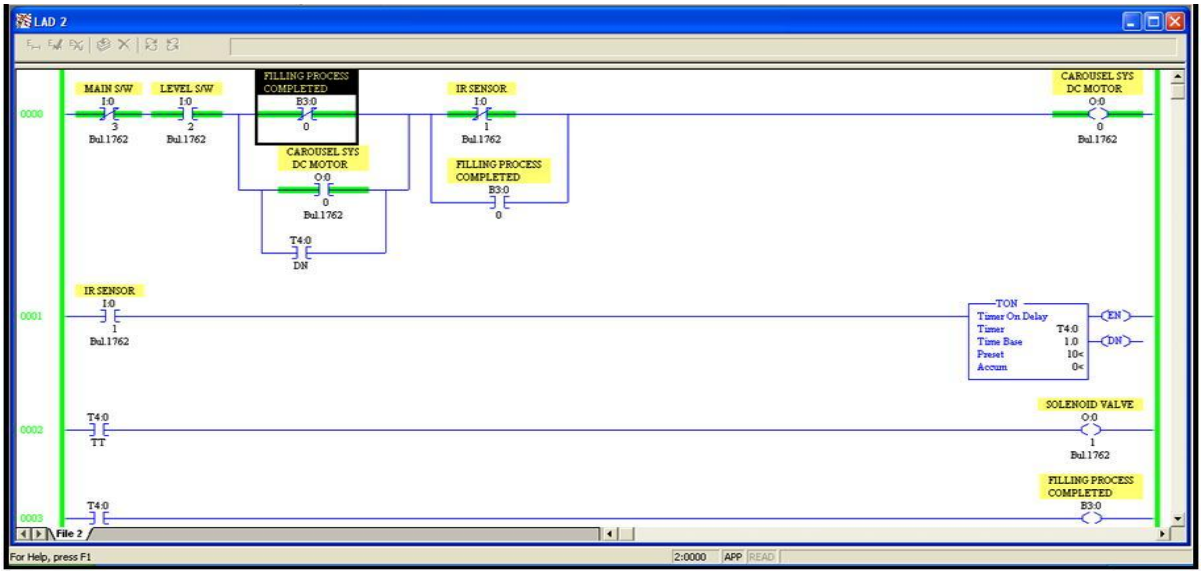

Figure 4 Ladder logics of automated carousel bottling system

Programming of the automated carousel bottling system is achieved through ladder logic using Allen Bradley software. Fig. 4 depicts the ladder logic developed for the automated bottling system.

Sequence of operational steps:-

- Check of minimum water level in the overhead tank by level sensor present inside the tank.
- If the minimum requirement of water is achieved then process starts. The stepper motor revolves the indexing mechanism carrying empty bottles that need to be filled at station.
- The IR sensor present on the platform near carousel system detects the empty bottles coming and when bottled detected the stepper motor stops near the proximity sensor in-line to filling point.
- At filling station the required quantities are filled by nozzles attached by solenoid valve.
- The filled bottles then moves out of the carousel system onto the conveyor system for further process.
- The process is not started unless the step: 1 satisfied

Figure 5 Fabricated Prototype automated carousel bottling system model

A fully working fabricated prototype of automated carousel bottling system is shown in the Fig. 5.

IX. CONCLUSIONS

The following conclusions could be drawn from the work described above.

- An automated carousel bottling system is successfully designed.
- As per the design and the circuit diagram, automated carousel bottling system is successfully fabricated.
- Programming of the bottling system is achieved through the development of ladder logic using Allen Bradley software.
- Automated bottling system is validated by conducting few trials and it was found that the system performed satisfactorily as expected.

REFERENCES

[1] H.M. Mallaradhya and K.R. Prakash, Automatic liquid filling to bottles of different height using programmable logic controller, Mysore, *Proc. AECE-IRAJ Int. Conf.*, 2013, 122-124.

[2] Hemant Ahuja, Arika Singh, Saubhagya Tandon, Shreya Srivastava, Sandeep Pal, Automatic filling management system for industries, *International Journal of Emerging Technology and Advanced Engineering,* 2014, 241-244.

[3] T. Kalaiselvi, R. Praveena, R. Aakanksha and S. Dhanya, PLC based automatic bottle filling and capping system with user defined volume selection, *International Journal of Emerging Technology and Advanced Engineering*, 2012, 134-137.

[4] Jagat Dhiman and Dileep Kumar , Hybrid method for automatically filling of the chemical liquid into bottles using PLC & SCADA, *International Journal of Engineering Research and General Science, 2(6)*, 2014, 1000- 1007.

[5] Savita and Lokeshwar, Implementation and performance analysis of bottle filling plant using ladder language, International *Journal of Science and Research*, 2014, 1803-1806.

[6] D. Baladhandabany, S. Gowtham, Kowsik Kumar, P. Gomathi, PLC based automatic liquid filling system, INFO Institute of Engineering, Coimbatore*; IJCSMC, 2015*,684-692.

[7] Sagar P. Jain and Sanjay L. Haridas, Energy efficient automized botteling plant using PLC and SCADA with speed variable conveyor assembly, *IOSR Journal of Electronics and Communication Engineering*, 2014, *152-158.*

[8] Vinit A. Dave and S. K. Hadia, Automatic bottle filling inspection system using image processing, *International Journal of Science and Research*, 2015, 394-398.