

Simulation of Dynamic Pick and Place Application using Unified Robot Control

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Problem Statement

Modern production lines require high-speed pick-and-place systems capable of accurately handling moving products while maintaining reliability and safety. Many systems face challenges with conveyor tracking, motion synchronization, hardware integration, and scalable electrical control design. The objective of this project is to develop a simulated 6-axis robotic pick-and-place system with real-time tracking, integrating Rockwell Automation's Unified Robot Control, while also designing a modular electrical cabinet that meets real industrial automation standards.

Customer Background

Rockwell Automation is a global leader in industrial automation, digital transformation, and smart manufacturing solutions. The company provides PLCs, motion control systems, robotics integration tools, drives, sensors, and industrial software used in manufacturing facilities worldwide. Its flagship platforms, including Allen-Bradley hardware and FactoryTalk software, help companies improve productivity, safety, and efficiency. For this project, Rockwell Automation is sponsoring a real-world robotics application that reflects common OEM packaging and material-handling challenges.

Unified Robot Control

A specialized library that allows users to program and coordinate robotic motion directly within the Logix environment. By eliminating the need for separate robot controllers, it enables a single PLC to manage both machine logic and complex 6-axis kinematics through Studio 5000. Reducing synchronization errors and streamlining deployment of high-speed applications.

Requirements

- Develop a pick-and-place system with dynamic tracking using a 6-axis robot.
- Simulate object tracking with accurate timing along a conveyor axis.
- Utilized URC Library V3, Emulate3D, Studio 5000, Optix Studio, Logix Echo, and Integrated Architecture Builder.
- Simulate Compact GuardLogix PLC-based machine control.
- Design a modular control cabinet for scalable automation hardware.
- Create an electrical cabinet layout including power, Kinetix 5700 drives, I/O, and safety devices.
- Apply proper wiring standards, labeling, and cable management practices.
- Ensure accurate placement without collisions or system faults.

Experimentation and Concepts

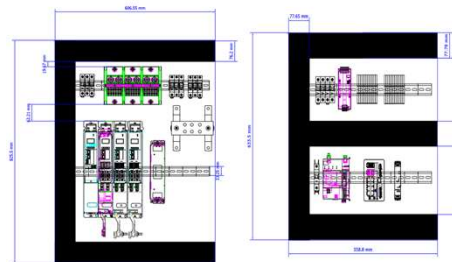
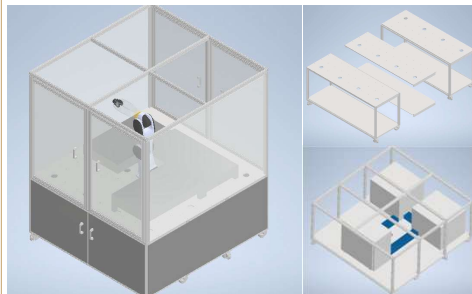
- 6-axis robot kinematics and high-speed motion control.
- Conveyor tracking and encoder synchronization.
- PLC ladder logic and machine sequencing.
- Robot-to-PLC communication architecture.
- Programmed dynamic object tracking along conveyor axis.
- Servo drive integration and motion axis control.
- 3D simulation in Emulate3D.
- Electrical schematic interpretation and panel design.
- Power distribution, safety relays, E-stops, and circuit protection evaluation.
- Modular cabinet layout for maintainability and future expansion.
- Testing cycle time, repeatability, and fault recovery strategies.

Final Solution and Physical Hardware.

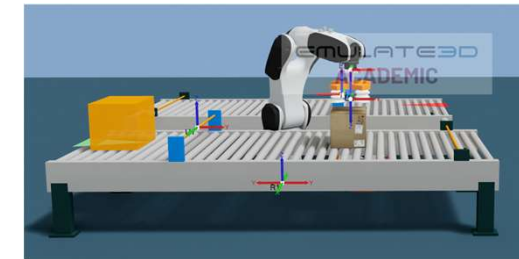
The final solution is a simulated 6-axis robotic system that is capable of dynamically tracking an object along a conveyor without performing the intended pick-and-place operation. The system uses a PLC ladder logic program developed in Studio 5000 with URC V3 integrated to coordinate robot motion, tracking, and status monitoring. To support the simulated system with real-world industrial practices, a modular control cabinet and electrical cabinet were also designed. Together, the simulation environment and physical cabinet design create a complete automation solution that bridges virtual testing with practical hardware integration, closely representing how OEM robotic systems are developed and deployed in industry.

The modular cabinet provides a scalable hardware platform that can be expanded or reconfigured for future automation projects, while housing major control components such as the PLC, I/O modules, drives, power supplies, and safety devices.

The electrical cabinet was wired following industrial standards to demonstrate proper panel layout, cable management, component protection, maintainability, and rigorous safety compliance protocols.



Testing and Results



- Partial completion of the intended robotic pick-and-place system, with a current milestone of successful object tracking along the conveyor axis.
- Accurate dynamic tracking of an object once the photo eye sensor is triggered.
- Utilized an Emulate3D environment, a Studio 5000 ladder logic program with URC V3, and an Optix HMI.
- Working towards achieving the intended pick-and-place system with dynamic tracking.
- Verified modular cabinet layout for component access and expansion.
- Completed electrical cabinet wiring design with safe and organized design practices using E-Plan.
- Functional I/O validation and hardware readiness for future live testing.
- Students gained practical experience in robotics, PLC programming, simulation, and industrial electrical design.