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Semi – automatic sealing machine

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ABSTRACT :

This project presents the design and implementation of a semi-automatic button press sealing machine, converted from a traditional manual pedal-operated model. The aim is to reduce operator fatigue, enhance sealing consistency, and improve overall productivity in small-scale packaging operations. The system is powered by an Arduino Uno, which controls a NEMA 24 stepper motor through a TB6600 motor driver. A gear-driven lead screw mechanism moves the sealing press bar, which activates the heating element through a switch. The automation cycle includes a 3-second sealing delay before the press bar retracts automatically. This low-cost solution demonstrates how basic automation and control techniques can significantly improve the ergonomics and efficiency of existing mechanical systems, making it a practical and scalable option for small to medium-scale industries.

Introduction

In the packaging industry, sealing machines play a vital role in ensuring product safety, preservation, and presentation. Traditionally, many small-scale industries rely on manually operated pedal press sealing machines due to their affordability and simplicity. However, such machines require continuous physical effort, leading to operator fatigue, inconsistent sealing quality, and limited productivity over time.

To address these challenges, this project focuses on transforming a manually operated pedal press sealing machine into a semi-automatic system. The upgraded machine performs the sealing process at the press of a button, minimizing manual effort and improving operational efficiency. This automation not only ensures consistent sealing performance but also enhances user convenience and productivity.

The project was undertaken by Electronics and Telecommunication (ENTC) engineering students as part of an initiative to apply automation and control techniques to real-world mechanical systems. The resulting machine is more ergonomic, efficient, and better suited to meet the demands of small to medium-scale packaging environments, showcasing the practical application of engineering knowledge to industrial problems.

2. Literature Survey

- Sealing machines play a crucial role in packaging applications, ensuring product safety and presentation. In small-scale industries, **pedal-operated sealing machines** are commonly used due to their affordability and mechanical simplicity. However, their reliance on continuous manual effort often results in user fatigue and limits productivity.
- Several studies and academic projects have explored automation solutions to address these limitations. Kumar et al. [1] discussed the advantages of converting manual machines into semi-automatic systems, reporting a significant improvement in sealing efficiency and reduced operator strain. Singh and Patil [2] studied the integration of automation in small-scale packaging industries and found that semi-automatic systems led to more consistent sealing quality and faster operation.
- Sharma and Verma [3] proposed a cost-effective sealing machine using microcontroller-based control and relay circuits. Their work demonstrated the feasibility of automation using basic electronic components such as timers, relays, and push-button controls, eliminating the need for expensive PLCs or pneumatic systems.
- Inspired by these works, the present project—executed by **Electronics and Telecommunication (ENTC) students**—focuses on converting a pedal press sealing machine into a semi-automatic system using a button-activated control mechanism. This solution offers a low-cost, efficient, and ergonomic alternative suitable for small-scale production environments.

3. Proposed System

The system converts a manual pedal-operated sealing machine into a semi-automatic model using an **Arduino Uno** to control a **NEMA 24 stepper motor** via a **TB6600 motor driver**. A gear system drives a **lead screw**, moving the press bar downward. The bar presses a switch to activate the transformer and heat the element. After a 3-second delay, the motor reverses, lifting the press bar back up, completing the sealing cycle.

4.Methodology

The semi-automatic sealing machine is built using an Arduino Uno as the central controller. A TB6600 motor driver controls a NEMA 24 stepper motor, which drives a lead screw to move the press bar. A bell switch is used to initiate the sealing cycle. When pressed, the Arduino rotates the motor forward to lower the press bar. As it reaches the sealing position, a switch is triggered to activate the transformer and heat the sealing element. After a 3-second delay, the motor reverses, raising the press bar.

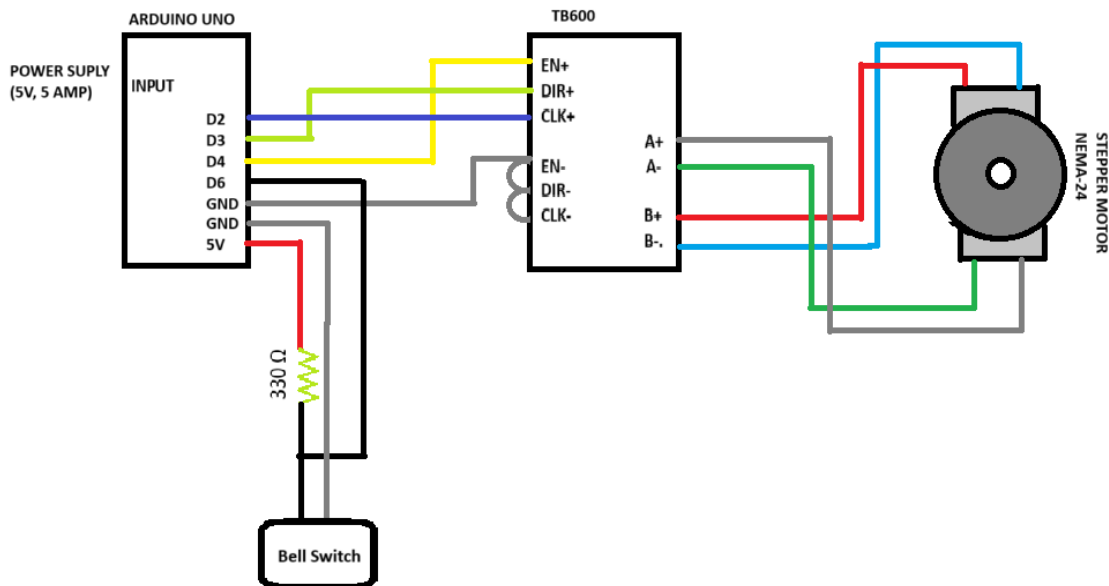
A 24V power supply powers the motor and driver, while a 5V 5A supply powers the Arduino and cooling fan. Connecting wires are used to integrate all components into a functional and safe control circuit.

The TB6600 motor driver's EN⁻, DIR⁻, and CLK⁻ pins are shorted together and connected to GND. The EN⁺, DIR⁺, and CLK⁺ pins are connected to Arduino Uno's digital pins D4, D2, and D3, respectively. The A⁺ and A⁻, B⁺ and B⁻ terminals of the TB6600 are connected to the corresponding wires of the NEMA 24 stepper motor.

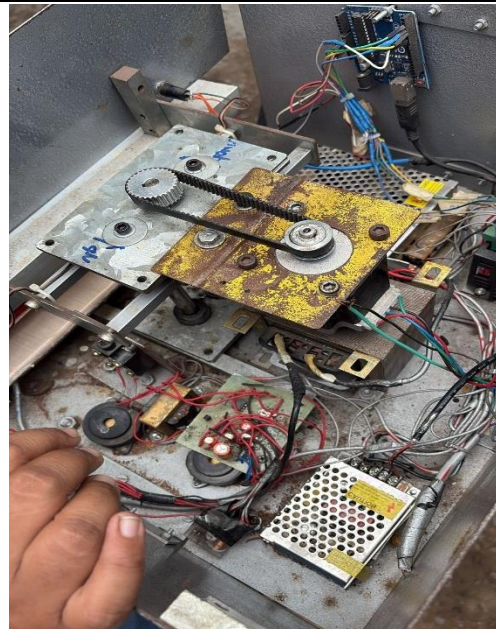
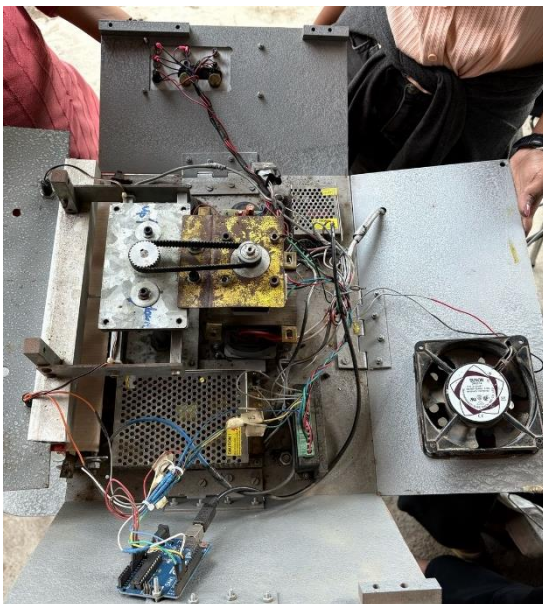
A bell switch is connected to Arduino pin D6 using a 330-ohm pull-up resistor. One terminal of the switch is connected to GND, while the other terminal is connected to both the 5V pin and D6 pin of the Arduino through the 330-ohm resistor.

The Arduino Uno is powered by a 5V 5A power supply, while the TB6600 driver and stepper motor are powered by a 24V DC supply. All components share a common ground to ensure proper operation and signal referencing.

fig. (a): circuit diagram



Result



6. Conclusion

The conversion of the pedal-operated sealing machine into a semi-automatic button press sealing system has proven to be an effective enhancement, offering improved ease of operation, better sealing consistency, and reduced operator fatigue. By incorporating an electromechanical mechanism activated by a simple button press, the machine now delivers more reliable performance while maintaining its low-cost and compact nature.

This semi-automatic modification not only modernizes the existing system but also opens the door for further automation and scalability in small to medium-scale packaging operations. Overall, this upgrade strikes a balance between manual control and automation, providing a practical solution for improving productivity and working conditions in the packaging industry.

7. Future Scope

- Design a modular structure for easy maintenance and scalability.
- Improve energy efficiency with smart components.
- Upgrade to full automation using sensors and PLCs.

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