DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON

# SYSTEM REQUIREMENTS SPECIFICATION
# CSE 4316: SENIOR DESIGN I
# FALL 2023


## ROBO CREW
## RV8 WORKCELL

MUHAMMAD ANAS
AMEEN MAHOUCH
AKSHAY PALURI
HYUN HO KIM
KUNDAN SINGH MAHATO

## Revision History

| Revision | Date | Author(s) | Description |
|---|---|---|---|
| 0.1 | 10.16.2023 | AM, MA, HK, AP, KM | Document Creation |
| 0.2 | 05.05.2024 | AM, MA, HK, AP, KM | Document Update |

# CONTENTS


**1 Product Concept** **8**
- 1.1 Purpose and Use . . . 8
- 1.2 Intended Audience . . . 8

**2 Product Description** **9**
- 2.1 Features & Functions . . . 9
- 2.2 External Inputs & Outputs . . . 9
- 2.3 Product Interfaces . . . 9

**3 Customer Requirements** **11**
- 3.1 Airbrush . . . 11
  - 3.1.1 Description . . . 11
  - 3.1.2 Source . . . 11
  - 3.1.3 Constraints . . . 11
  - 3.1.4 Standards . . . 11
  - 3.1.5 Priority . . . 11
- 3.2 Runtime setup . . . 11
  - 3.2.1 Description . . . 11
  - 3.2.2 Source . . . 11
  - 3.2.3 Constraints . . . 11
  - 3.2.4 Priority . . . 11
- 3.3 Green Light Signal . . . 12
  - 3.3.1 Description . . . 12
  - 3.3.2 Source . . . 12
  - 3.3.3 Constraints . . . 12
  - 3.3.4 Standards . . . 12
  - 3.3.5 Priority . . . 12
- 3.4 Orange Light Signal . . . 12
  - 3.4.1 Description . . . 12
  - 3.4.2 Source . . . 12
  - 3.4.3 Constraints . . . 12
  - 3.4.4 Standards . . . 13
  - 3.4.5 Priority . . . 13
- 3.5 Red Light Signal . . . 13
  - 3.5.1 Description . . . 13
  - 3.5.2 Source . . . 13
  - 3.5.3 Constraints . . . 13
  - 3.5.4 Standards . . . 13
  - 3.5.5 Priority . . . 13
- 3.6 Installation of Linear Rail . . . 13
  - 3.6.1 Description . . . 13
  - 3.6.2 Source . . . 14
  - 3.6.3 Constraints . . . 14
  - 3.6.4 Standards . . . 14
  - 3.6.5 Priority . . . 14

**4 Packaging Requirements** **15**
4.1 Hardware components . . . 15
4.1.1 Description . . . 15
4.1.2 Source . . . 15
4.1.3 Constraints . . . 15
4.1.4 Standards . . . 15
4.1.5 Priority . . . 15
4.2 Software components . . . 15
4.2.1 Description . . . 15
4.2.2 Source . . . 15
4.2.3 Constraints . . . 15
4.2.4 Standards . . . 15
4.2.5 Priority . . . 15

**5 Performance Requirements** **16**
5.1 Load Capacity . . . 16
5.1.1 Description . . . 16
5.1.2 Source . . . 16
5.1.3 Constraints . . . 16
5.1.4 Standards . . . 16
5.1.5 Priority . . . 16
5.2 Positioning with Offset . . . 16
5.2.1 Description . . . 16
5.2.2 Source . . . 16
5.2.3 Constraints . . . 16
5.2.4 Standards . . . 16
5.2.5 Priority . . . 16
5.3 Box Weight . . . 16
5.3.1 Description . . . 16
5.3.2 Source . . . 17
5.3.3 Constraints . . . 17
5.3.4 Standards . . . 17
5.3.5 Priority . . . 17

**6 Safety Requirements** **18**
6.1 Laboratory equipment lockout/tagout (LOTO) procedures . . . 18
6.1.1 Description . . . 18
6.1.2 Source . . . 18
6.1.3 Constraints . . . 18
6.1.4 Standards . . . 18
6.1.5 Priority . . . 18
6.2 National Electric Code (NEC) wiring compliance . . . 18
6.2.1 Description . . . 18
6.2.2 Source . . . 18
6.2.3 Constraints . . . 18
6.2.4 Standards . . . 18
6.2.5 Priority . . . 18
6.3 RIA robotic manipulator safety standards . . . 18

6.3.1 Description . . . 18
6.3.2 Source . . . 19
6.3.3 Constraints . . . 19
6.3.4 Standards . . . 19
6.3.5 Priority . . . 19
6.4 Emergency Stop . . . 19
6.4.1 Description . . . 19
6.4.2 Source . . . 19
6.4.3 Constraints . . . 19
6.4.4 Standards . . . 19
6.4.5 Priority . . . 19
6.5 Inductive Switch . . . 19
6.5.1 Description . . . 19
6.5.2 Source . . . 19
6.5.3 Constraints . . . 19
6.5.4 Standards . . . 19
6.5.5 Priority . . . 20

**7 Maintenance & Support Requirements 21**
7.1 Operation Manual . . . 21
7.1.1 Description . . . 21
7.1.2 Source . . . 21
7.1.3 Constraints . . . 21
7.1.4 Standards . . . 21
7.1.5 Priority . . . 21
7.2 Safety Connections . . . 21
7.2.1 Description . . . 21
7.2.2 Source . . . 21
7.2.3 Constraints . . . 21
7.2.4 Standards . . . 21
7.2.5 Priority . . . 21
7.3 Major Connections . . . 21
7.3.1 Description . . . 21
7.3.2 Source . . . 21
7.3.3 Constraints . . . 22
7.3.4 Standards . . . 22
7.3.5 Priority . . . 22

**8 Other Requirements 23**
8.1 Host PC Security . . . 23
8.1.1 Description . . . 23
8.1.2 Source . . . 23
8.1.3 Constraints . . . 23
8.1.4 Standards . . . 23
8.1.5 Priority . . . 23

**9 Future Items** **24**
9.1 GUI App . . . 24
9.1.1 Description . . . 24
9.1.2 Source . . . 24
9.1.3 Constraints . . . 24
9.1.4 Standards . . . 24
9.1.5 Priority . . . 24
9.2 Visual Sensor . . . 24
9.2.1 Description . . . 24
9.2.2 Source . . . 24
9.2.3 Constraints . . . 24
9.2.4 Standards . . . 24
9.2.5 Priority . . . 24

## List of Figures


1 Mitsubishi RV8-CRL [1] . . . . . 8
2 Robot arm of RV8-CRL . . . . . 9
3 Linear rail . . . . . 10
4 Emergency stop . . . . . 10
5 CR800 controller . . . . . 10

# 1 Product Concept

This section describes the purpose, use, and intended user audience for the RV8 Work Cell. RV8 Work Cell is a system that performs precise marking using an air brush in an industrial manner. Users of this work cell will be able to practice standards in industrial robotics, while improving time efficiency.

## 1.1 Purpose and Use

The conventional approach to automotive air brushes in warehouses contains several challenges. Using manual spray painting or air brush for painting can be time consuming, and can cause errors in its precision. Since manual spray painting can be prone to errors, any imprecise markings can cause cost overheads due to cleaning and repainting on the product. Finally, with modern commerce continuing to grow, spray painting on different products must be done with efficiency, while saving time and costs per paint. The RV8 robot work cell will precisely paint using an air brush in an organized manner according to customer's requirements with high efficiency and accuracy.

## 1.2 Intended Audience

This product is considered industrial, so the intended audience of this product are warehouses and factories where manual labor can be automated through the use of robotics.

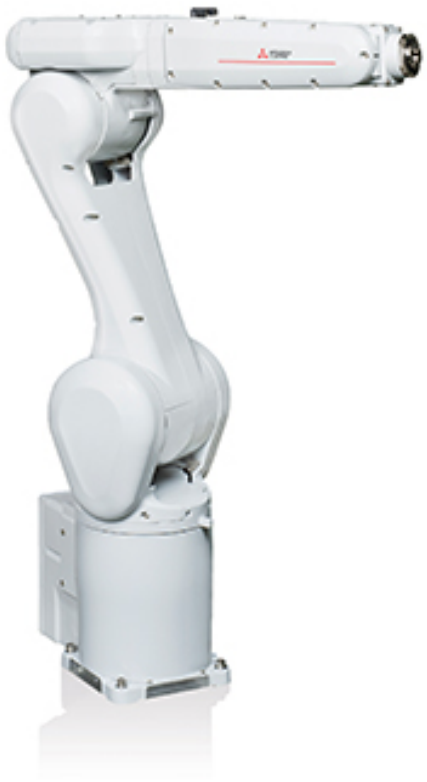

Figure 1: Mitsubishi RV8-CRL [1]

# 2 Product Description

This section provides the reader with an overview of the RV8 robot work cell. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the work cell, as well as critical user interactions are described in detail below.

## 2.1 Features & Functions

The RV8 work cell will specialize in precisely marking on an object incorporating all aspects of the robot arm and linear rail. It will perform these operations through the use of a compressor which will be connected to the PLC. The vertical robot initially has 6 axis, with a linear rail acting as the 7th axis. The robot will precisely paint, where the system will send signal to the compressor which will output the paint on a plastic sheet. While performing the operation, several safety features will be implemented, such as emergency stops, and industrial light towers. The integrated components of the work cell are the Programmable Logic Controller (PLC), host PC, and a CR800 handheld controller.

## 2.2 External Inputs & Outputs

| Name | Description | Use |
|---|---|---|
| Air brush & compressor | System output | Sprays the paint from the air brush |
| Presence Detection | System input | Detects motion within the work cell |
| Emergency Stops | User input | Stops the operation of the robot arm |
| Industrial Light Tower | System output | Indicates the state of the work cell |
| Inductive Switches | System input | Indicates the end limits of linear rail |

Table 2: Overview of external inputs and outputs

## 2.3 Product Interfaces

Specify what all operational (visible) interfaces look like to your end-user, administrator, maintainer, etc. Show sample/mocked-up screen shots, graphics of buttons, panels, etc. Refer to the critical external inputs and outputs described in the paragraph above.


Figure 2: Robot arm of RV8-CRL

Figure 3: Linear rail

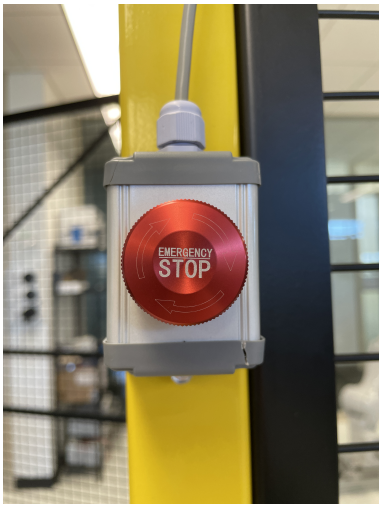


Figure 4: Emergency stop

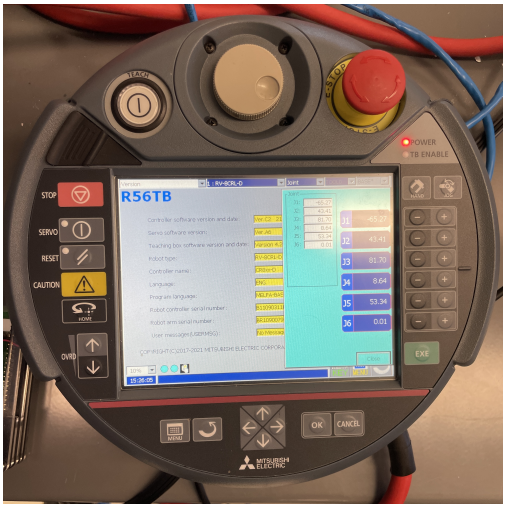


Figure 5: CR800 controller

# 3 Customer Requirements

This robot is a device that allows users to program what they want to draw using an airbrush. The airbrush is connected to an air compressor and operates by receiving signals from a computer. Additionally, there are emergency stop buttons placed in several locations so that users can terminate the program at any time. At the end of the rail that moves the robot along the Y-axis, there are inductive sensors that will display a warning orange light if the allowed range is exceeded. The light tower indicates the current program status with green, orange, and red lights.

## 3.1 Airbrush

### 3.1.1 Description

The airbrush is connected to an air compressor, which in turn is connected to a PLC (Programmable Logic Controller) to receive signals for operation. The air compressor is designed to automatically adjust the pressure. Users can command the robot to spray ink when it reaches the desired position and to stop. Additionally, the robot is programmed to work when the light tower is green.

### 3.1.2 Source

CSE Senior Design project specifications.

### 3.1.3 Constraints

If the drawings or prints are large, the ink storage capacity could be an issue. A large ink storage space would be needed based on usage. Additionally, it is important to continuously maintain the cleanliness of the airbrush to ensure it does not clog and can spray a consistent amount.

### 3.1.4 Standards

- ISO 10218 Robots and robotic devices - Safety requirements for industrial robots: In order to ensure the safe interaction of the robot arm with the airbrush and other equipment.

### 3.1.5 Priority

- Critical: This is the main purpose of the project. Without the airbrush, it cannot function.

## 3.2 Runtime setup

### 3.2.1 Description

This feature is related to the ability to configure and adjust the time parameters of automated operations or processes within the system. Users can specify the duration of various tasks, ensuring precise control over timing for optimal system performance. This setting allows for the fine-tuning of process duration to meet specific operational needs.

### 3.2.2 Source

Hyun Ho Kim has expressed the need for flexible and customizable runtime settings to adapt the system's performance to their unique requirements.

### 3.2.3 Constraints

Sustainability: Any changes made to runtime settings should not compromise the system's overall sustainability and energy efficiency.

### 3.2.4 Priority

- Low: While the ability to configure runtime parameters is a valuable feature, it is not considered critical to the core functionality of the product at this time.

## 3.3 Green Light Signal

### 3.3.1 Description

The green light tower is a visual indicator designed to signal the operational status of a critical system or process. This tower consists of multiple stacked light modules that emit a bright green light when the system is in an operational or "go" status. When the system is in a non-operational or "stop" status, the green light tower remains off. The green light tower serves as a quick and easily visible means of providing real-time status information, enhancing safety and productivity in industrial and manufacturing environments.

### 3.3.2 Source

CSE Senior Design project specifications.

### 3.3.3 Constraints

Health and Safety: It should meet safety standards to prevent potential hazards or misinterpretation of status. Environmental: The components of the green light tower should be environmentally friendly and compliant with relevant regulations regarding materials and energy consumption.

### 3.3.4 Standards

- EN ISO 13850: Safety of machinery - Emergency stop function - Principles for design.
- IEC 60947-5-2:2019 Low-voltage switchgear and controlgear - Part 5-2: Control circuit devices and switching elements - Proximity switches

### 3.3.5 Priority

- High: This feature is very important for the product as it directly impacts the safety and efficiency of industrial operations. The green light tower is essential for providing real-time status information, enhancing worker safety, and ensuring smooth and error-free processes. Its absence would compromise both operational safety and productivity, making it a fundamental requirement.

## 3.4 Orange Light Signal

### 3.4.1 Description

The orange light is a distinctive visual indicator designed to signal specific conditions or events within the system. This light module emits a bright orange light when the inductive sensors detect metals or when a warning or alert status is triggered. It serves as a clear and easily recognizable means of providing immediate visual cues to operators or users, enhancing safety and ensuring efficient response to critical events.

### 3.4.2 Source

CSE Senior Design project specifications.

### 3.4.3 Constraints

Health and Safety: It should meet safety standards to prevent potential hazards or misinterpretation of status. Environmental: The components of the orange light tower should be environmentally friendly and compliant with relevant regulations regarding materials and energy consumption.

### 3.4.4 Standards

- EN ISO 13850: Safety of machinery - Emergency stop function - Principles for design.
- IEC 60947-5-2:2019 Low-voltage switchgear and controlgear - Part 5-2: Control circuit devices and switching elements - Proximity switches

### 3.4.5 Priority

- High: This feature is very important for the product as it directly impacts the safety and efficiency of industrial operations. The orange light tower is essential for providing real-time status information, enhancing worker safety, and ensuring smooth and error-free processes. Its absence would compromise both operational safety and productivity, making it a fundamental requirement.

## 3.5 Red Light Signal

### 3.5.1 Description

The red light signal is a vital visual indicator designed to signal immediate stop or emergency conditions within the system. This light module emits a bright red light when predefined critical events or emergency states occur. It serves as a clear and universally recognized means of conveying urgent visual cues to operators or users, ensuring safety and facilitating quick, decisive responses in emergency situations.

### 3.5.2 Source

CSE Senior Design project specifications.

### 3.5.3 Constraints

Health and Safety: It should meet safety standards to prevent potential hazards or misinterpretation of status. Environmental: The components of the red light tower should be environmentally friendly and compliant with relevant regulations regarding materials and energy consumption.

### 3.5.4 Standards

- EN ISO 13850: Safety of machinery - Emergency stop function - Principles for design.
- IEC 60947-5-2:2019 Low-voltage switchgear and controlgear - Part 5-2: Control circuit devices and switching elements - Proximity switches

### 3.5.5 Priority

- High: This feature is very important for the product as it directly impacts the safety and efficiency of industrial operations. The red light tower is essential for providing real-time status information, enhancing worker safety, and ensuring smooth and error-free processes. Its absence would compromise both operational safety and productivity, making it a fundamental requirement.

## 3.6 Installation of Linear Rail

### 3.6.1 Description

In addition to the robot arm, an important component is required for desire functionality, namely the linear rail. Serving as the system's 7th axis complementing the robot arm's existing 6 axes, the linear rail is a crucial addition. Its primary role is to facilitate backward and forward movements, significantly enhancing the system's versatility. The integration of this linear rail component adds seamless and efficient operations, allowing the robot arm to navigate and position itself with great accuracy and efficiency, meeting the specific customer demands.

#### 3.6.2 SOURCE

Team ROBO CREW

#### 3.6.3 CONSTRAINTS

Linear rail needs to setup properly.

#### 3.6.4 STANDARDS

Not applicable.

#### 3.6.5 PRIORITY

High

# 4 Packaging Requirements

Though the RV8-CRL is housed in the Engineering Research Building, this particular project contains several modular hardware and software components that can be packaged for implementation to other workcells that house the RV8-CRL. This makes it possible to replicate the RV8-CRL's capabilities in other locations, without having to rebuild the entire system from scratch.

## 4.1 Hardware components

### 4.1.1 Description

The hardware components will be placed in a labeled box in the workcell, and will include the airbrush, air compressor, sensors, extra wiring, canvas, and any other hardware components that are necessary to implement the RV8-CRL project in another working environment. This also will include a USB drive.

### 4.1.2 Source

Dr. Chris McMurrough

### 4.1.3 Constraints

There may be several different wires and hardware components, which can become disorganized if not labeled properly.

### 4.1.4 Standards

There are no applicable standards.

### 4.1.5 Priority

Moderate

## 4.2 Software components

### 4.2.1 Description

All programs, code, scripts, and software will be written to a USB drive, as well as uploaded to a shared version control system GitHub repository.

### 4.2.2 Source

Dr. Chris McMurrough

### 4.2.3 Constraints

The software components must be compatible with the hardware components and operating systems used in the target workcells. Compatibility testing and adjustments may be required to ensure seamless integration.

### 4.2.4 Standards

There are no applicable standards.

### 4.2.5 Priority

Moderate

# 5 Performance Requirements

In an industrial setting, the performance and efficiency of machinery are pivotal in determining earnings. Any delay, inefficiency, or downtime in industrial operations can have a direct impact on the profitability of an organization. The RV8-CRL has specific performance requirements to adhere to.

## 5.1 Load Capacity

### 5.1.1 Description

The RV8-CRL has a rated payload of 7 kg (15.432 lbs) and a maximum payload of 8 kg (17.637 lbs).

### 5.1.2 Source

This requirement is sourced by Mitsubishi.

### 5.1.3 Constraints

The gripper used in conjunction with the robot must be designed and configured to support the same payload capacity as specified by the robot's rated and maximum payload. Failure to meet this constraint can lead to suboptimal performance and potential damage to the robot or the objects it handles.

### 5.1.4 Standards

There are no applicable standards.

### 5.1.5 Priority

Critical

## 5.2 Positioning with Offset

### 5.2.1 Description

The RV8-CRL robot must achieve a maximum positioning offset of no more than 1 millimeter (0.039 inches) from the intended target position when performing precision tasks. This requirement ensures that the robot can precisely mark and perform tasks with a high degree of precision, critical for applications such as painting, spraying, etc.

### 5.2.2 Source

This requirement is sourced by industrial robot standard.

### 5.2.3 Constraints

It may be challenging to measure performance accuracy.

### 5.2.4 Standards

ISO 9283 - This standard defines a set of tests for measuring the repeatability, absolute accuracy, and path accuracy of industrial robots

### 5.2.5 Priority

High

## 5.3 Box Weight

### 5.3.1 Description

Boxes used in the demonstration of the RV8-CRL must not exceed a weight of 8 kg (17.637 lbs). This weight limitation is imposed to safeguard the safety of robot operation and to ensure the reliability of its performance. Exceeding this weight may impede structural integrity.

#### 5.3.2 SOURCE

This requirement is sourced by industrial robot standard and Mitsubishi.

#### 5.3.3 CONSTRAINTS

This weight limitation restricts the amount of industrial applications that the program can be used in.

#### 5.3.4 STANDARDS

ISO 10218-1 and ISO 10218-2:2011 - These international standards provide guidelines for the safety of industrial robots. They include specifications related to the maximum payload and handling of objects by industrial robots.

#### 5.3.5 PRIORITY

High

# 6 Safety Requirements

The RV-8CRL robot arm is an industrial robot that can potentially harm those around those with electric shocks and serious injuries due to the movement of robot and wiring of robot. We shall include procedures that will make it more safer to be around the robot, and prevent any electrical hazard.

## 6.1 Laboratory equipment lockout/tagout (LOTO) procedures

### 6.1.1 Description

Any fabrication equipment provided used in the development of the project shall be used in accordance with OSHA standard LOTO procedures. Locks and tags are installed on all equipment items that present use hazards, and ONLY the course instructor or designated teaching assistants may remove a lock. All locks will be immediately replaced once the equipment is no longer in use.

### 6.1.2 Source

CSE Senior Design laboratory policy

### 6.1.3 Constraints

Equipment usage, due to lock removal policies, will be limited to availability of the course instructor and designed teaching assistants.

### 6.1.4 Standards

Occupational Safety and Health Standards 1910.147 - The control of hazardous energy (lockout/tagout).

### 6.1.5 Priority

Critical

## 6.2 National Electric Code (NEC) wiring compliance

### 6.2.1 Description

Any electrical wiring must be completed in compliance with all requirements specified in the National Electric Code. This includes wire runs, insulation, grounding, enclosures, over-current protection, and all other specifications.

### 6.2.2 Source

CSE Senior Design laboratory policy

### 6.2.3 Constraints

High voltage power sources, as defined in NFPA 70, will be avoided as much as possible in order to minimize potential hazards.

### 6.2.4 Standards

NFPA 70

### 6.2.5 Priority

Critical

## 6.3 RIA robotic manipulator safety standards

### 6.3.1 Description

Robotic manipulators, if used, will either housed in a compliant lockout cell with all required safety interlocks, or certified as a "collaborative" unit from the manufacturer.

#### 6.3.2 Source

CSE Senior Design laboratory policy

#### 6.3.3 Constraints

Collaborative robotic manipulators will be preferred over non-collaborative units in order to minimize potential hazards. Sourcing and use of any required safety interlock mechanisms will be the responsibility of the engineering team.

#### 6.3.4 Standards

ANSI/RIA R15.06-2012 American National Standard for Industrial Robots and Robot Systems, RIA TR15.606-2016 Collaborative Robots

#### 6.3.5 Priority

Critical

### 6.4 Emergency Stop

#### 6.4.1 Description

Robotic arm manipulator shall stop once any of the exterior, interior, and controller emergency stops are pressed.

#### 6.4.2 Source

CSE Senior Design laboratory policy

#### 6.4.3 Constraints

Only 2 emergency stops will be provided that are located outside the controller. Additionally, only those allowed to enter the work cell, instructor and the engineering team, shall have access to the interior and controller emergency stop.

#### 6.4.4 Standards

RV-8CRL Standards Specification

#### 6.4.5 Priority

Critical

### 6.5 Inductive Switch

#### 6.5.1 Description

Since the linear rail has bounds, inductive switches shall be used to prevent the robot arm from going beyond a certain limits. These inductive swtiches will be added on both ends of the linear rail.

#### 6.5.2 Source

CSE Senior Design RV8 Engineering Team

#### 6.5.3 Constraints

The inductive switches will only work if they are programmed into stopping the robot arm. Otherwise, they won't prevent the robot arm from traveling beyond those limits.

#### 6.5.4 Standards

There are no applicable standards.

#### 6.5.5 PRIORITY

Critical

# 7 Maintenance & Support Requirements

Apart from customers' requirements the team will provide to ensure robot performs smoothly.

## 7.1 Operation Manual

### 7.1.1 Description

A detailed operation manual will be provided to the customer. It will guide the customer through various steps to operate the robot. This will include the start, stop and any kind of minor malfunctioning troubleshoot procedures.

### 7.1.2 Source

Team ROBO CREW

### 7.1.3 Constraints

A manual should be followed accurately and should ask for assistance if needed in understanding.

### 7.1.4 Standards

No applicable standards.

### 7.1.5 Priority

Medium to high.

## 7.2 Safety Connections

### 7.2.1 Description

The team will assist by providing appropriate safety connections which include E-stops, industrial light towers, and inductive sensors, since this is an industry standard robot it requires 2 E-stops and a light tower. The light tower lights will indicate the current mode of the robot. E-stops will be placed in and out of the facility where the robot is operational.

### 7.2.2 Source

Team ROBO CREW

### 7.2.3 Constraints

The customer needs to follow safety procedures as instructed.

### 7.2.4 Standards

OSHA standards

### 7.2.5 Priority

High.

## 7.3 Major Connections

### 7.3.1 Description

There are several components which will require the connection between them. The team will assist with the connection between PLC, Controller, and PC which will be used to operate this robot arm. The other connections will be the air compressor which will help operate the airbrush attached to the arm.

### 7.3.2 Source

Team ROBO CREW

#### 7.3.3 CONSTRAINTS

No constraints.

#### 7.3.4 STANDARDS

No applicable standards.

#### 7.3.5 PRIORITY

High.

# 8 Other Requirements

Providing security to the host PC by protecting the login information.

## 8.1 Host PC Security

### 8.1.1 Description

The PC that is hosting the robot and the robot controllers must be secure with a username and password authentication.

### 8.1.2 Source

UTA Senior Design.

### 8.1.3 Constraints

The login information must be passed down to future teams.

### 8.1.4 Standards

There are no applicable standards.

### 8.1.5 Priority

Moderate

# 9 Future Items

Possible improvements to this project include the graphical user interface with a user who can control the movements using simple data. This will be implemented if everything goes well before the schedule.

## 9.1 GUI App

### 9.1.1 Description

A future item which can be added to this project is to provide the customer with GUI application. This will give all the options on graphical user interface.

### 9.1.2 Source

Team ROBO CREW.

### 9.1.3 Constraints

Good hands-on training will be required using the GUI application.

### 9.1.4 Standards

Not applicable.

### 9.1.5 Priority

Low.

## 9.2 Visual Sensor

### 9.2.1 Description

One future addition to this project could be mounting a visual sensor. This would enable the robot to trace what users draw.

### 9.2.2 Source

Team ROBO CREW.

### 9.2.3 Constraints

Good understanding of connecting a new device and maintenance skills will be required.

### 9.2.4 Standards

Not applicable.

### 9.2.5 Priority

Low.

## REFERENCES

[1] RV-8CRL Industrial Robot Overview | Mitsubishi Electric Americas. https://us.mitsubishielectric.com/fa/en/products/industrial-robots-melfa/vertical-type-robot/rv-cr-series/cr-series-overview/, 2023.