RV-8CRL Work Cell Robot

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Executive Summary

The Mitsubishi RV-8CRL robotic work cell is a simulated environment that mirrors robotic applications in industrial settings. With the rise of automation, the team focused research and implementation of industrial paint robots used in the automotive industry. To achieve this, the team started with integrating various components of the robotic work cell. Completed tasks include installing and programming an additional 7th axis linear rail, configuring the programmable logic controller (PLC), establishing TCP connectivity between components and configuring an air pneumatic line. The team prioritized safety while completing the integration by installing a signal light tower and inductive sensors to establish bound limits that prevent collisions with the outer cage.

Background

The typical clients for this application are any company that utilizes automated manufacturing. This system showcases an example of how an industrial robot can be used to spray paint different components and parts depending on the industry type.
For example, any automotive company is an excellent example of a client that can utilize the robotic work cell to paint different parts of an automotive.

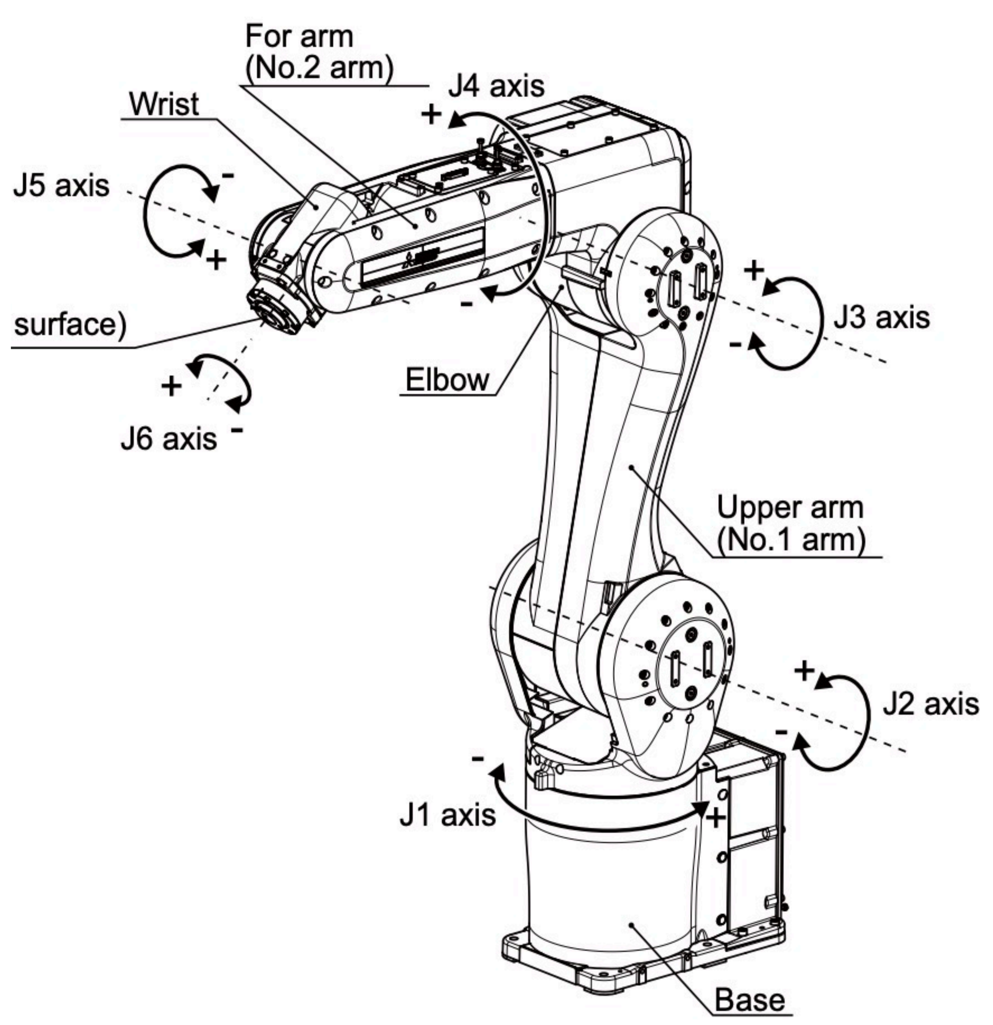


Figure 1. RV-8CRL robot arm specifications

Project Setup

Requirements:

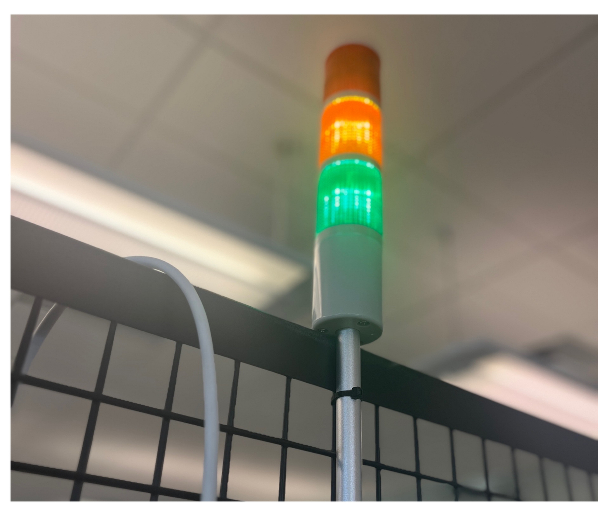
- The RV-8CRL robotic work cell should integrate an additional 7th axis linear rail to increase the range of motion.
- The programmable logic controller (PLC), robot controller, and host PC should be networked together via a TCP protocol.
- The work cell must incorporate an air pneumatic line with an airbrush system to mimic industrial paint applications, particularly seen in the automotive industry.
- The integration process must comply with relevant industry standards and regulations governing robotic work cell safety and operation.

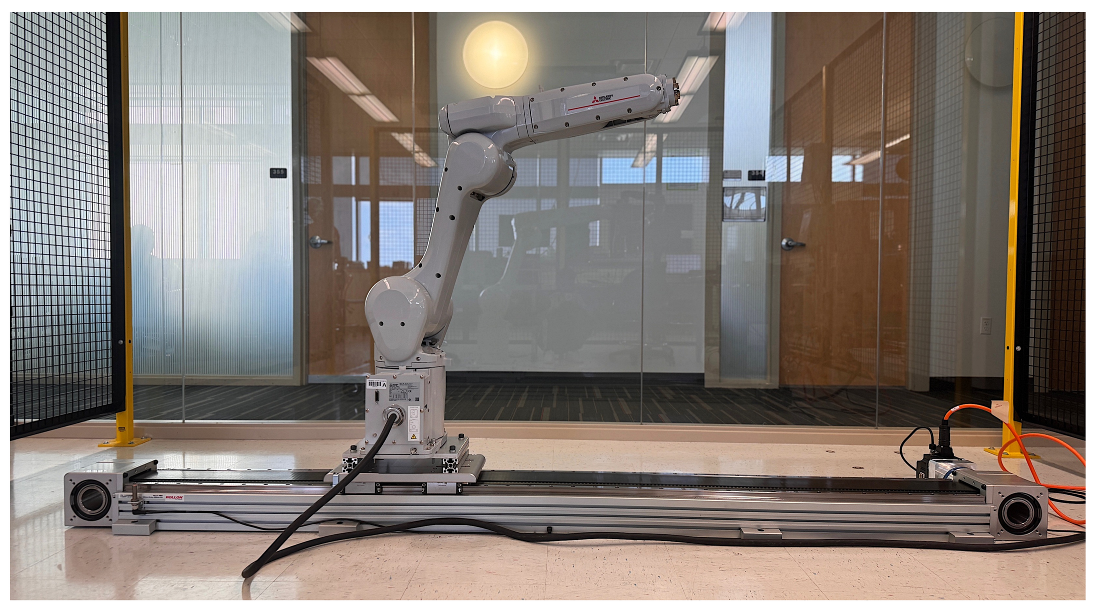
Constraints:

- The linear rail system uses an incremental encoder as opposed to an absolute encoder, leading to origin data erasure on power loss.
- Liquid paint is conductive; thus, the team must find alternatives to prevent shorts.
- Extensive documentation for each component, with
- The robot has an 8-kilogram payload, limiting the team to specific weights.
- The system must have a central control system to communicate with other external devices, as constraints on range and reliability of its communication systems.

Integration & Implementation

- Establishing a connection between robot controller and linear rail using fiber-optic cable, adding an additional 7th axis for this project.
- Initiating connection between PC and PLC via ethernet switch using TCP/IP protocol that can be logically controlled with GXWorks3 software.
- Triggering Mitsubishi PLC relay using GXWorks3 software written in ladder logic.
- Utilizing 20 GPIO pins, the PLC interfaces with various external devices, efficiently capturing signals and directing outputs to illuminate components like light towers.
- Programming the system using MELFA BASIC-VI in the RTToolbox software provided by Mitsubishi Electric. The language provides program logic and control the gestures of the robot including joint position, speed, override, torque, etc.
- Bridging connection between the robot controller and PLC using the CC-Link interface over ethernet connection.
- Following the regulatory practices of safety. Lockout tagout procedures are followed during wiring, and light tower indicates the status of the robot.
- Implementing emergency stops; one is located inside the cage whereas the second is located outside the cage. There is also an emergency stop on the robot controller.





Results

The team was able to integrate the robotic system, along with its logical and safety components. Emergency stops, light towers, and inductive sensors work as expected and communicate with the programmable logic controller. The robot supports an additional 7th axis and can be programmed freely.

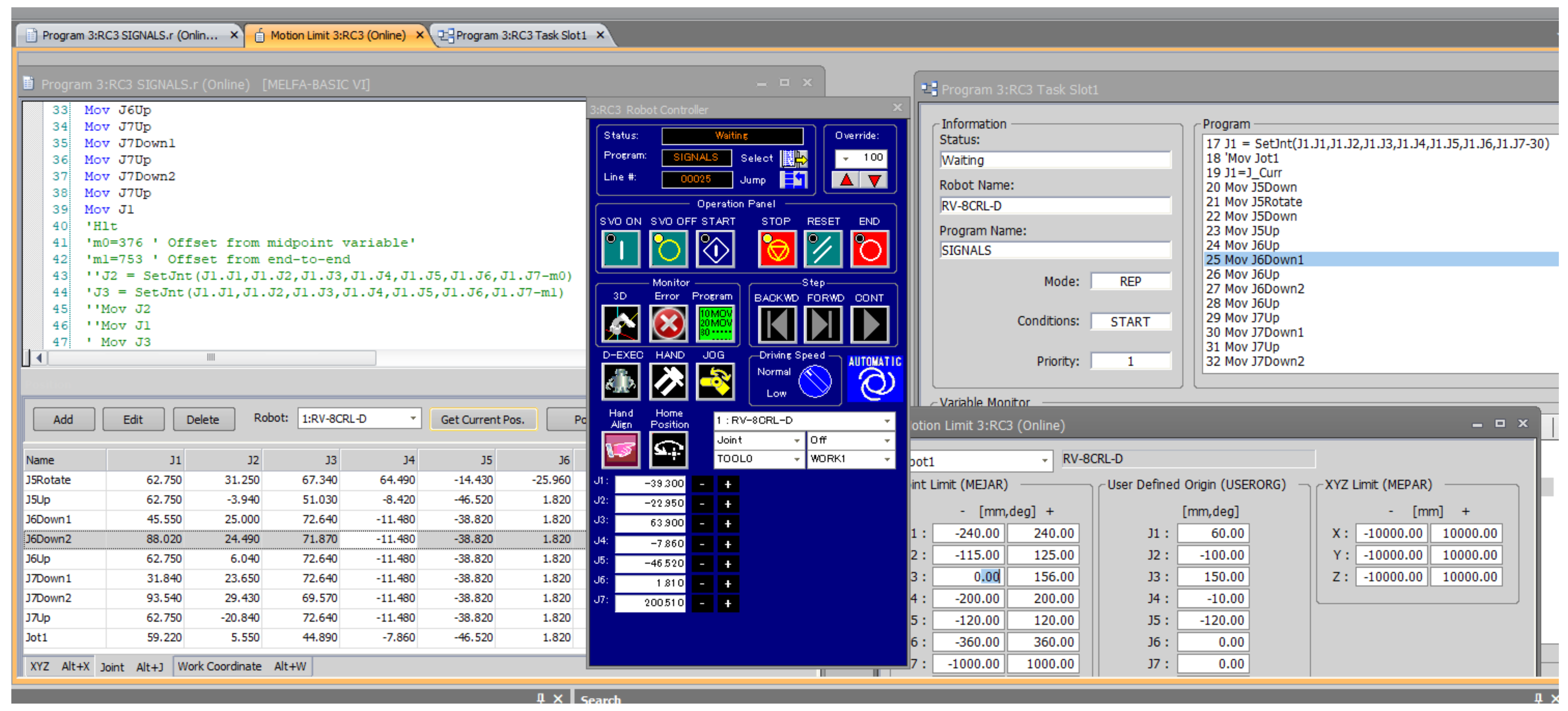
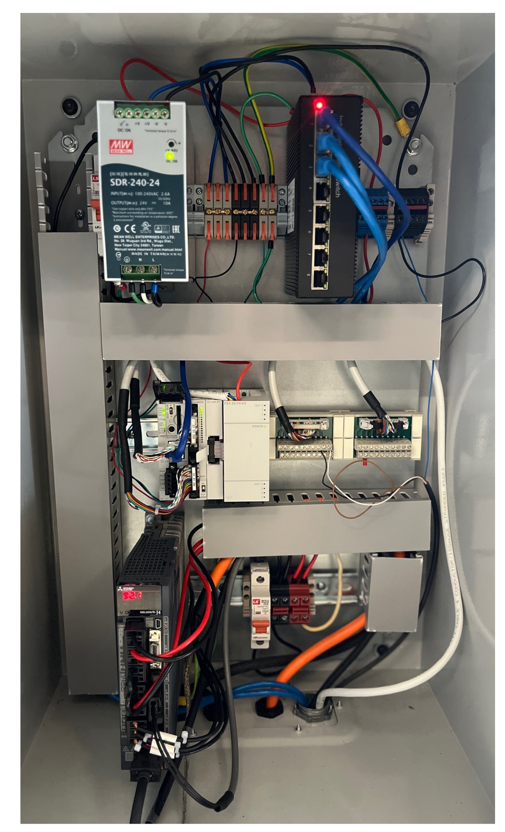


Figure 2. RTToolbox operation panel and programming

Conclusions

Our chosen design meets the requirements by our sponsors as our robot arm includes communication between PLC, PC and the robot arm. The PLC also utilizes the solenoid valves and uses the software of both GX Works3 and RT Toolbox3 to perform operations required to air spray. Some of the challenges we learned were about establishing communication between different components, especially between PLC and Robot Arm and configuring the CC Link and TCP/IP Protocol. In Conclusion, we were able to create an application that utilizes all the major components such as GPIO, Linear Rail, and the Robot Arm.



References

1. Mitsubishi Electric. (2024). CR800-D Controller RV-8CRL Standard Specifications Manual.