

Automated Conveyor Belt Printing System for Small Scale Industrial Commodities Using PLC

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Abstract

This paper develops an automated conveyor belt printing system for small-scale industrial commodities, utilizing a Programmable Logic Controller to control and coordinate the printing process. The conveyor belt transports commodities of varying sizes and shapes, while the printing system applies labels or prints information directly onto products. The PLC-based control system ensures precise and efficient printing, reducing manual labor and increasing productivity. With its modular design, the system integrates seamlessly with existing production lines, making it ideal for small-scale industrial applications. The proposed system aims to enhance product labeling efficiency minimize errors, and improve overall production quality, allowing businesses to streamline operations reduce costs and increase competitiveness. Its flexibility and adaptability make it an attractive solution for small-scale industrial manufacturers seeking to optimize their production processes.

Keywords: Printing System, PLC-Controller, Automation, Modular Design.

1. Introduction

In small-scale industries, where resources are often limited and the demand for high-quality products is constant, finding ways to improve production efficiency is crucial. One of the most significant challenges faced by these industries is the need to print labels, product information, and barcodes on a wide manner. Manual printing methods are often time-consuming, prone to human error, and can slow down the overall production process. This is where automated conveyor belt printing systems come into play. By integrating a Programmable Logic Controller (PLC), these systems enable a seamless, automated process that not only speeds up production but also ensures high accuracy. The conveyor belt moves products through different stages of printing without the need for manual intervention, and the PLC manages the entire process with precision, controlling factors such as speed, print placement, and timing. The beauty of using a PLC in these systems is its flexibility. It allows for easy adjustments, making it suitable for industries with

varying production needs and types of commodities. For small-scale manufacturers, the adoption of such automation can be a game-changer. It minimizes downtime, reduces labor costs, and, most importantly, improves product consistency and quality. Moreover, with automation, the risk of errors due to human oversight is minimized, ensuring that every product gets printed with the right information in the correct format. This not only enhances the quality of the product but also builds customer trust, especially in industries where labelling is essential for regulatory compliance or brand identity. In conclusion, integrating an automated conveyor belt printing system using PLC control offers a practical, cost-effective solution for small-scale industries looking to enhance their manufacturing processes. The result is faster production times, reduced operational costs, and higher quality products, all while maintaining flexibility to meet the demands of a dynamic marketplace. This vision continues to drive the development of modern stamping machines

today. The goal is not only to improve the quality of stamped products but also to reduce the cost of manufacturing, making the process accessible to a wide range of industries. In today's fast-paced world, with rapidly advancing technologies, businesses strive for perfection and speed. The demand for quick and efficient processes is more significant than ever. In industries like food packaging, stamping is still commonly done manually by workers. To achieve higher output, companies often require up to seven workers per production line. While this may meet the immediate production target, it comes with several drawbacks. The manual process is time-consuming and generates higher labour costs. It also results in poor finishes due to human error and fatigue, which can affect the overall quality of the product. To stay competitive and maximize profit, there is an increasing need for automation in stamping processes, especially in small-scale industries. Automatic stamping machines can significantly improve productivity by eliminating the time and effort required for manual labour. They offer faster processing times, higher precision, and a more consistent finish. This shift to automation is essential for industries to maintain their competitiveness in the market, as it helps reduce operational costs, minimize errors, and increase the quality of the final product. The modern stamping machines of today provide businesses with a solution that balances cost efficiency, productivity, and quality. By embracing automation, small-scale industries can not only improve their output but also enhance the overall performance of their operations. With the right stamping technology in place, businesses can focus on other core areas, driving growth and achieving long-term success.

2. Literature Review

Sheela et al proposed Low-Cost Automation for Sorting of Objects on Conveyor Belt which describes that using Raspberry pi [1] making the model generally sensing the colour of the object is a big challenge as there is a chance of high uncertainty due to the external lighting conditions and each nose. Similarly, while collecting objects from conveyor belt by a linear actuator, there are variations in weight and size of object. Further approaches to this system

can be made to increase the capability to segregate large and heavy objects and sort them effectively. The objects once kept on the conveyor belt, the further assembly makes the work of sorting the objects very efficiently. In the paper, the author have revealed that they have proposed a system which sorts the objects based on their colour which can future be enhanced to sort them based on their size and shape with the help of IR sensor of near about short-range communication requirements. Amruta Pandit et al proposed Object Counting using Image processing techniques that are helpful for object counting and reduce the time of counting effectively [2]. Proper Recognition of the object is important for object counting. The accuracy of the algorithm depends on camera used, size of object, whether or not objects touching and illumination conditions. Object counting using image processing system has huge applications where automation is to be introduced and time of counting is to be reduced linearly it reduces the man power required behind the counting, sorting and identification mechanism. Avadhoot et al proposed Colour Object Counting and Sorting Mechanism Using Image Processing Approach [3] that the colour object counting and sorting is the major task that needs to be done at final dispatch section. Manual sorting is the tradition approach that preferred by industries. In this approach, visual inspection performed by human operators. This traditional approach is time-consuming and non-consistent. Gundawar et al proposed Pneumatic Stamping Machine [4] the idea behind the project is to create a pneumatic stamping machine at a very low cost. Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machine. The general purpose of the present invention, which will be described subsequently in greater details, is to provide a portable automatic pneumatic stamping machine which has many advantages of the low power consumption and effective performance and many specified features of the system, which is not anticipated. further objective of the system is, this is susceptible of a low cost of manufacturing with regards to both cost and labour, and which accordingly is then susceptible of low

prices of sale to the public, so thereby making such automatic stamping machine are very economically available to the public. Raju et al proposed Automatic Pneumatic Stamping Machine [5]. From last few years it has been seen that the pneumatic system playing very important role in industries due to its precision and cost. Mainly there is no need to be operated by skilled ones. The main advantage of this machine that it can be operated at low pressure. Solenoid valves are used as direction control valves for operation. By replacing some attachment, we can also elaborate other applications. The further objective of the system is, this is susceptible of a low cost of manufacturing with regards to both cost and labour, and which accordingly is then susceptible of low prices of sale to the public, so thereby making such automatic stamping machine [6-10].

3. Description of Existing System

The Automated Conveyor Belt Printing System, powered by a Programmable Logic Controller, helps achieve just that by automating the printing process. As products move along a conveyor belt, the system automatically prints labels, barcodes, or logos at precise points, eliminating the need for manual labor. The PLC acts as the brain, managing the timing and synchronization of each print, while sensors ensure the products are in the right position. This setup not only speeds up production but also reduces human error and waste, shown in Figure 1.

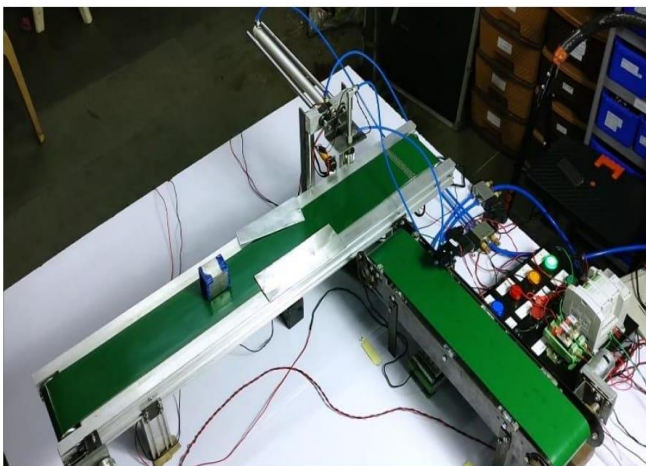


Figure 1 Existing System of Stamping Machine

At the heart of the system is a Programmable Logic

Controller which acts as the brain, controlling the entire process. The PLC coordinates the timing and synchronization of the labelling and stamping equipment, ensuring precision and efficiency. It ensures that each item moving along the conveyor is stamped accurately according to preprogramed specifications. This helps minimize errors, increase speed and maintain consistent quality across large volumes of products. The combination of automation with a flexible modular approach allows manufacturers to adapt the system as their needs change. Whether you're labelling boxes, stamping serial numbers or applying barcodes, this integrated solution provides a reliable and efficient way to automate key processes, reducing labour costs and improving production efficiency while maintaining a high standard of product quality. Additionally, the system's scalability ensures it can evolve as production volumes and product types change over time [11-15].

4. Components of Existing System

The Automatic Printing Machine controlled by a Programmable Logic Controller is designed to apply labels, logos, or markings on products with high precision and speed. This automation reduces human effort, minimizes errors, and enhances efficiency in industrial production. At the heart of the system, the PLC acts as the control unit, processing inputs and managing machine operations. Operators interact with the system through a Human-Machine Interface allowing them to set parameters, monitor performance, and troubleshoot issues. To ensure accurate stamping, a sensor array consisting of proximity and photoelectric sensors detects the position and presence of products. The actuators, such as pneumatic cylinders or servo motors, drive the stamping mechanism, applying the right amount of force for a clear and consistent imprint. A conveyor system moves products into position, synchronizing with the stamping process for smooth operation. Solenoid valves regulate airflow in pneumatic systems, ensuring precise control over movement. The power supply unit provides stable energy to all electrical components, maintaining uninterrupted functionality. For safety, the machine is equipped with emergency stop buttons and safety

switches, preventing accidents and ensuring operator protection. This automated printing system offers higher efficiency, accuracy, and reliability, making it ideal for industries requiring fast and flawless product marking, Shown in Figure 2.

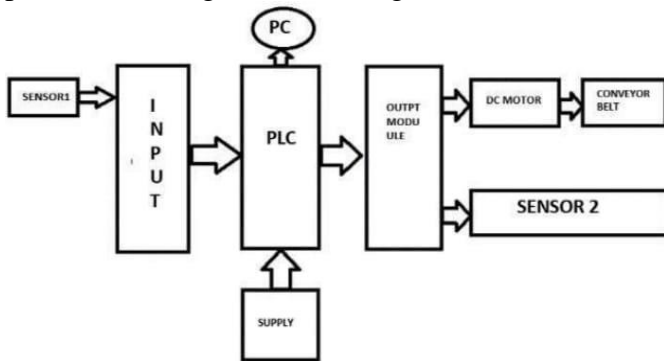


Figure 2 Block Diagram of Existing System

5. Proposed System

In order to the proposed Automatic Printing Machine using a Programmable Logic Controller is designed to enhance efficiency, precision, and consistency in industrial stamping applications. This system automates the process of imprinting labels logos or markings on products, significantly reducing manual labour and human error. At its core, the PLC controls entire operation ensuring smooth synchronization of all components. Products move along a conveyor system guided by proximity and photoelectric sensors that detect their presence and position for accurate alignment. Once in place, actuators such as pneumatic cylinders or servo motors drive the stamping mechanism, applying a controlled force to ensure a clear and consistent impression, Shown in Figure 3.

5.1. Block Diagram

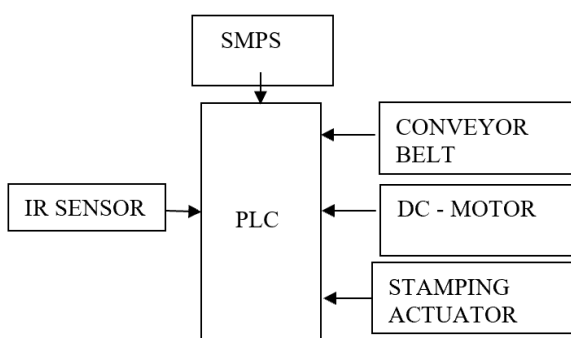


Figure 3 Block Diagram of Proposed System

Operators interact with the machine through a Human Machine Interface which allows for easy configuration, real time monitoring, and troubleshooting. To enhance safety, the system is equipped with emergency stop buttons and safety switches, ensuring immediate shutdown in case of malfunctions. The advantages of this system include increased efficiency by automating stamping tasks, high precision for consistent and error-free markings, and reduced manual labour, which lowers operational costs and minimizes worker fatigue. Additionally, its intuitive control system makes operation seamless while maintaining high safety standards. This proposed stamping machine is an ideal solution for industries requiring fast, high-quality and reliable marking, making the production process more streamlined and cost effective, Shown in Figure 4.

5.2. Flow Chart

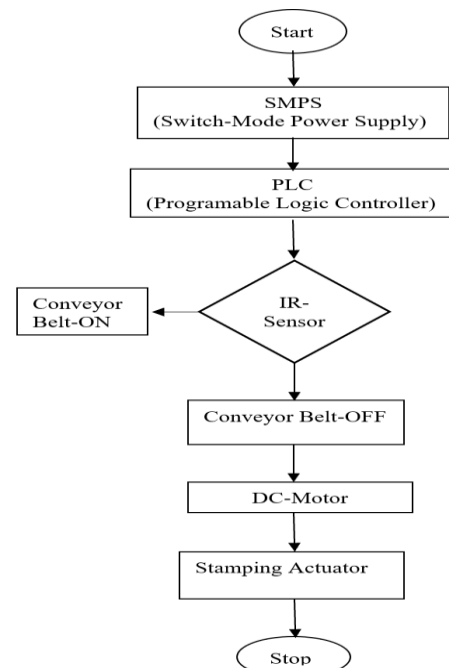


Figure 4 Flow Chart of Proposed System

The Automatic Printing Machine follows a structured sequence to ensure smooth and efficient operation. The process begins with the Start command, initializing the system. The Switched Mode Power Supply provides stable power to all electrical components including the Programmable Logic Controller which acts as the brain of the system. Once

powered, the IR sensor continuously monitors the conveyor belt for incoming products. When a product is detected, the PLC signals the DC motor to activate the conveyor belt, moving the product into the stamping position. As soon as the product reaches the designated spot, the IR sensor sends a signal to the PLC prompting the system to stop the conveyor. At this moment, the stamping actuator, controlled by the PLC engages to press the marking onto the product with precision. After stamping, the conveyor belt resumes its motion, ensuring the stamped product moves forward for further processing or collection. The process continues seamlessly until there are no more products detected, at which point the system either waits for the next product or reaches the Stop state when manually turned off. This well-coordinated flow ensures accuracy, speed, and automation, reducing human effort while maintaining high efficiency in the stamping process, Shown in Figure 5.

5.3. Proposed System Methodology

1. Planning

- Requirement Analysis needs of the system such as precision stamping, automation level, and production speed.
- Component Selection is essential parts like the PLC, IR sensors, conveyor belt, DC motor and stamping actuator to build a reliable system.
- Workflow Design the sequence of operations, from detecting products to stamping and moving them forward.

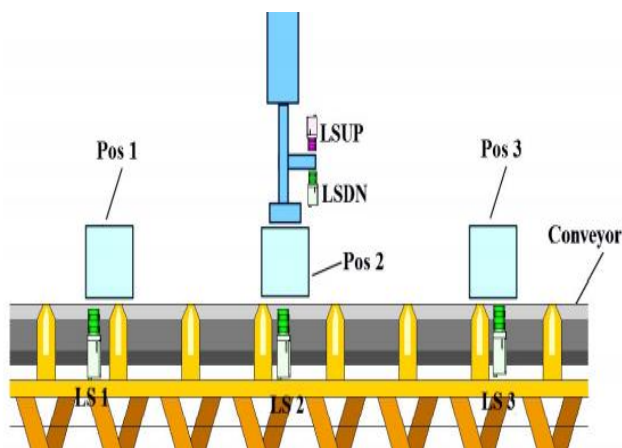


Figure 5 Developed Model of Proposed System

- Risk Assessment is potential challenges, such as sensor accuracy, stamping force, and safety concerns, and planning solutions in advance
- Development
- Hardware Assembly Integrating all components, including mechanical, electrical and pneumatic systems for a seamless setup.
- PLC Programming and testing logic control programs to automate the entire stamping process.
- HMI Integration an intuitive interface that allows operators to set parameters and troubleshoot efficiently.
- Conducting initial tests to verify the proper working of sensors, actuators, and conveyor movement.

2. Implementation

- System Installation by Setting up the machine in an industrial environment ensuring proper alignment connectivity.
- Calibration and fine-tuning the sensor accuracy, actuator speed, and conveyor movement for optimal performance.
- Verifying the effectiveness of emergency stop buttons, overload protection, and fault detection systems.
- Running the machine under real working conditions to detect and fix any operational issues before full-scale production.

3. Evaluation

- Performance Analysis by Monitoring key factors like stamping accuracy, cycle time, and error rate to measure efficiency.
- Operator Feedback Collecting input from workers to understand usability and identify areas for improvement.
- System Optimization necessary software or hardware adjustments to enhance reliability and performance.
- Ensuring the system remains efficient, durable and cost-effective over extended periods.

5.4. Working of Proposed System

The automatic printing machine using PLC operates

in a structured and efficient manner to ensure accurate and consistent stamping of products. The process begins when the system is powered on, and the switched mode power supply provides the necessary electrical supply to all components, including the programmable logic controller which controls the entire operation. As products arrive on the conveyor belt, an IR sensor detects their presence and signals the PLC. Once detected, the DC motor drives the conveyor belt, moving the product into the stamping position. The IR sensor continuously monitors the position, and when the product reaches the exact spot, the PLC sends a command to stop the conveyor. At this stage, the stamping actuator, which may be a pneumatic cylinder or servo motor, is triggered to press the stamping mechanism onto the product, ensuring a clear and precise imprint. After the stamping process is complete, the PLC reactivates the conveyor belt, allowing the stamped product to move forward for further processing or collection. The system operates in a continuous cycle, ensuring high-speed and error-free stamping. Safety mechanisms such as emergency stop buttons and overload protection are incorporated to prevent accidents and ensure smooth operation. The human-machine interface allows operators to monitor real-time data, adjust parameters, and troubleshoot issues easily. This automated process enhances efficiency, reduces human intervention, and ensures consistent quality in industrial stamping applications.

5.5. Applications of Proposed System

The automatic printing machine using PLC is a highly efficient system that can be used across various industries to improve productivity, accuracy, and consistency. Its ability to automate the stamping process makes it ideal for applications where speed and precision are essential. One of the primary applications is in the manufacturing and packaging industry, where products require branding, labeling, or batch number stamping. This ensures that every item is marked uniformly, reducing human errors and improving traceability. In the automotive sector, the machine can be used for stamping serial numbers, logos, or specifications on metal and plastic components, ensuring compliance with industry standards. The system is also beneficial in the

pharmaceutical industry, where medicine packaging and labeling need to be precise and legible. It helps in marking expiry dates, batch codes, and regulatory information on bottles, blister packs, and cartons. Additionally, in the electronics industry, the machine is used to imprint part numbers and identification codes on circuit boards and components, aiding in quality control and easy tracking. Beyond industrial applications, the automatic stamping machine can be used in printing and publishing, such as stamping official seals on documents or creating embossed impressions on certificates and legal papers.

6. Results and Discussions

- The automatic printing machine ensures precise and uniform marking on every product, reducing human errors and inconsistencies in stamping.
- Automation speeds up the stamping process, allowing industries to handle large volumes of products efficiently without delays.
- The PLC-controlled system minimizes the need for human intervention, making the process more convenient and reducing labor costs.
- The system is designed to integrate smoothly with existing production lines, ensuring a hassle-free transition to automated stamping.
- The IR sensor accurately detects product positioning, ensuring proper alignment before stamping for consistent results.
- The conveyor belt ensures smooth product movement, preventing jams or misalignment during the stamping process.
- The stamping actuator applies controlled force, ensuring clear and legible imprints on various materials, including metal, plastic, and paper.
- Enhanced Safety Features for the system includes emergency stop buttons and overload protection to ensure safe operation and prevent damage or accidents.
- By reducing manual labor, errors and material wastage, the system proves to be a cost-effective solution for industries requiring high-speed and precision stamping

Conclusions

The automatic printing machine using PLC is a reliable and efficient solution for industries requiring high-speed, precise, and consistent stamping. By automating the process, it significantly reduces human effort, minimizes errors, and enhances productivity. The integration of PLC control, sensors, actuators, and a conveyor system ensures smooth and accurate operation, making it suitable for applications manufacturing, packaging, automotive, pharmaceuticals, and electronics. With user-friendly interface safety mechanisms, and adaptability, this system not only improves operational efficiency but also ensures product quality and traceability. As industries continue to embrace automation, this stamping machine proves to be a cost-effective and essential solution for modern production environments, contributing to overall workflow optimization and industrial growth.

References

- [1]. Pasha, S., and Rajendra, S. (2024) "Design and Fabrication of PLC-Based Automated Object Sorting, Stamping, and Storage System," in International Journal of Research Publication and Reviews, Vol. 5, No. 11, pp. 1262-1265.
- [2]. Tongale, N. J., Kamble, N. D., Joshi, S. A., Jadhav, S. S., and Bhaisare, A. S. (2022) "Review Research Paper on Automatic Stamping Machine Using PLC," in International Journal of Advanced Research in Science, Communication and Technology, Vol. 2, Issue 1, pp. 286-289.
- [3]. Saranya, M., Aishwaryaa, R., Madhumidha, S., Palaniappan, C., and Uthaman, G. (2021) "Automatic Electrical Stamping and Sorting Machine Using PLC," in International Journal of Mechanical Engineering, Vol. 6, No. 3, pp. 240-245.
- [4]. Parihar, A., Yunus, S., Prasad, N., Sarthak, B., and Naresh, D. (2021) "Automatic Stamping Machine," in International Journal for Science and Advance Research in Technology, Vol. 7, Issue 7, pp. 222-225.
- [5]. Dhoble, A. (2018) "Design and Fabrication of Automatic Stamping Machine," in International Journal of Scientific & Engineering Research, Vol. 9, Issue 5, pp. 204-208.
- [6]. Sheela, S., Shivaram, K. R., Meghashree, S., Monica, L., Prathima, A., and Shriya, M. Kumar (2016) "Low-Cost Automation for Sorting of Objects on Conveyor Belt," in International Journal, Vol. 5, Special Issue 10, May 2016, pp. 195-200.
- [7]. Amruta Pandit, Jyoti (2014) "Object Counting Using Image Processing Technique," in Journal Name, Vol. 3, Issue 4, April 2014, pp. 8509-8512.
- [8]. Tripathi, E., and Chaudhary, P. (2011) "Material Sorting and Stamping Machine," in International Journal of Current Trends in Engineering & Research, Vol. 3, Issue 5, pp. 163-169.
- [9]. Sehgal, R., and Sharma, A. (2009) "A Graphical Approach for Kinematic Design and Development of an Automatic Stamping Machine Using Four Bar Chain," in Indian Journal of Engineering & Materials Sciences, Vol. 15, pp. 229-235.
- [10]. Shamsul, M. J. (2008) "Programmable Logic Control Application for Stamping Operation," in University Teknikal Malaysia Melaka Journal, Vol. 6, No. 4, pp. 178-184.
- [11]. Pimpalgaonkar, S. M., Kale, S. V., Ghugal, S. G., and Borkar, S. V. (2007) "Automatic Stamping Machine for Postcards to Overcome Manual Repetitive Stamping Work," in International Journal for Research in Emerging Science and Technology, Special Issue, pp. 89-95.
- [12]. Gunawardena, T. K., Dadigamuwa, P. R., and Madhusanka, B. G. D. A. (2009) "Low-Cost Automated Machine for Paper Gathering and Folding," in European Journal of Advances in Engineering and Technology, Vol. 2, No. 2, pp. 40-43.
- [13]. Welkar, D. S., Saindane, L. S., Nerker, N. S., Baviskar, H. R., and Sonawane, V. P. (2005) "Automatic Stamping and Pad Printing Machine," in 7th International Conference on Science, Technology and Management,

ISBN: 978-93-86171-30-6, pp. 112-118.

- [14]. Koppa, P., Nagaraja, N., Amith, V., Sushilendra, and Vyasraj, T. (2002) "Development and Fabrication of Electro-Pneumatic Automatic Stamping Machine," in International Journal of Innovative Research in Science, Engineering and Technology, Vol. 5, Issue 9, pp. 1023-1030.