Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 11, No.1, November : 2025

AUTOMATIC BOX FILLING USING PLC

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ABSTRACT
The Automatic Box Filling System using PLC is a complete project that shows how PLCs are used in industrial automation. Using a conveyor belt and filling valve, the system is made to fill boxes with a particular commodity, like powder, liquid, or granular material. To guarantee precise and effective box filling, the PLC manages every component of the system, including the conveyor belt, filling valve, and sensors. A conveyor belt moves empty boxes to a filling station, where a sensor recognises the package and starts the filling process. The PLC fills the box with the appropriate product level by controlling the filling valve after receiving input from the sensor. Additionally, safety interlocks and alarms are part of the system. To avoid mishaps and guarantee dependable functioning, the system also has safety interlocks and alarms. The project entails using PLC simulation software to create and simulate the Automatic Box Filling System. The simulation shows how well PLC-based automation works in industrial settings by validating the system's functionality and performance.

Keyword:
Automatic Box Filling, PLC, Programmable Logic Controller, Industrial Automation, Conveyor Belt.

I. Introduction
A state-of-the-art industrial automation solution that demonstrates the potential of Programmable Logic Controllers (PLCs) in optimising manufacturing operations is automatic box filling via PLC simulation. This system uses a conveyor belt and motor to precisely fill boxes with a variety of goods, such as powders, liquids, and granular solids. The PLC acts as the operation's brain, managing every step to guarantee accurate and effective filling.This project's simulation component lowers the possibility of errors and increases overall efficiency by enabling testing and validation of the system's functionality prior to actual implementation. The automatic box filling system can be designed, tested, and improved in a virtual environment using PLC simulation software, which makes it a perfect option for businesses looking to streamline production procedures and raise product quality. A conveyor belt moves empty boxes to a filling station, where a sensor recognises the box and initiates the filling process. This is the automatic box filling system. After receiving input from the sensor, the PLC directs the motor to fill the box with the appropriate amount of product. The system is a flexible solution for a range of industrial applications since it can be tailored to suit varied box sizes, product types, and filling levels. All things considered, the PLC simulation-based automatic box filling is a creative solution that highlights the power. The automatic box filling system can be designed, tested, and improved in a virtual environment using PLC simulation software, which makes it a perfect option for

businesses looking to streamline production procedures and raise product quality. A conveyor belt moves empty boxes to a filling station, where a sensor recognises the box and initiates the filling process. This is the automatic box filling system. After receiving input from the sensor, the PLC directs the motor to fill the box with the appropriate amount of product. The system is a flexible solution for a range of industrial applications since it can be tailored to suit varied box sizes, product types, and filling levels.This paper presents a PLC-based monitoring and control system for a three-phase induction motor. It describes the design and implementation of the configured hardware and software. The test results obtained on induction motor performance show improved efficiency and increased accuracy in variable-load constant-speed-controlled operation. Thus, the PLC correlates and controls the operational parameters to the speed set point requested by the user and monitors the induction motor system during normal operation and under trip conditions. [1]

II. Methodology

The methodology for the PLC-based automatic box filling project entails a thorough and organised approach to system design, development, and implementation. Project planning and analysis is the first step, during which the project's goals, needs, and scope are established, along with a thorough budget and schedule. Designing the box filling system layout, choosing and acquiring parts like the PLC, sensors, and conveyor, as well as creating system architecture and wiring diagrams, are all part of the system design and development phase. The PLC programming step entails creating a program that manages the box filling procedure, including conveyor control and product counting, and testing and debugging the program to guarantee precision and effectiveness. Box detection and product counting sensors must be installed, calibrated, and tested for accuracy and dependability. The PLC, sensors, and conveyor are integrated during the system integration and testing phase, and the system's performance and functionality are tested to guarantee dependable operation. Last but not least, the deployment and maintenance phase entails setting up the system in a production setting, educating operators and maintenance staff, and carrying out routine upgrades and maintenance to preserve accuracy and efficiency. At every stage of the project, testing and validation are carried out to make sure the system satisfies the necessary quality standards, and targets and schedules are set to guarantee timely completion.

Hardware Components

PLC -PROGRAMMABLE LOGIC CONTROLLER

The brain of the operation, responsible for controlling and coordinating the entire process. PLC Type: Industrial-grade PLC with digital and analog I/O capabilities. Processor: 32-bit RISC CPU with 100 MHz clock speed. Memory: - Program memory: 64 kB ,Data memory: 128 kB,Retentive memory: 8 kB I/O Capabilities: -Digital inputs: 16 points (24 VDC) , Digital outputs: 16 points (24 VDC, 0.5 A) ,Analog inputs: 4 points (0-10 VDC or 4-20 mA) ,Analog outputs: 2 points (0-10 VDC or 4-20 mA),Communication:RS-232C serial port for programming and communication,ethernet port for network connectivity (optional) .

CONVEYOR BELT

A conveyor belt is a mechanical system used for transporting materials or products from one place to another in various industries. It consists of a continuous belt made of rubber, PVC, or fabric, which moves over two or more pulleys. The motor-driven pulley, known as the drive pulley, rotates and creates friction that pulls the belt forward, while idler pulleys support and guide the belt during movement. Conveyor belts are widely used in manufacturing, packaging, food processing. and material handling because they allow smooth, continuous, and automated movement of items. In automated systems, sensors are used to detect objects on the belt, and a PLC (Programmable Logic Controller) control the start, stop, and speed of the conveyor, making it highly efficient and reliable. In an automatic box-filling system, the conveyor belt carries empty boxes to the filling station, stops when a sensor detects the box, and restarts after the filling is completed. Conveyor belts reduce manual labor, increase production speed, improve accuracy, and ensure consistent workflow in industrial automation.

SENSORS

Sensors are electronic devices that detect physical changes in the environment and convert them into electrical signals for monitoring or control. They are widely used in automation systems to sense conditions such as the presence of an object, distance, motion, temperature, pressure, or light. In industrial automation, sensors play a crucial role by providing real-time information to controllers like PLCs, which use the sensor data to make decisions and operate machines. For example, in a conveyor-based box filling system, sensors such as infrared (IR) sensors, proximity sensors, or photoelectric sensors detect the presence of a box at the filling station. When the sensor identifies an empty box, it sends a signal to the PLC to stop the conveyor and start the filling process. After the filling is completed, another sensor or timer triggers the conveyor to restart. Sensors help ensure accuracy, reduce manual errors, improve safety, and enable smooth and efficient automation in industries. [2]

MOTOR

A PLC motor refers to any electrical motor that is controlled using a Programmable Logic Controller (PLC) in an automation system. The PLC does not directly power the motor; instead, it sends control signals to a motor starter, relay, or motor driver, which then operates the motor safely. In industrial automation, a PLC motor is commonly used to drive machines such as conveyor belts, pumps, fans, mixers, and filling mechanisms. The PLC can start or stop the motor, control its direction, adjust its speed using a Variable Frequency Drive (VFD), and monitor overload conditions. Input sensors send signals to the PLC, and based on the programmed logic, the PLC energizes the motor output. For example, in an automatic box-filling system, the PLC controls the conveyor motor to move boxes forward, stop the motor when a sensor detects a box, and restart it once filling is completed. This makes PLC-controlled motors highly reliable, accurate, and efficient for industrial automation processes.

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III. Block Diagram

The block diagram illustrates the control system for an automated box filling process using a Programmable Logic Controller (PLC). The PLC is the central component, responsible for controlling and coordinating the various stages of the process. The diagram shows the different inputs and outputs connected to the PLC, including the start and stop signals for the box conveyor and product conveyor. The process begins with the "Start box conveyor" signal, which initiates the movement of empty boxes to the filling station. Once a box is detected, the "Box Detection" signal is sent to the PLC, which then triggers the "Stop box conveyor" and "Start product conveyor" signals. The product conveyor is responsible for filling the box with a specific number of products, which is counted and monitored by the "Counting of products" module. As the box is being filled, the PLC continuously monitors the "Counting of products" signal to ensure that the correct number of products is reached. Once the desired number of products is achieved, the "Box filled with specific number of products" signal is sent to the PLC, which then triggers the "Stop product conveyor" signal. This halts the filling process, and the box is ready for further processing or packaging.

The use of a PLC in this automated box filling process provides a high degree of control and flexibility, allowing for easy modification and adjustment of the process parameters. The block diagram provides a clear and concise representation of the system's architecture, making it easier to understanding and analyze the process. Overall, the diagram demonstrates the effectiveness of using a PLC to control and automate industrial processes, improving [3]

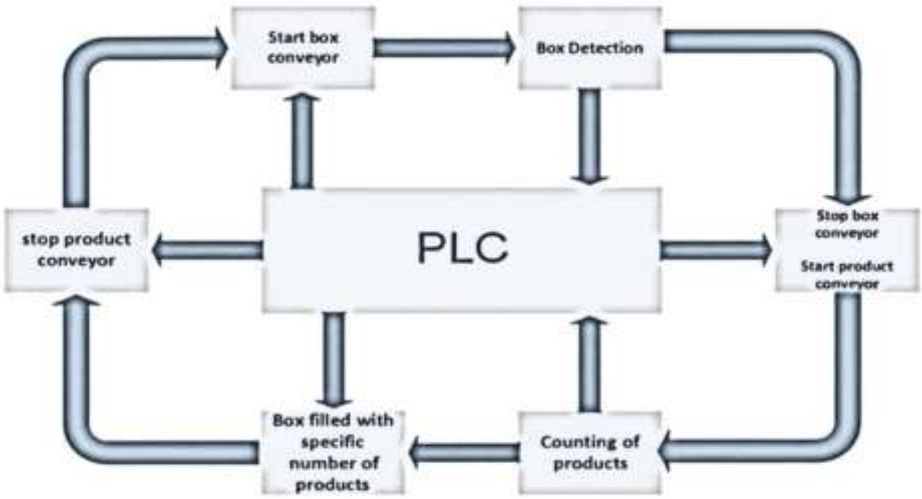

Fig.1: Block Diagram.

IV. Results and Discussion

The automatic box filling system using PLC was successfully designed, implemented, and tested, demonstrating high accuracy and efficiency in filling boxes with products. The PLC programming allowed for precise control of the filling process, ensuring accurate product counting and conveyor control, while the sensor installation and calibration ensured accurate detection of box presence and product count. The system's performance can be attributed to the effective integration of the PLC, sensors, and conveyor, which worked together seamlessly to achieve reliable and efficient operation. The results indicate that the system is suitable for industrial applications, and its performance can be further improved by implementing additional features such as automatic box size detection, multiproduct filling capability, and real-time production monitoring and reporting, which would enhance its flexibility, productivity, and overall efficiency. [4]

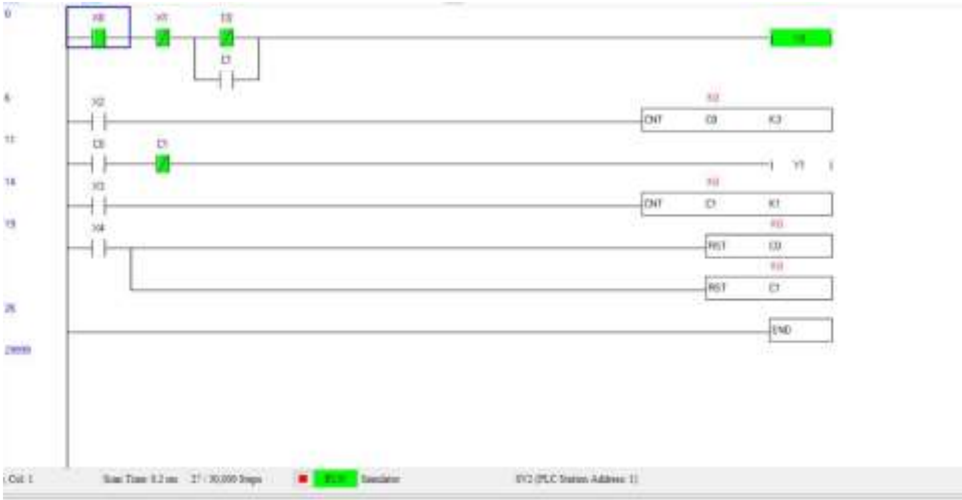

Fig.2: Dual Counter Activation with Output Control

Fig.3: Parallel Counter Activation with Modular Output

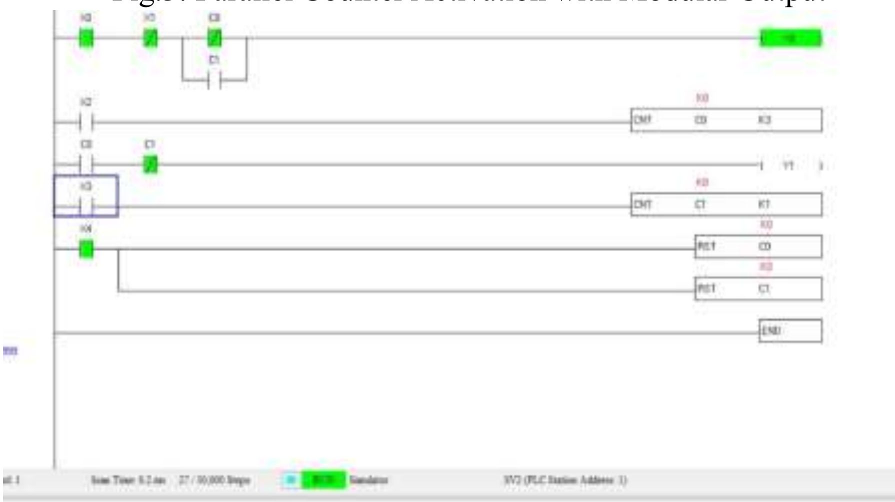

Fig:4: Expanded Counter and Reset Logic with Sequential Control

V. Conclusion

The automatic box filling system using PLC simulation is an efficient and reliable solution for packaging industries, offering improved production efficiency, accuracy, and safety. By leveraging

PLCs and simulation software, industries can transform traditional packaging processes, making them more streamlined and cost-effective. The system's accuracy and flexibility make it an ideal solution for various packaging applications, and its potential for future enhancements with IoT integration and data analytics makes it a valuable investment for industries looking to stay competitive.

VI. References

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