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Control of Automation in Filling Process through Smartphone

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Abstract: Automation is the different control technique for operating equipment's such as operation in factories, and other application with reduced human efforts. The filling process consists of a machine that fills liquid such as water or cold drinks. Traditional bottling methods include placing bottles on a conveyor belt and filling only one type of bottle. In this, a water filling machine system is designed for different sized bottles using PLC. The water filling machine system consists of a conveyor belt which runs with the help of a DC motor. The photoelectric sensor gives the information about the position of the bottle and the solenoid valve is used to control the filling process. The PLC plays an important role to implement the automatic filling process. The PLC is programmed using ladder diagram language. It is noted from the current work that it requires less operational cost and less power consumption than the traditional method. Wireless technology uses the technique of communication without using cables and wires. By using wireless technologies people can communicate very long distances. Bluetooth is one of the main wireless technology used in this decade. Here we control the PLC by using a smartphone via a Bluetooth. This introduces the advantage of mobility of control operator over the vicinity of industry.

Keywords: Automation, Bottle filling machine, PLC, smartphone.

I. INTRODUCTION

The main aim of automation is to reduce the human intervention with the help of several new technologies. PLC plays a vital role in automation. It reduces complexity and is very cost efficient. PLC can handle extreme conditions. Therefore the life time of PLC are optimal. The paper is divided into several phases. The first phase explains the description of the proposed project. A bottle filling system based on PLC allows the user to select volume of the filling water. We use ladder logic to programme the PLC to control the process. A sensor is placed in the conveyor belt. That senses the position of bottles under the solenoid valve, which is correspondingly switched on to fill the bottle. Filling is done using motor, sensors, conveyor belt, and PLC and solenoid valve. Wireless based HMI is used in this project. The HMI mainly consist of user interface like tabs which have application software to communicate with the PLC. The communication is done with the help of Bluetooth module which is connected to interface to the PLC.

II. METHODOLOGY

This project mainly divided into two parts: bottle filling and controlling section. The bottle filling section consist of a conveyor belt, roller, dc motor, solenoid valve, proximity sensor, PLC and a frame work for support. The bottle that is to be filled is placed on the conveyor belt. When the start button is pressed, the conveyor belt starts moving and carries the bottle towards the filling section with the help of a dc motor. In the bottle filling section, a proximity sensor is placed exactly below the solenoid valve for sensing the presence of bottle under the valve. Once the bottle is sensed, the conveyor belt stops and the solenoid valve will be open. This solenoid valve will remain open for a time duration which will be set by a timer and hence the bottle is filled for the set time duration. When the timer runs out, the solenoid valve will be closed and the conveyor belt starts moving thus carrying the bottle in to the next section of the process. This process can be halted at any instant by pressing the stop button. The whole process is automated with the help of a Programmable Logic Controller (PLC) which is programmed using Ladder logic diagram.
In the controlling section we incorporate a HMI by means of Bluetooth. A smartphone is used as an interface between the operator and the process. Various parameters of the process can be controlled through this smartphone from the vicinity of the industry.

III. PROPOSED MODEL

The whole system is divided into two parts which is the hardware and software section.

A. Hardware Description

For the automation system, the PLC used here is the Delta DVP SS2 model. This PLC performs input and output operations and ladder program is used for controlling inputs and outputs of the controller. This is a 24V 1.8W PLC with 6 inputs and 4 outputs. A SMPS is used for giving the input supply of 24V to the PLC.

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The other components used in the system includes Proximity sensor, DC motor, solenoid valve, relay, conveyor belt. The proximity sensor is used for the positioning the bottle. Proximity sensor used here is the photoelectric sensor. The dc motor is used for driving the conveyor system which results in high torque. The bottle is filled using the two way solenoid valve. The inputs to the PLC are the start and stop push button and the smart phones act as the HMI between the operator and the process.

B. Software Description

No The PLC can be programmed using five languages. They are listed below,

- Functional block diagram (FBD)
- Sequential function chart (SFC)
- Ladder diagram (LD)
- Structured text (ST)
- Instruction list (IL)

Out of this five languages, ladder diagram is used the most. This language is similar to the relay logic. Ladder logic is a written method to document the design and construction of relay racks and is used in manufacturing and process control. Each device in the relay rack would be represented by a symbol on the ladder diagram with connections between the devices. Ladder diagram represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware.

C. Working of PLC

Programmable Logic Controller (PLC) is a special computer device used in industrial control systems. It is used as more than a special purpose digital computer in industries due to its robust construction, exceptional functional features like sequential control, counters and timers, reliable controlling capabilities, ease of programming and ease of hardware usage.

The basic steps in the operation of all PLCs are

- Input scan: - The state of all input devices that are connected to the PLC are detected.
- Program scan: - The user created program language is executed.
- Output scan: - Energizes or de-energizes output devices that are connected to the PLC.
- Housekeeping: - Includes communication with programming terminals, internal diagnostics, etc.

These steps continuously takes place in a repeating loop.

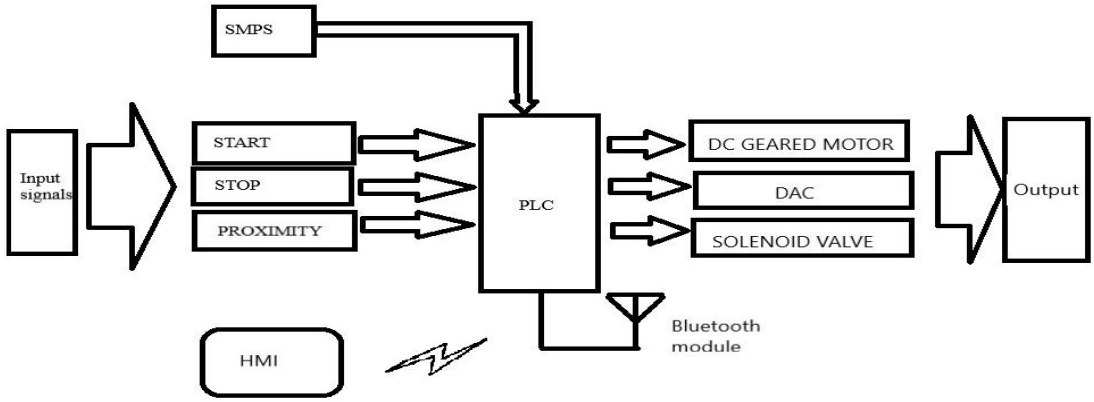

Fig 1: block diagram of process

IV. SELECTION OF PLC

For selecting the PLC, several factors have to be considered like:-

- Necessary input/output capacity
- Types of I/O required
- Memory required
- Speed and power required for the CPU and the instruction set
- Manufacturer's support and backup

Here we are using Delta DVP-14SS2 PLC for the project. It consists of 14 I/O points, with 8 input points and 6 output points. All the I/O points are digital. This PLC need power supply of 24V DC and 1.8W. Output module is of 1.5A, 250V AC. Reason of choosing this PLC is due to its ease of availability and low cost. Programming of the PLC is done by using WPLsoft, which is easily available in the market with free cost.

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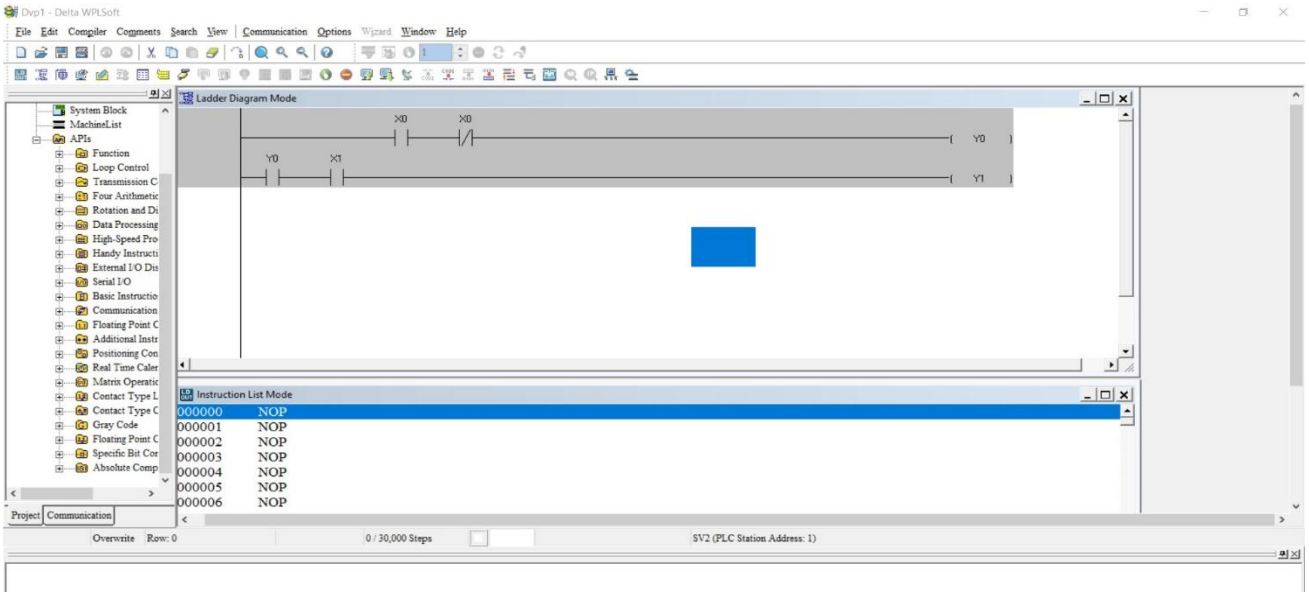

Fig 2. WPLsoft for DVP PLC

V. ALGORITHM

Step 1: Press the START push button.
Step 2: If the proximity sensor is LOW, the motor of conveyor belt starts.
Step 3: When the bottle is under solenoid valve, the proximity sensor become HIGH.
Step 4: Due to HIGH level of proximity sensor, the motor will be OFF and conveyor belt stops.
Step 5: The solenoid valve turns ON and timer starts counting for the set of duration.
Step 6: When the timer stops, the solenoid valve will be closed.
Step 7: The motor will start again and conveyor will be in motion. Also the bottle moves on the belt.
Step 8: The process will continue until the STOP push button is pressed.

VI. HMI

HMI is a user interface that connects a person to a machine or any system. Here it act as an interface between the PLC and operator. It provides a graphical visualization of an industrial control and monitoring system with real-time data acquisition. Some advantages of using HMI are

- Easy use for non-technical people
- Data Recording
- Improved productivity
- Cost reduction
- Easy overall management of plant
- User-friendly

Here we put forward a smart phone-controlled bottle filling method in this project. This Wireless technology allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for more direct integration between physical world and computer-based systems. It results in improved efficiency, accuracy and economic benefits.

We use smart phone as the HMI interface between the user and the PLC system. This smart phone shows the current status of the working condition of the whole system. The speed of the motor and the set pulse duration of the timer can be controlled with the help of this smart phone. The communication between PLC and smart phone is done by using a Bluetooth module. This Bluetooth module is a wireless serial transceiver having a footprint of 1m radius. An android application is used to control the PLC via Bluetooth. Android application is developed using android studio. In this project we incorporate three controls which can manipulate the on-off condition, volume of liquid filled and the speed of the conveyor belt. The on-off control through HMI works just like the on-off push button. The volume of the liquid to be filled can also be varied on basis of the size of the bottle that is to be filled, that is either to small quantity or large quantity. This interchanging of volume of liquid to be filled is controlled by a toggle switch on the HMI interface. This volume control is done by varying the pre-set value of the timer. The pre-set value of the timer will be low for low amount of liquid to be filled and high for large amount of liquid to be filled thereby varying the operating time of the

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solenoid valve. Here we provide four different speed modes. We can switch the speed of the conveyor belt from normal speed to half the speed, double or triple the speed. The speed of the dc geared motor is used to manipulate the speed of the conveyor belt. Thereby we can vary the speed of the process according to the demand of product.

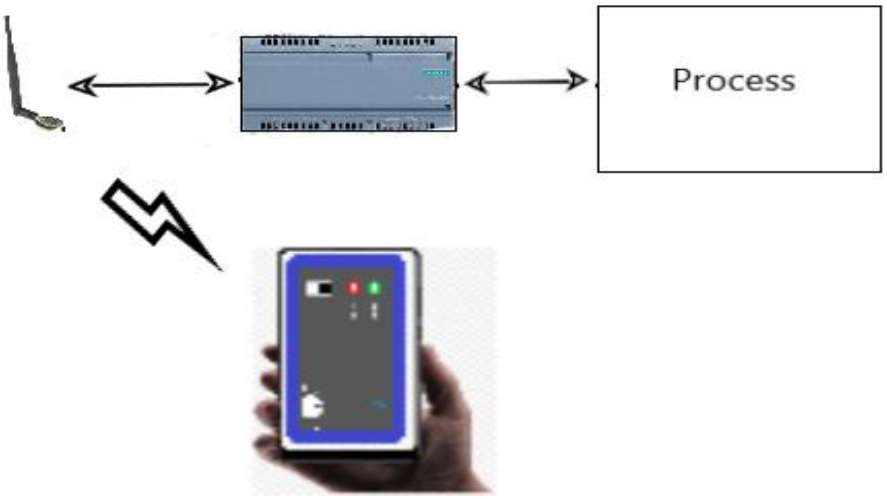

Fig 3. System Overview

VII. FUTURE WORK

With the help of Wi-Fi network, we can extend the process of controlling the system with larger range and can be controlled through the internet. We also aiming at the capping for the bottles after the filling process is done.

VIII. CONCLUSION

The main aim of the project is to develop smart phone-controlled bottle filling using PLC. We attained more knowledge about wireless technology and automatic process used in various industries. Also know how to develop an android app.

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