ABSTRACT

In modern industrial environments, repetitive material handling tasks remain labor-intensive, error-prone, and inefficient, especially for small and medium enterprises that lack access to advanced automation due to high costs and system complexity. Traditional robotic systems heavily rely on electrical components, leading to maintenance challenges, higher energy consumption, and increased operational risks in industrial setups. Addressing these limitations, this project presents a cost-effective pneumatic industrial robot capable of performing pick-and-place operations through air-powered linear and rotary motion, minimizing electrical dependency and simplifying control mechanisms.

The robot features a four-axis movement system—three for linear positioning and one for rotational control—powered by double-acting pneumatic cylinders and managed through a Delta PLC programmed in WPLSoft using ladder logic. Mechanical design and structural analysis were carried out using AutoCAD Mechanical to ensure structural integrity and proper alignment under operational stress. The integration of 5/2 solenoid-actuated directional control valves and an efficient power supply unit supports real-time responsiveness and consistent actuation.

This automation system improves workflow consistency, enhances safety, and reduces labor fatigue, all while delivering industrial-grade precision and repeatability. Its modular nature allows easy customization and maintenance, making it ideal for scalable deployment. Furthermore, this project lays the groundwork for incorporating advanced features like sensor feedback, machine vision, and IoT-based remote monitoring, aligning with future smart factory trends. Ultimately, the solution demonstrates a sustainable, reliable, and industry-adaptable approach to modernizing repetitive manual processes in compact and cost-sensitive manufacturing environments.