AUTOMATIC FILLING AND SEALING MACHINE

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Abstract- *This paper presents the design and implementation of an automatic filling and sealing machine tailored for grocery stores to enhance operational efficiency and reduce packaging time. The machine aims to streamline the packaging process, ensuring consistency in packaging size, weight, and sealing while preserving product freshness. By automating these tasks, the machine minimizes manual labor, thus increasing production output and meeting customer demand effectively. The design incorporates customization options for packaging sizes, shapes, and materials to adapt to various product requirements and consumer preferences. Through this innovation, grocery stores can improve overall efficiency, reduce costs, and maintain high standards of product quality, ultimately enhancing customer satisfaction and loyalty.*

***Key Words*: Automatic Filling and Sealing Machine, Grocery Stores, Operational efficiency, Automation, Enhancing customer satisfaction.**

1.INTRODUCTION

Grocery stores are pivotal in catering to the daily needs of consumers, necessitating efficient and timely processes to meet the ever-growing demand for packaged goods. However, traditional manual methods of filling and sealing products often fall short in terms of time efficiency and operational effectiveness. In this context, the integration of automatic filling and sealing machine emerges as a promising solution to address the challenges faced by grocery stores. This machine is designed to streamline packaging processes, ensuring consistency, and quality while significantly reducing time and labor costs. This paper explores the design and implementation of an automatic filling and sealing machine tailored specifically for grocery stores, aimed at increasing efficiency and reducing time constraints. By leveraging automation technology, this machine has the potential to revolutionize packaging operations in grocery stores, enabling them to meet customer demands effectively and maintain competitiveness in the retail industry.

1.1 Problem Statement

The problem statement for automatic filling and sealing machine in grocery stores is to optimize packaging processes to meet consumer demand while ensuring product quality, freshness, and regulatory compliance. Challenges include efficient operation, error reduction, labor cost minimization, and adapting to diverse product requirements and packaging preferences. Additionally, concerns arise about perishable goods preservation, hygiene standards, and the need for continuous innovation to meet evolving market demands.

1.2 Objective

Automatic filling and sealing machine in grocery stores optimize packaging processes, ensuring consistency, freshness, and regulatory compliance while reducing manual labor and costs. This enhances operational efficiency, minimizes errors, and boosts brand image, ultimately enhancing customer satisfaction.

2. RESOURCES NEEDED

The main components of this system are given below:

- PLC
- LOAD CELL
- HMI (Human Machine Interface)
- SERVO MOTORS
- SENSORS

(a)PLC:

A PLC, or Programmable Logic Controller, is a ruggedized industrial computer used to automate electromechanical processes by monitoring inputs, executing logic based on programmed instructions, and controlling outputs accordingly.

Need of Delta DVP 28SV PLC:
The DVP 28SV PLC was selected due to its compatibility and tailored functionality for seamlessly integrating with load cells in our automation setup. Its specialized input modules or analog input channels are designed to efficiently interface with load cells, offering high-resolution analog-to-digital conversion for precise signal acquisition. Additionally, these modules incorporate advanced features like filtering and calibration to enhance the accuracy and reliability of load cell signal measurement. By leveraging these capabilities, the PLC facilitates seamless integration of load cell functionality into our automation system, ensuring accurate and dependable performance in monitoring and controlling load-related processes.

DVP 28SV PLC

Fig -1: DVP 28SV PLC

(b)Load Cell and Its Module:
Load cells are crucial transducers converting force into electrical signals for precise measurements in industrial and scientific fields. With their reliable conversion mechanism, load cells aid in essential data acquisition for quality control and research purposes.

Need of DVP201LC-SL Load Cell Module:
The DVP 201LC SL load cell module was chosen for its compatibility with the DVP 28SV PLC and its specialized capability to interface with load cells. Featuring dedicated analog input channels, it ensures accurate signal conditioning and processing of load cell outputs, enabling precise measurement of force or weight. Integrated seamlessly into the PLC programming environment, it enables precise control and monitoring of load-related processes within our automation system.

DVP 201LC-SL

LOAD CELL

Fig -2: DVP 201LC-SL **Fig -3**: Load Cell

(c)HMI (Human Machine Interface):
HMI, or Human-Machine Interface, facilitates user interaction with machines via touchscreens or graphical displays, enabling control and monitoring of automated systems.

Need of HMI:
The integration of a single Human-Machine Interface (HMI) device instead of separate display and keypad components streamlines user interaction and reduces hardware complexity. This consolidated approach optimizes space utilization and simplifies wiring, resulting in a more efficient and cost-effective control system design. Additionally, the unified HMI provides a cohesive user interface, enhancing user experience and facilitating intuitive operation within our automation setup.

EXOR eSMART 07M HMI

Fig -4: EXOR eSMART 07M HMI

(d)Servo Motor:
A servo motor functions as a rotary actuator, enabling precise management of angular position, velocity, and acceleration. It comprises a motor linked with a feedback

sensor, ensuring meticulous and controlled motion within automation setups.

Need of Servo Motor:
The selection of the Panasonic 200W 3000rpm servo motor was driven by the requirement for precise shaft rotation in our application. Integrated with a PLC, it facilitates accurate control over the motor's angular position, enabling precise positioning and stopping at specific angles. With its rated power and rotational speed, the Panasonic servo motor offers the necessary torque and velocity capabilities to meet our rotational degree specifications. This servo motor's high-speed operation and accurate feedback system ensure reliable performance, meeting the stringent demands of our automation system for precise motion control.

SERVO MOTOR

Fig -5: 200W Servo Motor

SERVO DRIVER

Fig -6: 200W Servo Driver

The selection of the Panasonic 400W 3000rpm servo motor with gearbox was necessitated by the specific requirements of our application, which involved the operation of an arm and a crank mechanism. The addition of the gearbox serves to reduce the rotational speed of the motor while increasing torque output, enabling efficient operation of the arm and crank system. Without the gearbox, the motor would be subjected to hunting, causing instability and inefficiency in motion control. Additionally, the choice of a 400W motor over a 200W motor was driven by the need for increased power to effectively drive the load and ensure smooth and precise movement of the mechanism. This configuration optimizes performance and reliability, meeting the demanding requirements of our application.

SERVO MOTOR

Fig -7: 400W Servo Motor

SERVO DRIVER

Fig -8: 400W Servo Driver

Fig -9: Gearbox

(e)Sensors:
A sensor functions as a tool to identify or quantify physical attributes and transform them into interpretable signals, either for an observer or a computer. These devices find widespread use in diverse applications, including monitoring, control systems, and electronic devices, facilitating the collection of pertinent data regarding their surroundings.

Need of Sensors:
The utilization of the Inductive Sensor NBB8-18GM50-E2 and GTB6 N1212 sensors in our system serves specific purposes. The GTB6 N1212 sensor is employed for detecting the presence of a plastic bag. Its advanced technology allows reliable identification of non-metallic materials like plastic. On the other hand, the NBB8-18GM50-E2 inductive sensor is utilized for metal detection, assisting in accurately stopping the servo motors at predefined angles. When a metal object is detected, the sensor triggers the control system to halt the servo motors, ensuring precise positioning. This dual-sensor approach enhances the automation system's accuracy and reliability in handling plastic bags while achieving precise servo motor control based on metal detection.

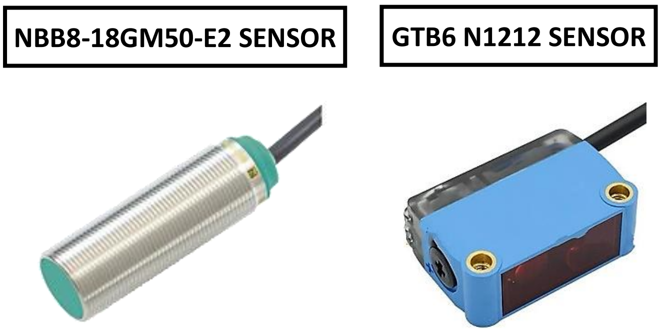

Fig -10: Sensors

3. LAYOUT OF THE MACHINE

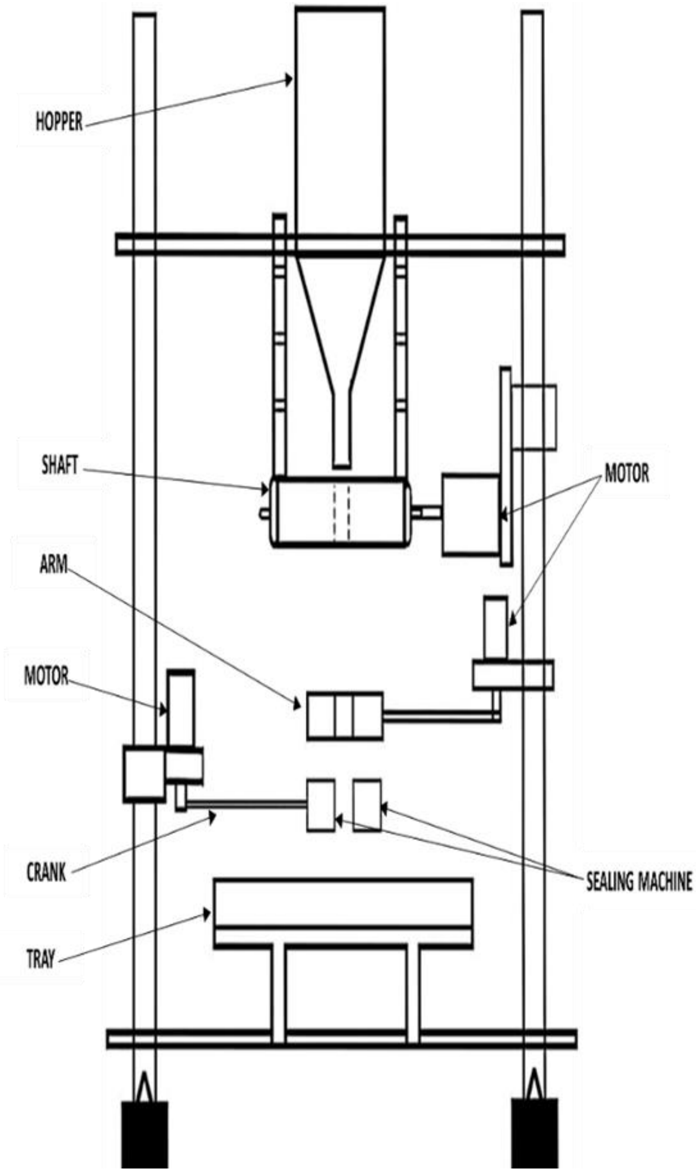

Fig -11: Layout of the Machine

3. BLOCK DIAGRAM

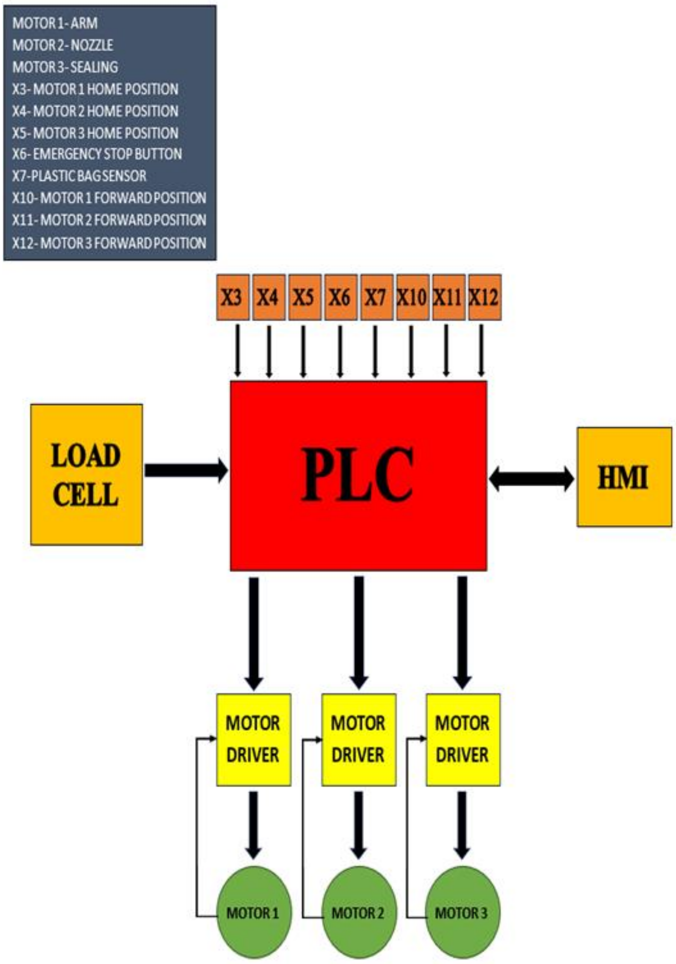

Fig -12: Block Diagram

Working:

The block represents a control system that uses a Programmable Logic Controller (PLC) to manage various motors and inputs in an industrial setting. Here's a breakdown of the components and how they work together:

1) **PLC (Programmable Logic Controller):** This is the central unit that controls the entire system. It receives input signals from various sensors and devices, processes these signals according to the programmed logic, and then sends output signals to control the motors.

2) **HMI (Human-Machine Interface):** This is the user interface that allows an operator to interact with the PLC. The operator can monitor system status, input commands, and make adjustments to the PLC program if necessary.

3) **Load Cell:** This is a type of sensor that measures the weight. The signal from the load cell is sent to the PLC, which can use this information to make decisions, such as controlling the motor for closing the nozzle.

4) **Motor Drivers:** These devices act as intermediaries between the PLC and the motors. They receive control signals from the PLC and supply the necessary power to the motors to drive them as instructed.

5) **Motors (MOTOR 1, MOTOR 2, MOTOR 3):** These are the actuators in the system that perform physical actions, such as moving an arm, adjusting a nozzle and sealing a package. Each motor is controlled by its respective motor driver.

6) **Inputs to the PLC:** The diagram lists several inputs which are connected to the PLC. These inputs are sensors that provide the PLC with information about the system's state. For example:

   a. X3, X4, and X5 are sensors indicating whether each motor is in its home position.
   b. X6 is an emergency stop button that, when pressed, sends a signal to the PLC to halt all operations for safety reasons.
   c. X7 is a sensor that detects the presence of a plastic bag, for a packaging process.

7) **Outputs from the PLC:** The outputs are the control signals sent from the PLC to the motor drivers, instructing the motors to move to specific positions or perform certain actions.

In operation, the PLC continuously monitors the input signals, processes them according to its programmed logic, and sends out commands to the motor drivers. The motor drivers then power the motors to perform tasks such as moving to a forward position (as indicated by X10, X11 and X12 for motors 1, 2 and 3 respectively).

The HMI provides a user interface for monitoring and control, allowing an operator to oversee the process and make adjustments as needed. The load cell input is an example of a feedback mechanism that the PLC can use to ensure precise control over the system, such as maintaining a specific weight during operation.

4. RESULT

The rapid filling and sealing capabilities of the automatic filling and sealing machine demonstrate its high-speed performance in packaging operations. With the ability to fill and seal a 500-gram pouch within just 10 seconds, the machine showcases exceptional efficiency and productivity. This impressive speed is achieved through the integration of advanced mechanical and electrical components, precise control algorithms implemented in the PLC, and optimized process parameters. The filling mechanism ensures accurate dosing of the product, while the sealing unit swiftly seals the pouch with precision. Additionally, the seamless coordination of various subsystems within the machine enables rapid cycle times, allowing for quick turnaround and increased throughput in production. Overall, the fast-processing speed of the automatic filling and sealing machine underscores its capability to meet the demanding requirements of high-volume packaging operations in various industries.

5. CONCLUSIONS

In conclusion, the development and implementation of automatic filling and sealing machine for grocery stores represent a significant advancement in packaging technology, addressing key challenges in meeting consumer demand while ensuring product quality, freshness, and regulatory compliance. Through this project, we gained valuable experience and knowledge in several areas. Firstly, we deepened our understanding of automation systems and their applications in the retail industry, particularly in optimizing packaging processes for perishable goods. Secondly, we enhanced our technical expertise in PLC programming, load cell interfacing, and HMI integration, crucial components in the design and operation of the machine. Overall, this project provided us with invaluable hands-on experience and knowledge in developing innovative solutions to address real-world challenges in the grocery store industry.

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