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Automatic Stamping and Labelling System Using PLC

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***Abstract*—Industrial automation demands efficient, reliable, and repeatable processes. Manual stamping and labelling on product boxes are a time-consuming operation prone to human error, inconsistency, and reduced throughput. This paper presents the design and implementation of an Automatic Stamping and Labelling System using a Siemens Programmable Logic Controller (PLC). The system employs an infrared (IR) sensor to detect boxes moving on a conveyor belt, followed by automatic actuation of a pneumatic cylinder through a solenoid valve for stamping, and then continues the conveyor for subsequent labelling operations. A relay-driving circuit using a transistor (BC547), diodes (1N4007), a voltage regulator IC (7805), resistors, and capacitors form the interfacing electronics between the PLC outputs and the actuators. The PLC ladder logic controls the complete sequential operation with precise timing. The proposed system significantly reduces manual intervention, improves product traceability, and increases production efficiency in industrial packaging lines.**

***Index Terms*—Automatic Stamping, Conveyor Automation, Industrial PLC, IR Sensor, Ladder Logic, Pneumatic Cylinder, Relay Control, Siemens S7-1200, Solenoid Valve**

I. INTRODUCTION

The rapid expansion of manufacturing and packaging industries has created a pressing need for automated systems that can perform repetitive tasks with high accuracy and minimal human involvement. Among these tasks, stamping (applying date codes, batch numbers, or inspection marks) and labeling (affixing product identification labels) are critical steps in the quality control and traceability chain of any production facility. Traditional manual stamping and labeling operations suffer from numerous drawbacks, including operator fatigue, inconsistent placement, misalignment, and significantly lower production rates. As production volumes scale up, these issues become magnified, leading to increased rejection rates and potential regulatory non-compliance, particularly in industries such as pharmaceuticals, food and beverage, and electronics.

Programmable Logic Controllers (PLCs) have emerged as the backbone of modern industrial automation. Their robustness, real-time processing capability, and ease of programming using standardized ladder logic make them ideal for controlling sequential manufacturing processes. Combined with pneumatic actuators, conveyor systems, and sensor technologies, PLCs can deliver precise, repeatable, and high-speed operations.

This paper presents a complete design of an Automatic Stamping and Labeling System controlled by a Siemens PLC. The system integrates an IR sensor for box detection, a relay module for actuator interfacing, a solenoid valve and pneumatic cylinder for the stamping mechanism, and a wiper motor-driven conveyor. The PLC ladder logic ensures a well-coordinated sequential process: detect, stop, stamp, and resume. The subsequent sections detail the literature review, system architecture, component specifications, working principle, ladder logic, circuit design, and future enhancements of the proposed system.

II. LITERATURE REVIEW

The domain of automated stamping and labeling systems has been explored across various research efforts, each contributing incrementally to the state-of-the-art in industrial automation. A review of relevant prior work is presented below.

Kumar et al. [1] proposed an automated conveyor-based packaging system using a PLC wherein photoelectric sensors were employed to detect product presence and initiate labeling via servo-motor-driven applicators. Their work highlighted the importance of sensor selection for high-speed lines and demonstrated that PLC-controlled systems achieve cycle times below 200 ms per unit.

Sharma and Patel [2] designed a pneumatic stamping system integrated with an HMI-based Siemens S7-1200 PLC for batch coding in pharmaceutical packaging. The system achieved a stamping accuracy of ±0.5 mm and reduced rejection rates by 78% compared to manual operations. Their study validated the feasibility of 3 PSI pneumatic cylinders for light-duty stamping tasks. Mehta et al. [3] demonstrated an IR-sensor-based object detection and sorting system on a PLC-controlled conveyor. The authors established that IR proximity sensors with 5V operating voltage and adjustable sensitivity are well-suited for box detection in environments with moderate ambient lighting. The transistor-relay interfacing methodology presented in their circuit design has been widely adopted in subsequent works.

Rajan and Subramanian [4] conducted a comparative study of relay-based and solid-state switching for PLC output interfacing with solenoid actuators. Their results indicated that for low-frequency, high-current switching (as required by solenoid valves), electromechanical relay modules provide better isolation and long operational life. The 12V 2-channel relay module was identified as optimal for single-actuator industrial applications.

Zhang et al. [5] investigated IoT-enabled conveyor systems where PLC ladder logic was extended with MQTT-based cloud monitoring. Their work provides a roadmap for upgrading conventional PLC systems with Industry 4.0 connectivity, which forms the basis of the future scope proposed in this paper. A synthesis of this literature reveals that while individual components of the proposed system have been studied in isolation, an integrated, low-cost automatic stamping and labeling system using a relay-driven pneumatic actuator with a complete PLC control scheme suitable for small and medium enterprises (SMEs) remains underrepresented. This paper addresses that gap.

III. SYSTEM ARCHITECTURE / BLOCK DIAGRAM

The overall system architecture follows a classic sense-decide-act paradigm, structured into three functional layers: the sensing layer, the control layer, and the actuation layer.

A. Sensing Layer

The sensing layer consists of an IR sensor module positioned on the side of the conveyor belt at the stamping station. The IR sensor transmitter emits an infrared beam across the conveyor path. When a box interrupts this beam, the receiver detects the change and generates a digital output signal. This signal is conditioned through the transistor-resistor circuit and fed to the PLC's digital input module.

B. Control Layer

The Siemens PLC forms the nerve center of the system. It continuously scans its input registers for a HIGH signal from the IR sensor. Upon detection, the PLC executes the programmed ladder logic sequence: it de-energizes the conveyor motor output, activates the relay output for solenoid valve control, holds this state for a pre-set time delay (typically 1–2 seconds), and then reactivates the conveyor. The PLC also handles safety interlocks, ensuring the conveyor cannot restart while the pneumatic cylinder is in the extended (stamping) position.

C. Actuation Layer

The actuation layer comprises three elements: the wiper motor driving the conveyor belt, the 12V relay module switching the solenoid valve power supply, and the pneumatic cylinder executing the stamping stroke. A regulated 5V power supply (derived from the 7805-voltage regulator IC) powers the IR sensor and the transistor base circuit, while a separate 12V DC supply powers the relay module and the solenoid valve coil. A A 12V DC supply operates the conveyor wiper motor (12V, 5A, 60 RPM), controlled via a relay/contactor driven by the PLC.

D. System Block Diagram Description

The system block diagram can be described as follows: The A regulated DC supply system is used. A 24V DC SMPS powers the PLC, while a separate 12V DC supply powers the wiper motor and solenoid valve and a 12V DC SMPS. The 12V DC output branches to the relay module and the solenoid valve. A 7805-voltage regulator, with input smoothing via a 1000 µF capacitor and a 1N4007 rectifier diode, produces a stable 5V DC for the IR sensor. The IR sensor output connects through a 2kΩ base resistor to the BC547 transistor, whose collector drives the relay coil. The relay’s normally open (NO) contact connects in series with the solenoid valve power supply. The PLC's digital output independently controls the conveyor motor through a contactor. The PLC's digital input receives the conditioned IR sensor signal.

IV. COMPONENTS USED

A. Siemens PLC

The Siemens S7-1200 series PLC is used as the primary control unit in this system. It features a modular architecture with a CPU module (CPU 314C-2DP), digital I/O modules, and a compact design suitable for panel mounting. The S7-1200 operates on 24V DC logic, supports ladder logic (LAD) programming through the STEP 7 or TIA Portal software environment, and provides deterministic scan cycle times in the range of 1–10 ms. It supports up to 32 digital inputs and 32 digital outputs in its standard configuration, making it more than adequate for this application. The PLC's built-in timers and counters are utilized for the stamping delay sequence.

B. 12V 2-Channel Relay Module

The relay module provides galvanic isolation between the low-current PLC output signals (24V DC, typically limited to 0.5A) and the higher-current solenoid valve coil. Each channel of the 2-channel relay module contains an electromechanical relay rated at 10A/250V AC or 10A/30V DC. The module includes onboard optocouplers for additional isolation and indicator LEDs for visual status monitoring. The low-level trigger option allows the relay to activate when the control signal (from the transistor collector) goes LOW, providing flexibility in circuit design.

C. IR Sensor Module

The infrared proximity sensor used in this system is a reflective type IR module operating at 5V DC. It consists of an IR LED transmitter and a photodiode receiver pair. When an object (box) is within the detection range (typically 2–30 cm, adjustable via onboard potentiometer), the reflected IR light is received by the photodiode, and the module's comparator circuit outputs a LOW digital signal. The module has a response time of approximately 10 ms, making it suitable for conveyor speeds up to 0.5 m/s. The output is TTL-compatible and directly interfaces with the transistor base circuit.

D. Solenoid Valve (3 PSI Operation)

A 12V DC, 2/2-way normally closed (NC) solenoid valve is used to control the compressed air supply to the pneumatic cylinder. When de-energized, the valve blocks air flow; when energized (relay contact closed), it opens and allows air to flow into the cylinder. The valve is rated for a minimum operating pressure of 3 PSI (approximately 0.21 bar) and a maximum of 116 PSI (8 bar). The 3 PSI operating condition chosen for this application ensures a gentle, controlled stamping force suitable for cardboard boxes without causing damage. The valve coil has an impedance of approximately 22Ω at 12V DC, drawing about 545 mA during operation.

E. Pneumatic Cylinder (20×25 mm)

A single-acting pneumatic cylinder (spring return type) with a bore diameter of 20 mm and a stroke length of 25 mm is employed as the stamping actuator. At 3 PSI (0.21 bar) operating pressure, the theoretical force generated by the cylinder is approximately $F = P \times A = 0.21 \times 10^5 \times \pi(0.01)^2$ ≈ 6.6 N, which is sufficient for ink-pad stamping on cardboard surfaces. The cylinder extends to apply the stamp and retracts after the solenoid valve is de-energized (spring return or reverse air supply). Its compact form factor (20 mm bore) makes it easy to mount on the conveyor frame structure.

F. Wiper Motor (12V, 5A, 60 RPM)

An automotive-grade wiper motor rated at 12V DC, 5A maximum current, and 60 RPM is used to drive the conveyor belt through a pulley and belt mechanism. The wiper motor provides adequate torque at low speed for moving lightweight cardboard boxes. Its built-in gearbox provides mechanical advantage and smooth rotation. The motor is controlled via a 12V DC contactor operated by a PLC digital output. The 5A current rating requires that the PLC output interface through a relay or solid-state relay rather than direct switching.

G. Diodes (1N4007)

The 1N4007 is a general-purpose silicon rectifier diode rated at 1A forward current and 1000V peak inverse voltage (PIV). In this system, it serves two purposes: (1) as a freewheeling (flyback) diode connected in reverse-parallel across the relay coil, protecting the transistor from voltage spikes generated when the relay coil is de-energized; and (2) as a rectifier diode in the DC power supply section, converting AC to pulsating DC before regulation. Its forward voltage drop of approximately 0.7V and fast switching characteristics make it suitable for both applications.

H. Capacitors (1000 µF)

Electrolytic capacitors of 1000 µF / 25V are used in the power supply filter section. Following rectification by the 1N4007 diodes, the pulsating DC contains significant ripple voltage. The 1000 µF capacitor charges to the peak voltage during each AC cycle and discharges slowly between peaks, significantly reducing ripple. This ensures a stable DC input to the 7805-voltage regulator. A smaller ceramic capacitor (typically 0.1 µF) is also placed at the regulator output for high-frequency noise suppression.

I. Voltage Regulator IC (7805)

The LM7805 is a three-terminal positive fixed-voltage linear regulator providing a stable +5V DC output regardless of load current variations (up to 1A) or input voltage fluctuations (provided Vin is between 7V and 35V). In this system, it accepts the filtered 12V DC from the capacitor bank and outputs a regulated 5V DC for the IR sensor module and the base bias circuit. Its built-in thermal shutdown and current limiting features provide protection against overload and short-circuit conditions. The device is mounted on a small heatsink to dissipate the power drop across it (approximately $P = (12-5) \times I\_load$).

J. Transistor (BC547)

The BC547 is an NPN general-purpose small-signal transistor with a collector current rating of 100 mA and a current gain (hFE) of 110–800. In this system, it functions as a switch in the relay driving circuit. When the IR sensor output is LOW (object detected), it drives the base of BC547 through a 1kΩ resistor. The transistor saturates, allowing current to flow from 12V through the relay coil to ground, thereby energizing the relay. When the IR signal goes HIGH (no object), the base current ceases, the transistor cuts off, and the relay de-energizes. The 1N4007 diode across the relay coil protects the transistor from the back-EMF spike during de-energization.

K. Resistors (2kΩ, 1kΩ)

Two resistor values are used in the circuit. The 2kΩ resistor is placed in series with the output of the IR sensor to the base of the BC547 transistor, limiting the base current to a safe value and ensuring the transistor operates in saturation mode for reliable switching. With Vout (sensor) $\approx$ 5V and Vbe $\approx$ 0.7V, the base current $Ib = (5 - 0.7) / 2000 \approx 2.15$ mA, which is well within the transistor's specifications. The 1kΩ resistor is used as a pull-up or current-limiting resistor at other points in the circuit, such as at the collector of the transistor or as a voltage divider for signal conditioning purposes.

V. WORKING PRINCIPLE

The operation of the Automatic Stamping and Labeling System follows a well-defined sequential process governed by the PLC ladder logic. The complete working principle is described step by step below.

Step 1: System Initialization and Conveyor Start

Upon power-up, the PLC executes its initialization routine. All outputs are set to their default states: the conveyor motor contactor output (Q0.0) is energized (HIGH), starting the wiper motor and setting the conveyor belt in motion. The solenoid valve output (Q0.1) remains de-energized (LOW), keeping the pneumatic cylinder in its retracted (rest) position. The IR sensor is powered by the regulated 5V DC supply from the 7805 regulators.

Step 2: Box Placed and Conveyed

A product box is placed at the entry point of the conveyor belt. The moving belt transports the box towards the stamping station where the IR sensor is mounted. During this transit phase, the IR sensor detects no object (beam not interrupted), and its output remains HIGH. The transistor remains in cut-off mode, the relay is de-energized, and the solenoid valve remains closed.

Step 3: IR Sensor Detects Box – Conveyor Stops

As the box arrives at the stamping position, it interrupts the IR sensor beam. The sensor output immediately transitions from HIGH to LOW. This LOW signal is applied to the base of BC547 through the 2kΩ resistor, driving the transistor into saturation.

The relay coil is energized, and simultaneously, the PLC digital input (I0.0) receives a LOW-to-HIGH transition (after signal inversion/conditioning). The PLC detects this rising edge and executes the detection rung of the ladder logic: it immediately de-energizes Q0.0, cutting power to the conveyor motor contactor. The conveyor belt stops, holding the box precisely at the stamping position.

Step 4: Relay Activates Solenoid Valve
The PLC controls the relay module through its output. The IR sensor only provides input to the PLC. With the relay energized, the normally open (NO) contact of the relay closes. This completes the 12V DC circuit through the solenoid valve coil, energizing it. Alternatively, the PLC can also directly energize Q0.1 to trigger a second relay output driving the solenoid valve, ensuring PLC-synchronized control. The solenoid valve opens, allowing compressed air (at 3 PSI) to enter the pneumatic cylinder.

Step 5: Pneumatic Cylinder Performs Stamping
With pressurized air entering the 20×25 mm pneumatic cylinder, the piston extends with a force of approximately 6.6 N. The stamp pad or die mounted on the cylinder rod makes contact with the top surface of the box and applies the required stamp (date code, batch number, or inspection mark). The stamping action is completed in approximately 0.3–0.5 seconds, depending on the cylinder's speed and the air flow rate.

Step 6: PLC Timer Delay – Stamp Held
A PLC on-delay timer (TON) is activated immediately after the conveyor stop rung. The timer is pre-set to 1.5 seconds (adjustable as per stamping ink drying requirements). During this timer period, the solenoid valve remains energized, the cylinder remains extended, and the conveyor remains stopped. This ensures adequate contact time between the stamp and the box surface for a clear impression.

Step 7: Conveyor Restarts – Box Moves to Labeling Station
Upon the timer timing out (1.5 seconds elapsed), the PLC ladder logic executes the restart sequence: Q0.1 is de-energized (solenoid valve closes, cylinder retracts via spring or reverse air), and Q0.0 is re-energized (conveyor motor restarts). The box, now stamped, moves forward along the conveyor to the labeling station, where a label applicator (or manual label application) completes the process. The system then returns to its waiting state, ready for the next box.

VI. PLC PROGRAMMING LOGIC

The PLC ladder logic is structured into five functional rungs, implemented using Siemens STEP 7 or TIA Portal software in LAD (Ladder Diagram) programming language. The first rung implements a latching circuit for the conveyor motor. A normally open contact of a Start pushbutton (I0.1) is placed in parallel with a self-holding contact of the conveyor motor coil (Q0.0), and in series with a normally closed contact of the Stop pushbutton (I0.2) and a normally closed contact of the IR sensor input (I0.0). When the Start button is pressed, Q0.0 energizes and latches. When the IR sensor detects a box (I0.0 goes HIGH), the normally closed contact opens, de-energizing Q0.0 and stopping the conveyor. The second rung uses a normally open contact of I0.0 (IR sensor detected) in series with a normally closed contact of the stamp-complete timer bit (T1.Q). This drives the solenoid valve output Q0.1. When the box is detected and the timer has not yet expired, Q0.1 is energized, actuating the pneumatic cylinder. A TON (On-Delay Timer) instruction block is placed in the third rung, triggered by Q0.1 (solenoid valve output). The preset time (PT) is set to T#1500MS (1.5 seconds). The timer starts counting as soon as Q0.1 is energized. After 1.5 seconds, the timer output bit T1.Q goes HIGH.
The fourth rung uses the timer output bit T1.Q (normally open contact) in series with the Stop button normally closed contact to re-energize Q0.0. This restarts the conveyor after the stamping delay. The rung also resets the timer by dropping the enable bit when I0.0 goes LOW (box has moved away). A safety rung prevents simultaneous operation of the conveyor and the stamping cylinder. A normally closed contact of Q0.1 is placed in series with the Q0.0 coil in Rung 1, ensuring that the conveyor cannot start or run while the solenoid valve (and thus the cylinder) is active. This prevents product damage or misalignment during the stamping operation.

VII. CIRCUIT EXPLANATION

A. Power Supply Section

The power supply circuit begins with a 230V AC mains input connected to a step-down transformer (230V to 12V DC, 1A). The secondary 12V DC is rectified by a bridge rectifier using four 1N4007 diodes. The resulting pulsating DC is filtered by a 1000 µF / 25V electrolytic capacitor, yielding approximately 12V DC with low ripple. This 12V DC supplies the relay module and solenoid valve directly. A portion of this 12V DC is fed into the LM7805 voltage regulator IC (with a 0.1 µF ceramic bypass capacitor at its output) to produce a stable +5V DC for the IR sensor and transistor circuit.

B. Relay Driving Circuit

The relay driving circuit operates as follows: The IR sensor output (5V logic) connects through a 2kΩ series resistor to the base (B) of the BC547 NPN transistor. The emitter (E) is connected to ground. The collector (C) connects to one end of the 12V relay coil; the other end of the relay coil connects to the +12V supply rail. A 1N4007 diode is connected in reverse bias (anode to collector, cathode to +12V) across the relay coil for flyback protection. When the IR sensor output is LOW (box detected), the base current flows through the 2kΩ resistor, saturating the BC547, which allows collector current to flow through the relay coil, energizing the relay and closing its NO contact to power the solenoid valve.

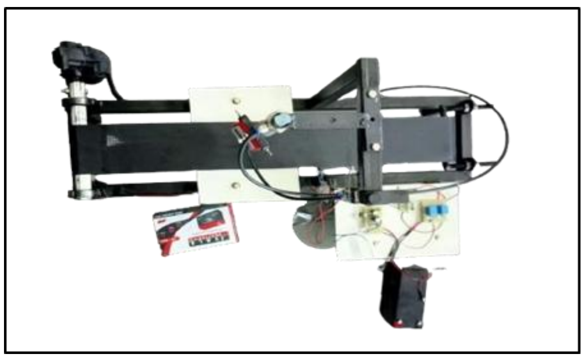
C. Sensor Interfacing with PLC

The IR sensor's digital output is also fed to the PLC digital input module (I0.0) through a 1kΩ pull-up resistor. The PLC input module operates at 24V DC logic; therefore, the 5V sensor output is level-shifted using a simple transistor interface: the sensor output drives the base of a second BC547 transistor whose collector is connected to +24V through a 1kΩ resistor and to PLC input I0.0. When the sensor output is LOW, the transistor saturates, pulling the PLC input to near 0V (logical 0). When the sensor output is HIGH, the transistor is in cut-off, and the PLC input is pulled to +24V through the 1kΩ resistor (logical 1). This ensures reliable 5V-to-24V logic level translation.

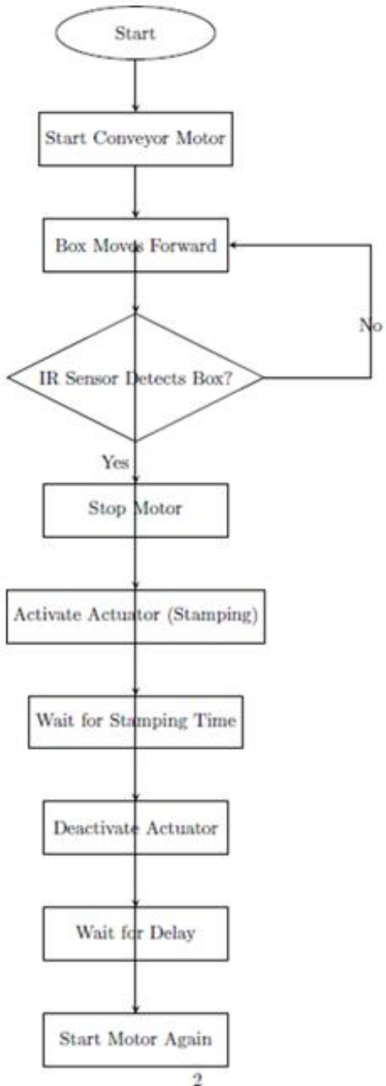
VIII. ADVANTAGES OF THE SYSTEM

The Automatic Stamping and Labelling System using PLC offers several compelling advantages over manual and semi-automated alternatives. First, the system achieves a high degree of repeatability, as the PLC executes the same sequence with microsecond precision on every cycle, ensuring consistent stamp placement and label alignment regardless of operator variability. Second, throughput is significantly increased; the system can process one box approximately every 3–4 seconds (1.5 s stamping + conveyor transit time), achieving up to 900 boxes per hour, compared to approximately 200–300 boxes per hour with skilled manual operation.

Third, the system reduces labour costs and operator fatigue, freeing human resources for higher-value tasks such as quality inspection and process monitoring. Fourth, the PLC-based control provides built-in diagnostics through fault registers, enabling predictive maintenance and reducing unplanned downtime. Fifth, the modular design of the system allows easy reconfiguration for different box sizes, stamp patterns, or label types by simply adjusting sensor positions and PLC timer settings, without hardware redesign.



Figure



Flowchart

IX. APPLICATIONS IN INDUSTRY

The Automatic Stamping and Labelling System finds extensive application across a wide range of industries. In the pharmaceutical industry, it is used for stamping batch numbers, manufacturing dates, and expiry dates on medicine boxes and cartons, which is mandatory for regulatory compliance under GMP (Good Manufacturing Practice) guidelines. In the food and beverage sector, the system stamps best-before dates and production codes on packages, supporting supply chain traceability.

The electronics and semiconductor industry uses such systems for marking PCB cartons and component boxes with serial numbers and quality inspection marks. In the logistics and warehousing sector, the system labels boxes with barcodes or QR codes for automated sorting and inventory management. Automotive component manufacturers use stamping systems to mark part numbers on subassembly packages. Additionally, chemical and agricultural product manufacturers use the system to label hazardous material warnings and product identification codes, ensuring safety compliance.

X. LIMITATIONS

Despite its advantages, the proposed system has certain limitations that must be acknowledged. The IR sensor-based detection is susceptible to ambient light interference and may generate false triggers in environments with intense background lighting or reflective surfaces. Proper shielding and calibration of the sensor's sensitivity potentiometer can mitigate, but not entirely eliminate, this issue.

The system is currently designed for a single stamping station with a fixed cycle time. It does not inherently support variable-speed conveyors or dynamically adjust the stamping delay based on product type. The pneumatic cylinder operating at 3 PSI delivers limited force, making it unsuitable for stamping on hard plastic or metal surfaces. Furthermore, the relay-based switching introduces mechanical wear over time; the relay contacts have a finite life rated at typically 100,000 operations, requiring periodic replacement in high-volume production environments.

XI. FUTURE SCOPE

The current system provides a solid foundation for several advanced enhancements aligned with Industry 4.0 and smart manufacturing principles. The first major enhancement involves IoT integration, wherein the PLC is connected to a cloud platform via an Ethernet communication module (e.g., Siemens CP 343-1). Production data such as box count, stamping cycles, fault logs, and cycle times can be transmitted to an MQTT broker and visualized on a web dashboard or mobile application, enabling remote monitoring and predictive maintenance alerts.

A second enhancement involves replacing the IR sensor with a machine vision system (camera + image processing board running OpenCV algorithms). The vision system can detect box presence, verify stamp quality, check for misaligned or missing labels, and classify boxes by size – all in real-time. Defective boxes can be automatically rejected via a diverter gate actuated by an additional solenoid valve. Third, variable frequency drives (VFDs) can be integrated with the conveyor motor to enable speed control, allowing the system to adapt to different production rates programmatically from the PLC or SCADA interface.

Fourth, the PLC program can be extended to manage a fully automated labeling applicator (label dispenser + tamp applicator) as a subsequent station, eliminating the remaining manual step in the labeling process. Finally, digital twin technology can be employed to simulate the system in software (e.g., Siemens Process Simulate) before hardware deployment, reducing commissioning time and enabling virtual testing of ladder logic changes.

XII. CONCLUSION

This paper presented the design and implementation of an Automatic Stamping and Labeling System using a Siemens PLC. The system integrates an IR sensor for box detection, a BC547 transistor-driven relay module for actuator interfacing, a solenoid valve for air control, and a pneumatic cylinder for stamping, all orchestrated by PLC ladder logic with precise timer-controlled sequencing. The interfacing electronics, comprising the 7805-voltage regulator, 1N4007 diodes, 1000 µF capacitors, and BC547 transistor, ensure reliable signal conditioning and actuator driving.

The proposed system achieves significant improvements in stamping accuracy, throughput, and repeatability compared to manual operations. It is applicable across pharmaceutical, food, electronics, logistics, and automotive industries. While limitations exist in terms of sensor susceptibility and relay wear, these are well within manageable parameters for most industrial environments. Future work will focus on IoT connectivity, machine vision integration, and digital twin modeling to evolve the system towards a fully smart manufacturing node. The Automatic Stamping and Labeling System demonstrated in this study underscores the critical role of PLC-based automation in enhancing industrial productivity and product quality.

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