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SCADA Controlled Multi-Ingredients Bottle Filling System Using Conveyor Mechanism

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Abstract: *Traditional and semi-automatic systems often lack consistency in bottle filling and require significant human effort, which leads to product wastage and inconsistency in quality. To overcome these limitations, automated systems based on PLC and SCADA technologies are increasingly adopted in modern industries. This paper presents the design and implementation of an automated multi-ingredient bottle filling system with the objective of achieving precise, efficient, and sequential liquid dispensing using a conveyor mechanism. The hardware architecture consists of a Delta DVP16ES2 PLC and IR sensors for accurate bottle detection at multiple stations, a PLC for executing sequential control logic, and a SCADA interface for real-time monitoring and visualisation of the system. The system operates sequentially: bottles are detected, positioned at different stations, filled with specific ingredients for predefined durations, and moved forward until the process is complete. The developed system improves efficiency and accuracy, reduces human intervention, which makes it suitable for industrial applications. The designed setup is beneficial for educational purposes to understand industrial processes such as PLC Programming real-time monitoring carried out in industries*

Keywords: *Conveyor System, Infrared Sensors, PLC Automation, Delta DVP16ES2 PLC, SCADA, DC pump motor, Bottle filling, Bottle Counting, Relay, Buck Converter, Lab utilisation, Process control, Industrial Automation.*

I. INTRODUCTION

Automation significantly improves efficiency, accuracy, and productivity in manufacturing and industrial automation systems. The precise control and consistency in bottle filling is essential in industries such as pharmaceutical, chemicals and beverages. Traditional or manual filling methods can affect product quality and production rate, which requires more filling time prone to inaccuracies. To overcome these limitations, this work details the design and development of SCADA Controlled Multi- Ingredient Bottle Filling System Using Conveyor Mechanism. Among various techniques, conveyor-based automation systems play a crucial role in modern material handling and bottle filling applications. An automated bottle filling system uses a SCADA system integrated with sensors and timing algorithms to ensure precise operation, as presented in this project. This system uses a motor-driven conveyor to transport bottles at multiple stations and infrared sensors for bottle detection and filling. According to sensor inputs, the PLC controls conveyor movements, and the DC pump motor connected to the storage tank controls the filling process based on a time delay. This project aims to provide a cost-efficient and educational platform for understanding PLC automation and SCADA monitoring. The developed system not only integrates real industrial processes but also helps students to gain practical knowledge in production, process automation, instrumentation and control systems.

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II. LITERATURE REVIEW

To achieve accurate, uniform and efficient filling of multiple ingredients, modern bottle filling systems have significant advancements with the integration of automation and sensors to improve industrial efficiency. The need for real-time data and bottle count is essential for process management and monitoring.

Kaushika Patel (2025) presented an automatic bottle filling system using PLC and SCADA, where the complete process was automated through a programmable logic controller (PLC). The proposed system uses IR sensors for bottle detection and level sensors to monitor the liquid filling process, ensuring accurate and consistent filling of bottles. The control logic for sequential operations such as conveyor movement, bottle detection, positioning, filling, and stopping was developed using PLC programming. Furthermore, the system was integrated with SCADA for real-time monitoring, visualisation, and supervisory control, with implementation carried out using TIA Portal, enabling efficient operation, reduced human intervention, and improved production reliability.

M. D. Balsaraf (2024) developed a PLC-based automatic bottle filling system in which bottle detection, conveyor movement, and liquid filling operations were integrated using sensors and actuators. The system utilised infrared sensors to detect bottle presence and control the filling process accurately, thereby minimising wastage and improving efficiency.

Diptee Patil (2021) proposed an automated bottle filling, capping, and labelling system using a PLC-based controller. The study highlighted that automation significantly increases production rate, ensures uniformity, and reduces dependency on manual labour, making it highly efficient for large-scale industries.

Md. Liton Ahmed et al. (2019) presented an automated bottle filling system using PLC technology, emphasising the role of sensors and control logic in ensuring reliable operation. Their work highlighted the importance of integrating hardware and software components for achieving accurate and efficient automation.

Pankaj Prajapati (2019) implemented a PLC-based automatic bottle filling and capping system, focusing on synchronisation between conveyor movement and filling mechanisms. The study demonstrated improved coordination between different stages of the process, resulting in higher productivity and reduced operational errors.

III. METHODS

Hardware Description

I. Programmable Logic Controller

Fig. 1. PLC Unit

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The Delta DVP16ES2 Programmable Logic Controller is used as the central control unit in the system. It has 16 digital I/O points, including 8 inputs and 8 outputs, which are operated by a 24V DC supply. PLC provides input signals from IR sensors, which monitor the conveyor motor and liquid filling pumps through relay output.

II. Conveyor System

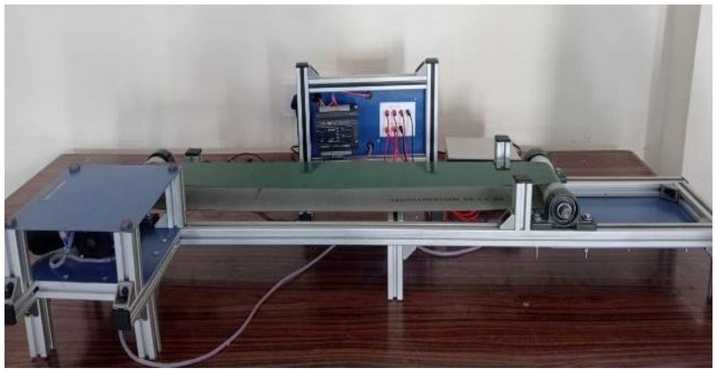

Fig. 2. Conveyor System

The conveyor system is operated with a 12V DC motor that provides movement for bottle filling. This mechanism is used for the transportation of bottles between different filling stations.

Infrared Proximity Sensor

Fig. 3. IR Proximity Sensor

The Infrared Proximity Sensor operated on a 5V DC supply and it works on the reflection of infrared light from bottles. When the bottle is placed in front of the IR sensors, it gives a digital signal to the PLC. This signal controls the conveyor movement and filling stations. It is used for proper synchronisation of bottles at filling stations.

Water Pump

Fig.4. Water Pump

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The DC pump is used for dispensing liquid ingredients into bottles at multiple filling stations. It is operated by a 12V DC supply and activated by a PLC through a relay module. The pump enables consistent and precise liquid dispensing.

Power Supply

Fig. 5. Power Supply

The power supply unit provides electrical power to all components in the system. Different components of different voltage levels, such as 24V for PLC, 12V for pump and motor and 5V for sensors, are operated by a power supply unit.

Relay Module

Fig. 6. Relay Module

Relay Module acts as a switching device used to control high-power loads. It interface between the Delta PLC and field devices such as 12V DC pumps and the conveyor motor. This module increases system safety by providing electrical isolation between the control unit and actuators.

Buck Converter

Fig. 7. Buck Converter

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A buck converter is a DC-to-DC step-down voltage regulator. It converts a high input voltage into a lower output voltage. It is used to step down a 12V or 24V supply to 5V required for IR sensors. It ensures a stable supply to sensors for bottle detection.

SOFTWARE DESCRIPTION

WPL Soft

A user-friendly ladder logic programming software, WPL Soft, is used for programming and control of the PLC-based system. It ensures simulation, debugging and efficient development of the control program. It uses multiple programming instructions like counters, timers, data registers and internal relays, which are used for implementing automation processes. It provides real-time observation of PLC inputs, outputs and internal states. This software is used to design control logic for multi-station bottle filling.

Input	Output
X3	Y2
X4	Y3
X5	
X6	

DIAView

In this project, DIAView SCADA Software is integrated with the Delta DVP16ES2 PLC, which controls the system. It provides real-time monitoring by continuously displaying the status of components such as conveyor belt, IR sensors and filling stations. This software also allows for performing control actions such as starting and stopping the conveyor and resetting the system. It ensures accurate operation of the multi- station bottle filling system by increasing process visualisation, control accuracy and operational efficiency.

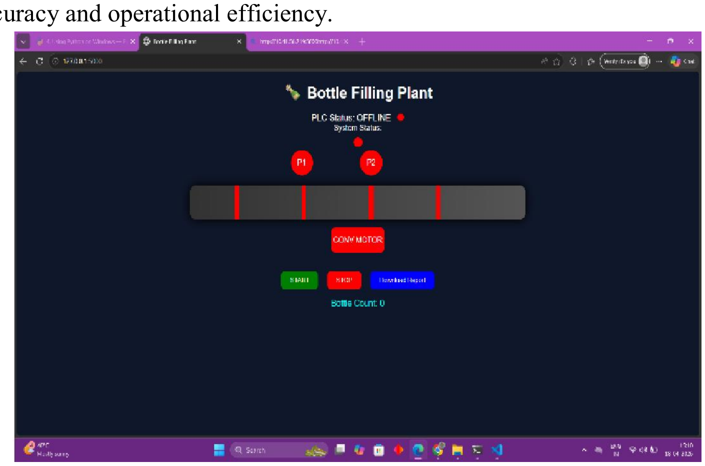

Fig. 8. SCADA System

IV. WORKING PRINCIPLE

The operation is based on sequential automation designed to perform automatic detection, positioning and filling of bottles with multiple liquid ingredients. The working principle is described as follows:

Bottle Detection

The process begins when the bottle is placed on the conveyor belt in front of the sensor. An Infrared sensor positioned at the starting point of the conveyor detects the bottle and sends the signal to the PLC, which starts the conveyor.

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Conveyor Mechanism

By receiving the detected signal, the conveyor motor is activated by the PLC. The conveyor, driven by a 12V DC motor, ensures the smooth bottle transportation towards the designated filling station.

Bottle Filling

The bottle is stopped at the first filling station for the dispensing of the first ingredient. After completion, the conveyor starts to transport the bottle to the next station. The same process of bottle filling is carried out at the second station.

Process Completion

After bottle filling at both stations, the bottle moves to the final stage, where it is detected by the last sensor. This sensor transmits the signal to the PLC, which stops the conveyor, indicating the process is completed.

V. WORKING OF THE MODEL

The operation begins when an empty bottle is placed in front of the first sensor on the conveyor belt as input. An infrared(IR) sensor positioned at the entry point detects the presence of a bottle. This sensor works on the principle of infrared reflection, where the emitted IR rays are reflected upon the bottle surface. Once the bottle is detected, a signal is transmitted to the Programmable logic controller. This PLC signal initiates the activation of the conveyor motor through a relay interface.

The conveyor motor of a 12V DC supply starts the movement of the conveyor belt and transports the bottle towards the first filling station. The bottle is detected at the first filling station by the second infrared sensor, and the PLC stops the conveyor to hold the bottle in the correct position for the filling process. Once the bottle is reached at first filling station, the PLC activates the liquid filling pump connected to the first ingredient tank. The pump is controlled by an internal timer in the PLC for a fixed duration of 5 seconds. During this time, 100 ml of liquid is dispensed into the bottle. After completion of 5 seconds interval, the PLC stops the working of the pump, ensuring that no excess liquid is dispensed. After the filling process is completed at the first filling station, the conveyor gets restarted until the bottle reaches the next station. Once the bottle is reached at third filling station, it is detected by the third infrared sensor, and conveyor gets stopped for filling the bottle. As the bottle is detected at the second station, the working of the pump is initiated again. The pump is responsible for dispensing the second ingredient within the time interval of 5 seconds, delivering an additional 100 ml of liquid into the bottle. This results in a combined filling of two ingredients in a controlled and sequential manner. The use of time-based control ensures uniform filling for each cycle.

After completing both filling stages, the bottle is transported towards the final position on the conveyor. The fourth infrared sensor is used to detect the presence of a bottle on the conveyor. When the sensor is triggered, the PLC interprets it as the completion of the filling process. The conveyor is then stopped, allowing the bottle to be removed. All this process is monitored and controlled through a Supervisory Control and Data Acquisition System (SCADA). This provides real-time visualisation of the sensor status, conveyor movement and filling operations. It continuously updates the bottle count and provides the accurate count of bottles, displayed on the SCADA screen. In addition to bottle count, the system records the actual time at which each bottle is filled, often referred to as watch time. By maintaining accurate historical data, the system enhances transparency, improves operational efficiency and supports better decision-making in automated industrial processes. The overall process depends upon the interaction between sensors, PLC logic, conveyor mechanism and the SCADA system. It results in a reliable, efficient and automated bottle filling process for industrial applications.

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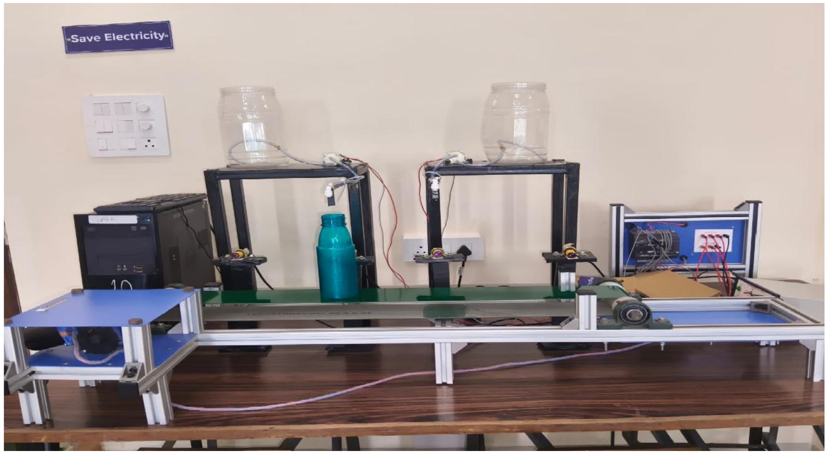

Fig. 9. Working Model

VI. RESULT

The SCADA-controlled multi-ingredient bottle filling system was successfully implemented and tested, demonstrating accurate and reliable operation. The conveyor system responded effectively to input from the IR sensors, ensuring smooth transportation of bottles between different stations. When the first sensor detected a bottle, the conveyor started automatically, and subsequent sensors correctly identified bottle positions at each filling stage. At the second and third stations, the conveyor stopped precisely for a fixed duration of 5 seconds, allowing proper dispensing of ingredients using 12V pumps. After each filling operation, the conveyor resumed motion without delay, maintaining a continuous process flow. The final sensor detected the bottle at the last stage and stopped the system, indicating completion of the filling cycle.

The system maintained consistent timing throughout multiple trials, with an average cycle time of approximately 15 to 20 seconds per bottle. The filling process showed uniformity, with only slight variations due to the time-based control mechanism and pump performance, resulting in an error margin. The IR sensors exhibited reliable detection when properly aligned, and the conveyor mechanism operated smoothly without mechanical disturbances. The SCADA system successfully displayed the real-time status of sensors, conveyor, and pumps, and also recorded operational data such as cycle time and bottle count, confirming effective monitoring and control of the entire system.

VII. CONCLUSION

The SCADA-controlled multi-ingredient bottle filling system using a conveyor mechanism was successfully designed and implemented to achieve automated and sequential filling operations. The integration of IR sensors, PLC (Delta DVP16ES2), DC motors, pumps, and relay modules enabled smooth coordination between bottle detection, conveyor movement, and liquid dispensing processes. The system demonstrated reliable performance by accurately stopping the conveyor at each filling station, dispensing ingredients for a controlled time duration, and resuming operation without manual intervention. The SCADA system provided effective real-time monitoring and control of the entire process, including visualisation of sensor states, conveyor status, pump operation, and process timing. It also supported data logging, which can be used for production analysis and performance improvement. The overall system reduced human involvement, improved process consistency, and enhanced operational efficiency. Although the system achieved satisfactory results, the use of time-based filling introduced minor variations in accuracy. This limitation can be improved in future developments by incorporating flow sensors or volume-based control techniques. Additionally, further enhancements such as IoT integration and advanced fault detection can make the system more efficient and suitable for large-scale industrial applications. Overall, the project successfully fulfils the objective of developing an automated, SCADA-based multi-ingredient bottle filling system with improved reliability and efficiency.

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REFERENCES

[1]. M. D. Balsaraf, Industrial Automation and Control Systems (used as an academic reference in PLC/SCADA studies).
[2]. Dr. Kaushika Patel, Research Contributions in Industrial Automation and SCADA-Based Systems (academic reference).
[3]. Bolton, W. (2015). Programmable Logic Controllers. Newnes, Elsevier.
[4]. Petruzella, F. D. (2017). Programmable Logic Controllers. McGraw-Hill Education.
[5]. Boyer, S. A. (2004). SCADA: Supervisory Control and Data Acquisition. ISA (International Society of Automation).
[6]. Webb, J. W., & Reis, R. A. (2013). Programmable Logic Controllers: Principles and Applications. Prentice Hall.
[7]. Mackay, S., Wright, E., Reynders, D., & Park, J. (2003). Practical Industrial Data Networks. Newnes.
[8]. Krishna Kant. (2010). Computer-Based Industrial Control. Prentice Hall of India.
[9]. Johnson, C. D. (2003). Process Control Instrumentation Technology. Prentice Hall.
[10]. Delta Electronics Inc. DVP-PLC User Manual (DVP16ES2 Series).