

MCT-313L: HYDRAULICS AND PNEUMATICS LAB



PNEUMATICS-BASED STAMPING SYSTEM

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Introduction:

Industrial automation is essential for modern manufacturing, delivering enhanced efficiency, consistency, and scalability. Pneumatic systems, recognized for their simplicity and reliability, significantly contribute to these advancements by using compressed air for precise tasks in packaging, material handling, and assembly lines. This project develops a pneumatic-based stamping system to demonstrate the application of pneumatic technology in industrial automation. It integrates key components, including a conveyor belt for object transport, an infrared (IR) sensor for detection, and a pneumatic cylinder for stamping. Timing controls ensure synchronization between detection and stamping, showcasing core automation principles. The model illustrates how pneumatic systems can improve productivity and precision, serving as both a functional stamping prototype and a foundation for understanding pneumatics in industrial automation.

Motivation:

The choice to develop a pneumatic stamping system stemmed from several factors, highlighting pneumatics' value in industry. Pneumatic systems are favored for their simplicity and cost-effectiveness, and this project underscores their practical benefits in achieving automation. Demonstrating the interaction between mechanical, electrical, and pneumatic components showcases how these technologies can work together effectively. Stamping processes are common in industries such as packaging, and automating them enhances consistency and reduces labor. Additionally, this project serves as an educational opportunity to explore pneumatics, sensor detection, and timing control, bridging theory and practice to improve industrial workflows.

Objectives:

1. **Demonstrate Pneumatic System Applications:** To showcase the practical use of pneumatic systems in industrial automation by designing a stamping mechanism integrated with a conveyor belt and IR sensor.
2. **Enhance Process Automation Understanding:** To illustrate how pneumatic, mechanical, and electronic components can work together seamlessly for precise and efficient task execution.
3. **Provide a Scalable Automation Model:** To create a functional prototype that highlights the potential of pneumatic systems in improving productivity and consistency in real-world manufacturing processes.

Components:

The model integrates several key components, including a conveyor belt, an infrared (IR) sensor, and a pneumatic cylinder, to execute a stamping operation. The conveyor belt facilitates the movement of objects, while the IR sensor detects the presence of objects and triggers the pneumatic cylinder to stamp them. Timing control mechanisms ensure synchronized operation, stopping the conveyor precisely when an object is detected for accurate stamping.

Infra-red (IR) Sensor :

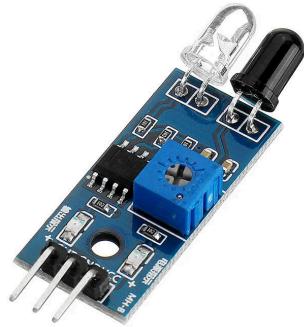


Fig 1: IR sensor

Working: An IR sensor consists of a pair of infrared transmitting and receiving tubes. The transmitting tube emits infrared light at a specific frequency. When the emitted infrared light encounters an obstacle (a reflective surface), it gets reflected back and is detected by the receiving tube. After processing the signal through a comparator circuit, the green indicator light will turn on. At the same time, the signal output interface will send a digital signal (a low-level signal of 1).

Specifications:

- Voltage range: 3.3-5V.
- Output: Digital output signal.

Role in Setup: Detects the presence of object and directs stamping action.

DC (Geared) Motor:

Description: A DC gear motor is an electric motor with a gear mechanism attached to it. This combination allows the motor to deliver increased torque while reducing its speed. Commonly used in applications requiring precise movement and high power at lower speeds.



Fig 2 : DC gear Motor

Specifications:

- Voltage range: 5V.
- speed: 250RPM
- Applications: Conveyors, robotic arms.

Role in Setup: Provides mechanical power for rollers and moves the conveyor belt

24V Relay:

Description: A 24V relay is an electromechanical switch that uses DC input to control the operation of its internal switching mechanism. It allows low-power control signals to manage higher-power circuits safely and efficiently. Commonly used in automation, control systems, and industrial applications.



Fig 3: relay 24v

Specifications:

- Voltage rating: 24V (maximum).

Role in Setup: Enable reliable switching of motor.

Indicator LEDs:

Description: Indicating Traffic LEDs are used to show the conveyor status. It can also be used to control the conveyor remotely using wifi module.

Specifications:

- input: 5V supply
- output: LED Lights



fig 4: indicating Lights

Boost Converter:

Description: A boost converter is a type of DC-DC power converter that steps up (increases) the input voltage to a higher output voltage while maintaining energy efficiency. It achieves this by using components such as an inductor, diode, switch (usually a transistor), and a capacitor. Boost converters are widely used in battery-powered devices, renewable energy systems, and automotive applications to provide stable, higher voltage outputs from a lower voltage source.

Specifications:

- input: 5V
- output: 24V

Role in setup: boost converter steps up the input 5V to 24V.

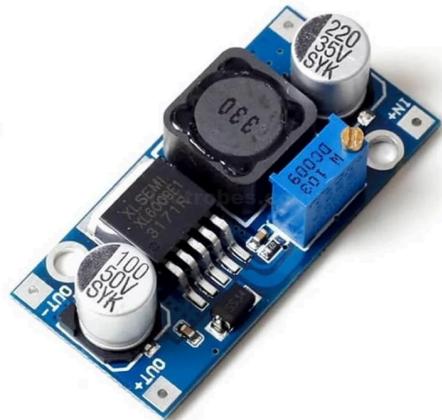


Fig 5: Boost converter

ESP 8266:

The ESP8266 is a low-cost Wi-Fi microchip with built-in TCP/IP networking capabilities. It is widely used in IoT (Internet of Things) projects and applications to enable devices to connect and communicate over a network. Equipped with a powerful processor and multiple GPIO pins, the ESP8266 can be programmed to control sensors, relays, and other components, making it ideal for smart automation systems.



Fig 6: ESP 8266 Module

SOLENOID VALVE:

A 5/2 solenoid valve is a type of directional control valve commonly used in pneumatic systems. The term "5/2" indicates that the valve has five ports and two positions. It is typically operated by a solenoid (electromagnetic actuator) to control the direction of airflow. This valve is used to switch between two states, such as extending and retracting a pneumatic cylinder. Its versatility and precise control make it ideal for automation in industrial applications.



Fig 7: 5/2 Solenoid Valve

Single Acting Cylinder:

A single-acting pneumatic cylinder is a type of actuator that uses compressed air to perform work in one direction, typically extending the piston rod. The return stroke is achieved by a built-in spring or external force. This design makes single-acting cylinders simple, compact, and efficient for applications requiring unidirectional motion, such as clamping, stamping, or lifting. They are widely used in industrial automation for tasks where the return stroke does not require significant force.



Fig 8: single acting Cylinder

CONNECTION CONFIGURATION:

The following are the configuration of pinouts of all the components used:

Sr No.	COMPONENT	PIN CONFIGURATION	
1.	IR Sensor:	PD0	
	LED Indicator	D2	Green LED
		D3	Red LED
		d4	Yellow LED
4.	DC Gear Motor	PD6	
5.	Pneumatic Valve	PD7	

circuit Schematics:

The following is the circuit diagram and the layout of it:

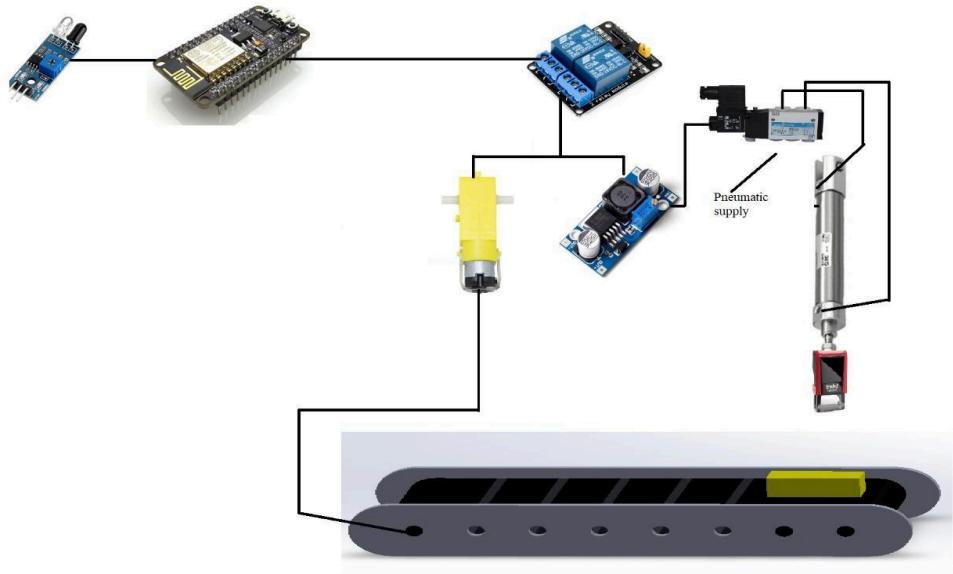


Fig 9: project schematic

FLOWCHART:

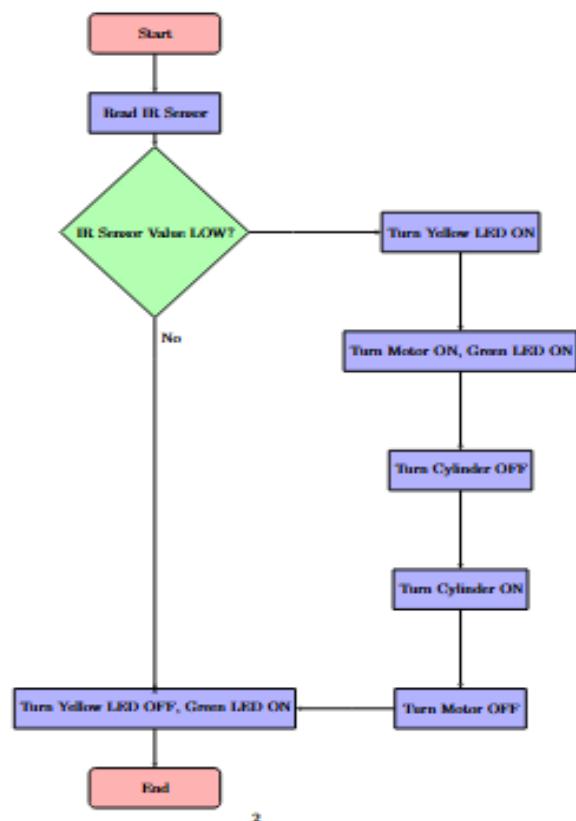


fig 10: flowchart

PROJECT HARDWARE:

The following below is the HARDWARE of the whole setup:

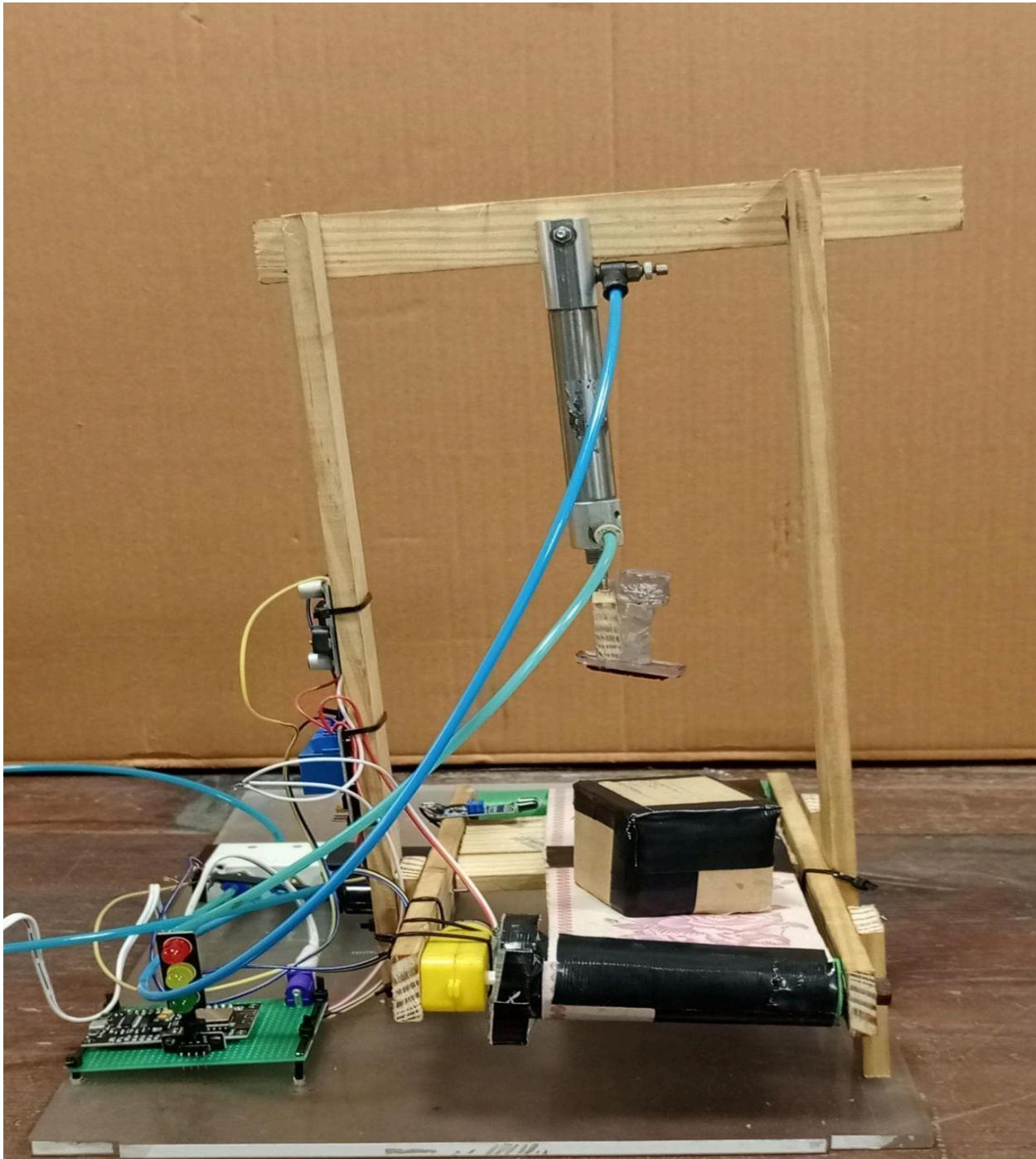


Fig 11 : Project Hardware

WORKING:

The pneumatic-based stamping system operates by integrating several key components in a synchronized manner. A conveyor belt transports objects to the stamping station, where an IR sensor detects the presence of an object. Upon detection, the sensor signals the control unit to halt the conveyor and activate the pneumatic cylinder. The cylinder, powered by compressed air, extends to stamp the object precisely. Once the stamping operation is complete, the conveyor resumes motion, allowing the next object to be processed. Timing controls ensure seamless coordination between the sensor, conveyor, and pneumatic cylinder, demonstrating an efficient and automated stamping process.

FUTURE ENHANCEMENT:

This project can be further enhanced by incorporating advanced technologies and features to improve functionality and adaptability. Some potential future enhancements include:

1. **Integration with IoT:** Adding IoT capabilities to enable remote monitoring and control of the system.
2. **Variable Speed Control:** Implementing a variable speed drive for the conveyor belt to accommodate objects of different sizes and processing speeds.
3. **Multi-Functionality:** Modifying the stamping mechanism to perform additional operations, such as labeling or quality checks.
4. **Enhanced Sensing:** Replacing the IR sensor with more advanced sensors like vision systems for improved accuracy and object detection.
5. **Energy Efficiency:** Optimizing the pneumatic system to minimize air consumption and energy use.

These enhancements can make the system more versatile and suitable for a wider range of industrial applications.

Bill of Material:

Sr No .	COMPONENT	DESCRIPTION	UNIT PRICE	QUANTITY	TOTAL PRICE	VENDOR	STATUS
1	DC GEAR MOTOR	12V motor	300	1	300	Digilog electronics	Active
2	IR SENSOR	OBJECT DETECTION	110	1	110	Epro electronics Phno.0301575575	Active
3	RELAY	24V RATING	135	2	270	Epro electronics Ph no.03015755775	Active
4	ESP 8266	CONTROLLER	850	1	850	Digilog electronics	Active
5	5V DC POWER SUPPLY ADAPTER	5V, 2AMP	170	1	170	Epro electronics Ph no.03015755775	Active
6	DC TO DC BOOST CONVERTER	AMPLIFIER BOARD	150	1	150	Epro electronics	Active
7	Indicating LEDS			1	120	Epro electronics	Active
8	PLASTIC SHEET	For conveyor	100	1	100		Active
9	Tape	for conveyor	280	1	280	shamsi photocopy	Active
9	wooden blocks	For conveyor	400		400		
10	pneumatic cylinder	For Stamping	1500	1	1500		Active
11	stamp						

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