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PLC Based Automatic Bottle Filling and Capping System

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ABSTRACT:

The objective of this paper is to design, develop and monitor PLC (Programmable Logic Control) based automatic bottle filling and capping system. This system provides advantages like low power consumption, low operational cost, less maintenance, precise operation etc. This project biased on industries where packaging and distribution takes place on continuous basis. It has wide use in many industries like milk industries, mineral water filling etc. A small version is developed to illustrate the system. The DC motor is used to make the conveyor system operation simple. The IR sensor is used to detect the bottle present at various places in the system. Filling is carried out by machine and this process is widely used in many industries. The complete process is monitored and controlled by PLC. The filling process is done by peristaltic pump. Capping of the bottle is done by solenoid piston. The filling and capping operation takes place in synchronized manner. The PLC used in this system is Delta DVP14SS211R which makes the system more flexible and easily useable. Ladder logic has been used for programming the PLC, WPLsoft software is used for programming the PLC.

Keywords: Delta PLC, Conveyor belt, IR sensor, Ladder logic, etc.

1. INTRODUCTION:

Automation is the need of control system and information technology to pacify the more work in less time. The production of goods and services is a moving trend for today's world, so to fulfil their demand need of automation has increased, hence the use of PLC is increasing day by day. The word 'Automation' itself says on making a tedious process very simple and without the use of manpower. Day by day industries are using high end technologies so the use of simpler versions circuit is in demand so the PLC came to an existence.

PLC plays an important role in the world of automation. A bottle filling system allows the user to fill definite amount of liquid in the bottle without any wastage. Ladder logic is used to

manage whole sequence of the PLC. The Delta PLC works on 24Volts DC 1.85Amp and is a compact system with fixed amount of 8 inputs and 6 outputs. For future use we can also monitor the whole system using the SCADA software.

2. OBJECTIVE:

Our objective is that the filling and capping operation should take place in synchronised manner. It also includes defined volume selection of liquid that to be filled in bottle which makes system a time saving. The monitoring of such system using PLC is very feasible, that makes it cost effective, space efficient and less complex.

3. METHODOLOGY:

First empty bottles are placed on the disc slots corresponding to filling and input stages. As soon as empty bottles are placed on conveyor belt, the presence of liquid in the tank is detected using limit switches. If there is no liquid present in the tank, then whole operation is stopped. Again, the presence of bottles on the conveyor belt is detected using IR sensor placed above the conveyor belt. If there is no bottle present the conveyor belt will not move but, the bottles present on the disc on the respective stages will be processed till the end.

Initially, when the machine is turned on, first the bottle present in the filling stage will be filled using peristaltic pump and after certain time delay disc motor will start rotating till the rod placed at 45 degree is not detected by IR sensor, which signifies the complete rotation of the disc motor for the next stage. After this, the conveyor motor will run using the arrangement of two DC motors till no bottle is detected in the input stage of the disc by the IR sensor. Similarly, in the next turn bottles will be present in the filling and capping stage. In this turn the bottle present at the filling stage is filled, as well as the bottle present at capping stage is capped using solenoid piston. Before that caps are mounted on the filled bottle using cap hopper arrangement. After that the completely processed bottle will be thrown from the machine by slant slope on the base of the disc. The control signals are given by the DELTA PLC DVP 14SS2 according to the input sensors such as ir sensors and limit switch. Ladder logic is used in PLC so as multiple tasks can be carried out simultaneously.

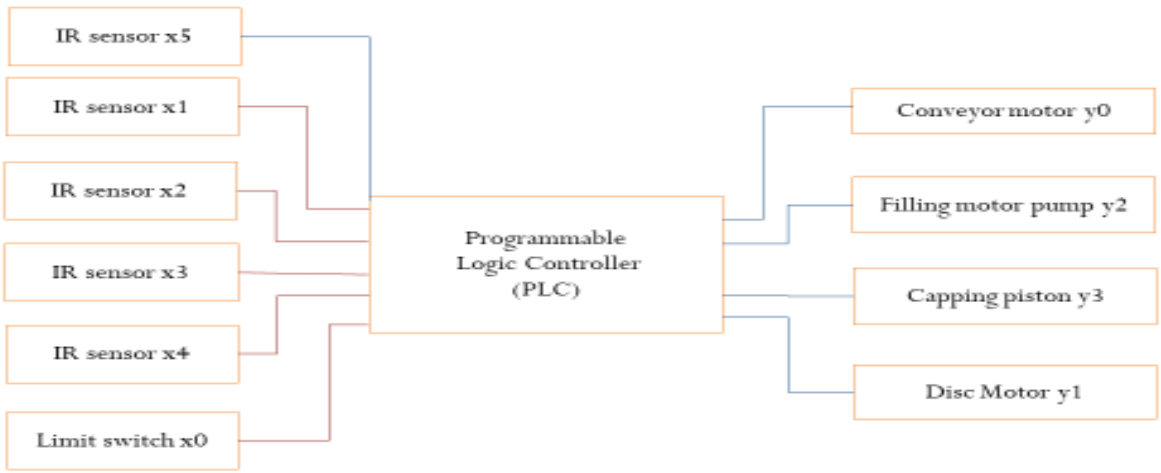

Fig: Block diagram

4. HARDWARE DESCRIPTION:

The Delta PLC 14SS2R requires 24V, 1.85A supply, the PLC input signals are 24V, 5mA and the outputs are 24V, 1.5A and 12V, 1.5A. For regulating the voltage and current to specified level, voltage regulators and current limiters are used. LM317 IC's are used to limit the current level to specified level. IC 7824, 7818, 7812 are used to regulate the voltage levels. The IR sensors require 5V supply for operation. Hence IC 7805 is used for regulating voltage for IR sensors. IR sensor gives 5V output, but PLC's input signal is 24V, 5mA. Hence relays are used for isolating 5V and 24V circuit so as when IR sensor gives 5V output, PLC will get 24V, 5mA inputs. A common 24V regulated voltage supply is used to drive the whole circuitry. The piston is the highest current rated actuator. Hence separate current regulator IC LM317 is used for driving solenoid piston.

5. SOFTWARE DESCRIPTION:

We have used ladder diagram for programming the Delta PLC14SS2R. The actual real time simulation can be done by connecting PLC to the PC by RS 232 port and simulating in WPLsoft software in online mode.

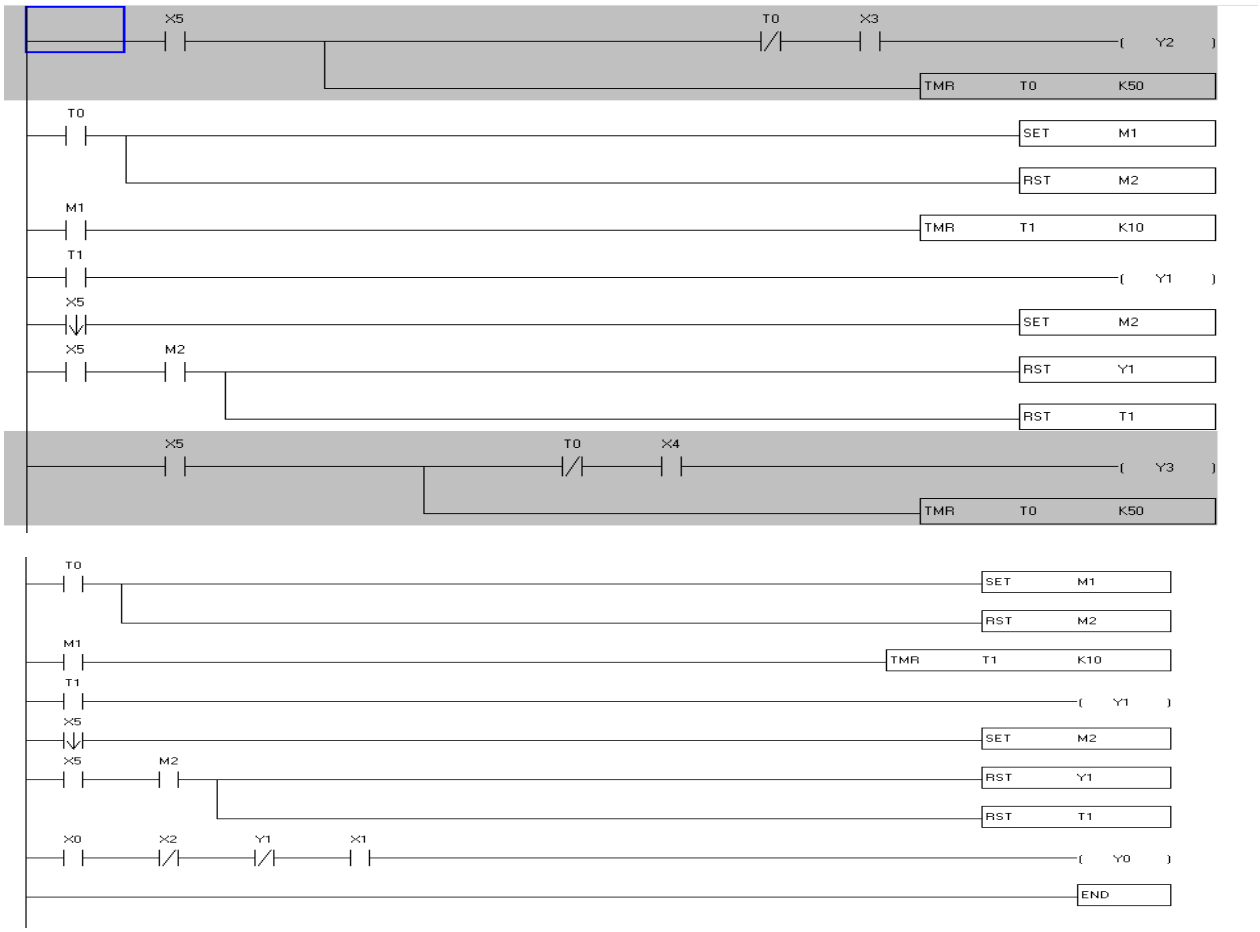

Fig: ladder diagram

6. ALGORITHM:

The PLC does not work like microcontrollers which work on machine cycles and cannot do two tasks simultaneously. The PLC can monitor each step simultaneously as well as execute each step simultaneously.

Step I – If limit switch x0 = 0 go to last step.

Step II – If conveyor belt ir sensor x1 = 0 stop conveyor belt.

Step III – If x0 = 1 & x2 = 0 & y1 = 0 & x1 = 1 set y0.

Step IV – While (x5 = 1) & while (x5 = 0) reset y1.

Step V – If x5 = 1 & x4 = 1 set y3 for time t2.

Step VI – If x5 = 1 & x3 =1 set y2 for time t1.

Step VII – After t1 = 1 & t2 = 1 start t3.

Step VIII – After t3 = 1 set y1.

Step IX – END.

7. FUTURE SCOPE:

With the help of High-end technologies PLC systems are increasing day by day the drawback of productivity can be overcome. Here we are using normal pump for the purpose of filling of bottles which can be replaced by peristaltic pump which sucks definite amount of liquid and throws the same amount of liquid, which is controlled by changing the RPM of the machine, this means more bottles can be filled in lesser amount of time. Also, levels sensors can be used for level detection of liquid filled. For future use we can also monitor the whole system using the SCADA software.

8. RESULT:

We have developed The PLC Based Automatic Bottle Filling and Capping System successfully.

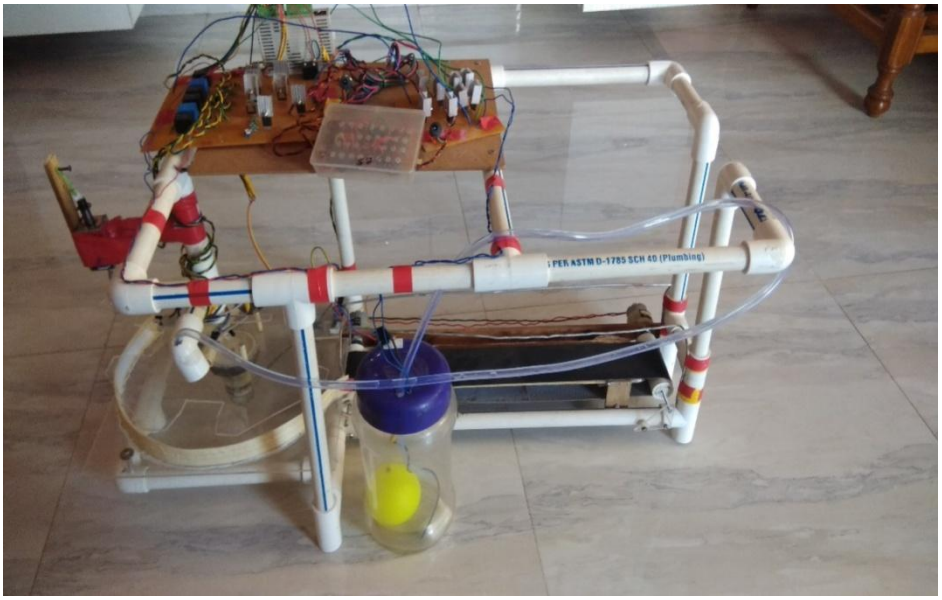

Fig: complete PLC based system

9. CONCLUSON:

The purpose of this project is to develop a system which requires less man power and more precise machine output. We have gained knowledge about the industrial functions that are used for our liquid bottles that are filled and capped. We learnt WPLsoft for PLC ladder logic.

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