Automated Bottling System for Milly's Organics

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Abstract

- The automated bottling system for Milly's Organics was a joint collaboration project between a team of mechanical engineers and computer/electrical engineers.
- The system sorts, fills, caps, heat seals, and labels the bottles of dressing, which are then ready to be packaged.
- The system mixes products such as fruits, vegetables, and vinegar which were fed into the bottles.
- The system accommodates and is adjustable for three different bottles sizes and a range of different dressing flavors; these are selected on the HMI.
- The highest priority of the system was that the integrity of the product remain the same, and the quality of the product must fulfil the clients expectations.
- Moreover, precious, quality control, and self-reliance was the main focus of this project.
- The mechanical engineers focused on designing and assembling mechanisms for each phase of the project.
- The selectical/computer engineers focused on sensors, PLC, and an HMI to fulfil the clients expectations.

Pneumatic Schematic

Figure 3: Long Double Acting Cylinder

Figure 4: Short Double Acting Cylinder

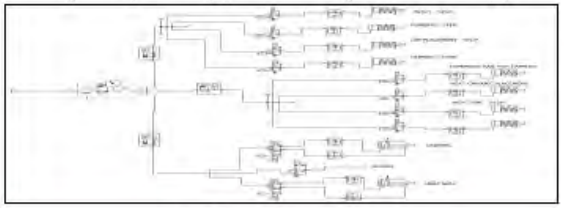

Figure 5: Pneumatic Schematic Diagram

Solenoids

Figure 10: Solenoid Valve AVS-3212-24D
Source: Automation Direct

The solenoid valve (top left) is what sends pressurized air to the actuators. The solenoid connector (top right) is what **receives the control signal** from the PLC to activate/deactivate. The circuit diagram for the connector is seen on the right.

Figure 11: Solenoid Connector 1/4in female NPT
Source: Automation Direct

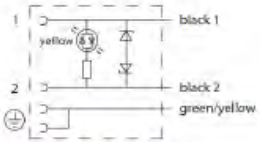

Figure 12: Wiring Diagram
Source: Automation Direct

Design

Figure 1: Complete design of the automated Bottling system on SOLIDWORKS

PLC

Figure 6: MicroS30 2080-LC30-48QBB
Source: Allen Bradley

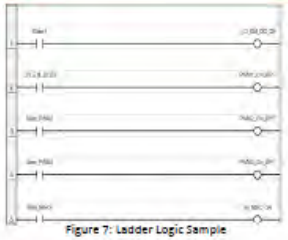

Figure 7: Ladder Logic Sample

The controller operates by reading and outputting **24V DC signals**. The sensors send a signal to the pins in the top row, which the controller reads and executes the logic based on these signals. It is programmed in **ladder logic** through Allen-Bradley's software (CCW).

Motors/Drivers

Figure 13: 4-wire stepper 17HE16-2004S1
Source: Automation Direct

Figure 14: 6-wire stepper 17HM13-0316S
Source: Automation Direct

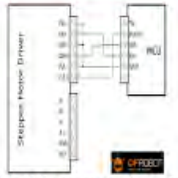

Figure 15: Stepper Motor Driver TB6600
Source: DFRobot

The motors used in the system consisted of 4-wire and 6-wire **hybrid stepper motors** in conjunction with the TB6600 stepper motor drive, and a 24V/20A DC power supply. The TB6600 drive allows the control of the motors with one control signal (**PWM**) produced by the PLC. A high amperage power supply must be used to power all of the motors simultaneously.

Block Diagram of the Systems

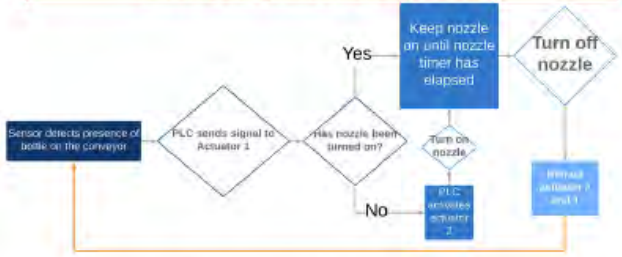

Figure 2: Block Diagram of the Filling Process

HMI/Sensors

Figure 8: HMI Dispense Control Screen

The HMI is the **touchscreen** that the user can use to monitor or adjust the system. Things such as sensor status, motor speed, or number of bottles can be viewed on the screen. The machine is also able to be **controlled** from the screen by assigning components to data registers as Boolean variables and changing their state by pressing a button on the screen.

Figure 9: URBEST Proximity Sensor PNP

Capacitive proximity sensors are sensors that are used to detect objects. They work by detecting the dielectric constant of an object other than air. Depending on this constant, the **change in electric field** changes which affects the range of detection (typically around 1 inch). These sensors were used to detect the presence of bottles at different locations.

Conclusion/Sponsor

- The team was successfully able to integrate their individual tasks into a complete working automated system.
- The system was able to be controlled through the HMI to produce a finished product.

- This project was sponsored by Milly's Organics.

Milly's Organics — Organic Fruit & Fresh Herb Salad Dressings — Gluten-Free • No Added Salt • No Preservatives

2019