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Robot Manufacturing Cell
Product Requirements

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Document History

Rev Number	Date	Modified By	Reason
1	26June2018	M. Leitner	First Revision
2	1July2018	M. Leitner	Second Revision

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1 Objective

The objective of the Robotic Manufacturing Cell is to integrate the two robots into a mini assembly line, constructing an object by sorting through varied pieces and using specified barcodes to determine the placement of each. One robot will place the objects, the other will push the pieces together.

2 Scope

The scope of this document is to define each requirement of the project. Each requirement shall be explicitly stated to ensure they are met.

3 References

3.1 Cited Documents

"Products." Training Courses Available at DENSO Robotics, densorobotics.com/products/vs-g-series/download-materials. (Manuals for the Denso Robotic Arms)

"Robotic Arm Manufacturing Cell." Cutter Types (Mill) - Mindworks, mindworks.shoutwiki.com/wiki/Robotic_Arm_Manufacturing_Cell. (Previous Robot Manufacturing Cell Group Project)

"Denso RC7M Manuals." Manuals Library, www.manualslib.com/products/Denso-Rc7m-8883395.html. (Operating manuals for the Denso Robotic Arms)

WINCAPS III (Program used to write code and simulate the function of the robot)

Davison, Pat. Safety Standards and Collaborative Robots, www.robotics.org/userAssets/riaUploads/file/6-Pat.pdf. (Safety Standards for Robots)

Murashov, Vladimir, et al. "Working Safely with Robot Workers: Recommendations for the New Workplace." Advances in Pediatrics., U.S. National Library of Medicine, Mar. 2016, www.ncbi.nlm.nih.gov/pmc/articles/PMC4779796/. (Safety Recommendations for Industrial Robotics)

3.2 Acronyms

EPO	Engineering Purchase Order
ER	Engineering Release
POC	Proof of Concept
PTP	Point to Point
CP	Continuous Point
I/O	Input/Output
ISO	International Organization for Standardization

3.3 Variable Types

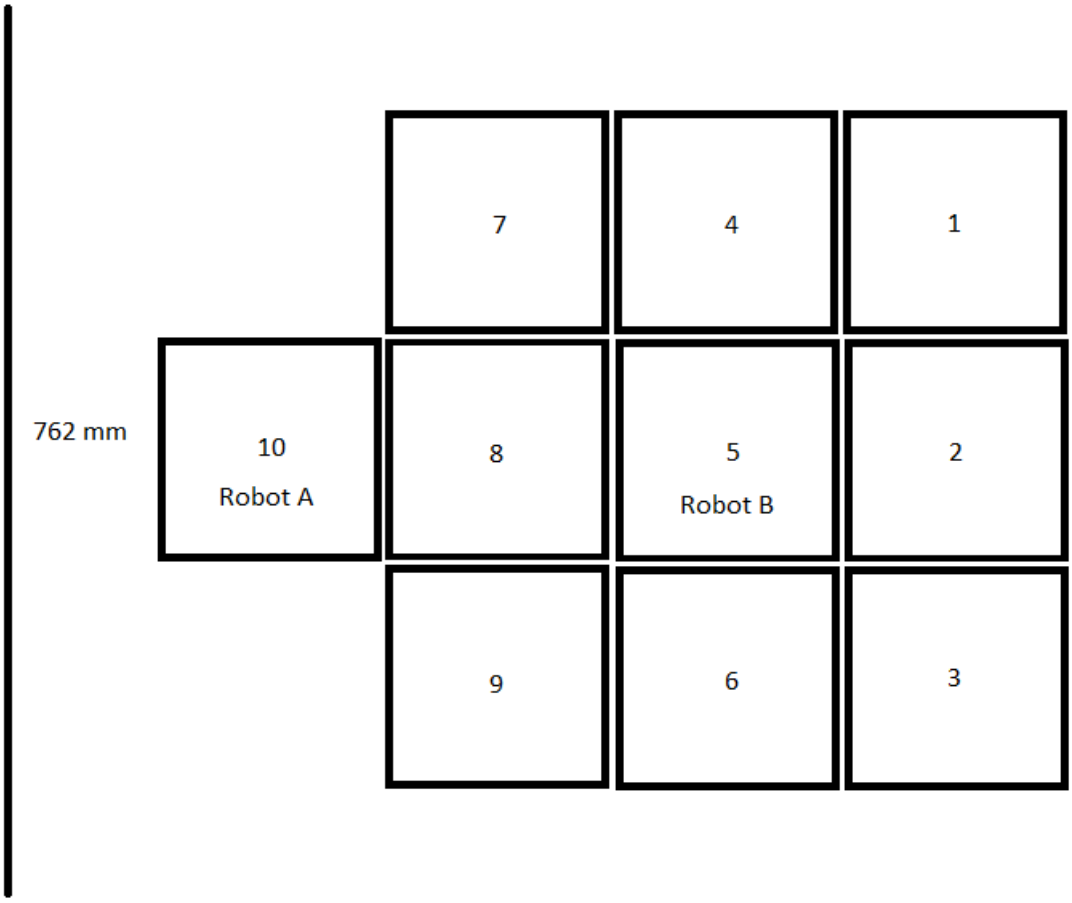
Type I: Integer
Type F: Floating Point
Type D: Double-precision

Type S: String
Type V: Vector
Type P: Position
Type J: Joint
Type T: Homogeneous
Type IO: I/O

3.4 Commands

PROGRAM XXXX: Declares program name
TAKEARM: Obtains arm control
GIVEARM: Releases arm control
SPEED ###: Sets the internal speed
MOVE: Moves the arm from its current position to a targeted position
END: Ends the robot motion and program
APPROACH: Moves the tool end of the arm to the approach point specified
DEPART: Moves the tool end of the arm to the depart point specified
DRIVEA: Executes an absolute motion of each axis
COM_ENCOM: Opens the port and establishes connection with the external device for the data transmission
COM_DISCOM: Closes the port and disable connection with the external device
FLUSH: Clears the input buffer
INPUT: Gets data from an Ethernet port
WRITE: Outputs data from an Ethernet port to an external device
SET: Set an I/O port to ON
RESET: Set an I/O port to OFF
IF…THEN: Executes statement if condition is true
ELSE: Executes statement if condition is false
SELECT_CASE: Executes statements block associated with the matching condition out of multiple conditions
FOR…NEXT: Repeatedly executes a block of statements in a loop according to the specified condition

3.5 Robot Cell Layout



4 Functional Requirements

4.1 User Interface Requirements

The assembly must be self-functioning, or automated. The only user involvement shall be to start the process, as well as end it. In case of malfunction, emergency stop switches are in place: one on each controller and one on the outside of the cell.

4.2 What it should do

The project must illustrate supervisory control between the two arms. The two robotic arms must be able to communicate with one another to complete a task – as an integrated assembly line system. One robot should utilize an electronic screwdriver, while the other will pick up and sort the pieces. A slide will distribute the parts to the robot, with a scanner recognizing which item is which. This data will be transmitted to one robot arm and a code will be in place for it to acknowledge what to do with that part. The other arm will then screw the bolts into the pieces. A final distribution of the parts will then occur.

5 Mechanical Requirements

5.1 Strength Requirements

The robotic arm has a limitation of 5-7 kg load.

Pressure limitations also take place. The operating air pressure is .1 - .39 MPa. The max air pressure is .49 MPa.

5.2 Spatial Requirements

The assembly line shall fit within the space provided in the manufacturing cell. This area is a 2438.4 mm x 1835 mm rectangle (X vs Y). Due to limitations on the arm with University of Idaho serial number 196-549, the negative X-Axis must not exceed a length of 762 mm.

5.3 Weight/Mass Requirements

Tools must have a maximum mass of 1 kg. Any pieces, or combination of pieces, shall remain at maximum 4 kg. In total, the maximum mass allowed by the robotic arm shall be 5 kg.

5.4 Mounting / Interface Requirements

Any electrical or pneumatic connections will be attached into the back of the robotic arm, seen in the figure at the left. If connecting to the tool in the arm, the connections above the black screw ring will be used, seen at the right. Any tool must be able to screw into the figure at the right to be able to attach to the arm.

5.5 Appearance Requirements

The final process should be smooth cooperation between the two robotic arms.

5.6 Durability Requirements

The system shall be designed to continuously work, without any human interaction, until the process has ended.

5.7 Reliability Requirements

All components (bearings) shall have 90% reliability. The robots must be programmed to avoid collisions with each other, as well as the surroundings. Due to limitations on the arm with University of Idaho serial number 196-549, the negative X-Axis must not exceed a length of 762 mm in order to not collide with the wall. After each arm completes a task, they will return to a pre-specified origin point to avoid collision with each other. If necessary, multiple emergency stop switches are in place to shut down the program: One on each controller, and one on the outside of the manufacturing cell.

6 Electrical Requirements

6.1 Operational Voltage
The Denso robots will have an AC200-230V power limit.

6.2 Operational Power Capability
Each axis has a different power limit.

Axis 1 – 750 W
Axis 2 – 400 W
Axis 3 – 200 W
Axis 4 – 100 W
Axis 5 – 80 W
Axis 6 – 50 W

6.3 Energy Storage Capacity
The storage capacity of the equipment shall be the sum of the power of the 6 axes working together. In total, this should be 1.58 kWh.

7 Software Requirements

7.1 Functionality

We will be using WINCAPS III, Solidworks, MATLAB and LabView.

7.2 User Interface

The robot will be controlled through WINCAPS III software via the controller. Using the specified controller for each robot, a unique code will program the robot after inputting through the unique IP Address of each robot.

8 Environmental Requirements

8.1 Temperature
The robot is expected to be utilized from 0-40 C and to be maintained under 90% RH.

8.2 Environmental Sealing
The manufacturing cell must be surrounded by a wall, to promote the safety of the workers. An emergency stop switch will be located outside of the walls, to kill the program if required.

9 Regulatory Requirements

9.1 UL Requirements
ISO 10218-1:2006 - Standards for Robots, Robot system/cell and application
ISO TS 15066 – Technical Specification Standards on Robots
ANSI/RIA R15.06-2012 – American National Standard for Industrial Robots and Robot Systems

ISO 10218-1:2011 – Standards for Robots, Robot system/cell and application
ISO 10218-2:2011 – Standards for Robots, Robot system/cell and application

9.2 Shipping Requirements

Standard shipping for parts will be used unless absolutely necessary.

10 Cost Requirements

10.1 Prototype Cost

Cost to build a POC prototype shall not exceed $1000.

10.2 Production Requirements

N/A

11 Schedule Requirements

The following are the major Project Milestones:

- Approval of Requirements June 25, 2018
- Concept Design Review July 26, 2018
- EPO of long lead parts Aug. 2, 2018
- Detailed Design Review Aug. 2, 2018
- ER of drawing package Oct. 2, 2018
- Complete Prototype build Nov. 30, 2018
- Final Report / Drawings Nov. 30, 2018