Department of Computer Science & Engineering
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System Requirements Specification
CSE 4316: Senior Design I
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Team Kratos
Mitsubishi Robotic Arm

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Revision History

Revision	Date	Author(s)	Description
0.1	03.30.2022	NRB, CJK	document creation
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1 Product Concept

Robotic arm is build to play tic-tac-toe with the human. Robotic arm is attached with a gripper which can hold pen to write and play tic-tac-toe. It is also attached with the eraser so it can erase the board and can start the new game again.

1.1 Purpose and Use

Robotic arm is designed to draw grid in the glass which can play tic-tac-toe game with the user from outside the glass passing through the hallway. As it is kept beside the glass with railing attached to it so it can move in up and down. The main purpose of this project is to able to make a robotic arm which can interact with human and they can play game as they pass throught it.

1.2 Intended Audience

For now, the main intended audience is the students and staffs members passing through the room 335A.Human do not need access to the room as they can play tic-tac-toe from outside. Therefore, robotic arm can play games as long as robotic arm in powered on from inside and anyone can play game with it as they pass through the glass.

2 Product Description

It's primary features is it can interact with human through game of tic-tac-toe. This product is using gripper that can be changed into pen or eraser as needed. Since, the robotic arm is fitted in a rail, it can move up and down the hallway. Therefore, later in the future it can be programmed to play multiple games of tic-tac-toe in different windows with multiple human. But for now, we are only focused on one game.

2.1 Features & Functions

The main feature of this robotic arm is we are using vacuum valve to push pen and eraser front and back. It is able to detect user at the other side of the glass. It is able to draw grid in glass and write in one of the grid. The product is able to get user input that is provided from the outside on other side of the glass. The robotic arm is fixed in a rail so it can move along the window up and down.

2.2 External Inputs & Outputs

The system should be able to detect user that is outside the glass. This system gets input from user outside the window.It process the input then draw grid in the window as output and write in one of the grid. System then waits input form the user. It reads the input that's written in the glass and calculate possible winning pattern and write in that grid. After the system finds three similar pattern 'O" or 'X' then it makes a straight line. After the game is finished, vacuum valve having eraser is pushed front and vacuum valve with pen is pushed backward.Then, it erase the glass.

3 Customer Requirements

This robot shall have all the necessary functions to play tic-tac-toe with customers. These functions include at least drawing the board lines, randomly determining the player who takes the first turn, using the marker to play the game, judging whether the game is over, and clearing the marker after game completed.

3.1 Draw tic-tac-toe board lines

3.1.1 Description

The robot shall be able use a marker to set evenly distributed four horizontal and four vertical lines on a designated medium (glass) for playing tic-tac-toe.

3.1.2 Source

Customer

3.1.3 Constraints

The physical plane used to set as the tic-tac-toe board must be perpendicular to the ground.

3.1.4 Standards

The board lines drawn by the robot for the game should be a 15cm x 15cm square.

3.1.5 Priority

High

3.2 Randomly decide which player will play first

3.2.1 Description

The robot shall be able to randomly decide who will take the first trun of tic-tac-toe through the built-in algorithm, and use an LED light to indicate whose turn is currently, green represents the human side, and red represents the robot itself. The player who take first turn should mark Ã on the board by default.

3.2.2 Source

Customer

3.2.3 Constraints

N/A

3.2.4 Standards

N/A

3.2.5 Priority

Moderate

3.3 Play tic-tac-toe by using markers

3.3.1 Description

The robot shall be able to automatically detect empty spots during the tic-tac-toe game, and strategically make moves by using a marker to play tic-tac-toe with the user.

3.3.2 Source

Customer

3.3.3 Constraints

The robot can only play one tic-tac-toe game at a time

3.3.4 Standards

N/A

3.3.5 Priority

Critical

3.4 Clean marks after game completed

3.4.1 Description

The robot shall be able use a marker eraser to remove marks after the game is over.

3.4.2 Source

Customer

3.4.3 Constraints

The marks drawn by the marker on a flat surface must be the only specified material (glass), and use a removable marker.

3.4.4 Standards

ASTM C1036-21

3.4.5 Priority

Low

4 Packaging Requirements

The final packaging of the tic-tac-toe robot should include all the components necessary to play the tic-tac-toe game, including the Mitsubishi RV-8CRL robot body, a detachable dual-hand gripper, external power plug, two trial markers, a marker cleaning wipe, and user instruction manual.

4.1 Software pre-installed

4.1.1 Description

All software parts will be pre-installed for the convenience of customers. Customers do not need to install any software after purchase.

4.1.2 Source

Developer

4.1.3 Constraints

Any damage caused by changing software layer will result in no after-sales service provided.

4.1.4 Standards

UL-1740

4.1.5 Priority

Critical

4.2 Modifiable logo

4.2.1 Description

The tic-tac-toe robot was produced upon the Mitsubishi Industrial Robots RV-8CRL prototype. According to the needs of customers, the original Mitsubishi logo can be removed and a personal logo that customers prefer to added can be carved.

4.2.2 Source

Customer

4.2.3 Constraints

Any logo involving existing intellectual property rights without a release license will not be carved.

4.2.4 Standards

USPTO

4.2.5 Priority

Moderate

5 Performance Requirements

The Mitsubishi RV-8CRL is an industrial robot that is relatively new to the field. It is an 8-axis robot which is able to maneuver and give exceptional result in the industrial world. The robot has a lighter weight and improved heat release leading to improved continuous performance. Similarly, use of a HK motor, the latest servomotor from Mitsubishi Electric allows improved torque characteristics, accuracy, and responsiveness while substantially reducing the size and weight.

5.1 Execution time

5.1.1 Description

The robot must be able to interact with the person on the other side of the window in order to play games with them. This requires faster performance time as failing to do it may lead to longer wait time to the player. So, the execution time for the robot should be relatively fast.

5.1.2 Source

Costumer

5.1.3 Constraints

Not having a proper cleaning mechanism may lead to performance hindrance in the screen. This may require one of the operator to go to the work shell and clean the glass manually. Similarly, working for too long may lead to the machine overheating.

5.1.4 Standards

ISO 9283:1998, ISO/TR 13309:1995

5.1.5 Priority

High

5.2 Clear work space

5.2.1 Description

As the field of operation is the glass screen between the robot and the player, it should be made sure that the glass is clean all the time so as to no hinder the performance of the robot. If the glass surface is dirty with marker marks, the robot may not be able to read it properly leading to low efficiency of the machine.

5.2.2 Source

Costumer

5.2.3 Constraints

Not having a proper cleaning mechanism may lead to performance hindrance in the screen. This may require one of the operator to go to the work shell and clean the glass manually. Similarly, working for too long may lead to the machine overheating.

5.2.4 Standards

ISO 18646-1:2016

5.2.5 Priority

High

6 Safety Requirements

The Mitsubishi RV-8CRL is an industrial robot that is mainly designed to be used in a enclosed work space without external disturbance. Being an industrial robot, there might be some safety concerns that needs to be kept in mind while operating the machine.

6.1 Industrial robot: Work with caution

6.1.1 Description

The robot is primarily designed to work without disturbance. Hence, the machine does not have any detection system to detect if someone is in there while working. This can lead to robot hitting someone who is in the cell while working. So, it needs more attention and it should be made sure that no one is in the cell while working.

6.1.2 Source

Federal regulations, Customer, Developer

6.1.3 Constraints

As it is a research based project. We may need to be more careful with the robot.

6.1.4 Standards

NFPA 79 2015

6.1.5 Priority

Critical

6.2 Glass surface as a working area

6.2.1 Description

As we will be working in a glass surface we need to be extra careful to not break the glass. Too much pressure in the glass surface may lead to glass breaking. Additionally, the power supply to the machine should be secure as the machine will be working for long hours and may overheat sometimes.

6.2.2 Source

Federal regulations, Customer, Developer

6.2.3 Constraints

Having a glass surface makes it a higher risk project.

6.2.4 Standards

RIA TR R15.406

6.2.5 Priority

Critical

6.3 Power supply

6.3.1 Description

The power supply to the machine should be secure as the machine will be working for long hours and may overheat sometimes.

6.3.2 Source

Federal Agency, Customer, Developer

6.3.3 Constraints

Needing a secure source of power is one of the main priorities that we have.

6.3.4 Standards

ISO 10218-2:2011

6.3.5 Priority

Critical

7 Maintenance & Support Requirements

The RV8CRL is a Mitsubishi product and would require technical support from Mitsubishi for any malfunctions. These are maintenance and support requirements address items specific to the ongoing maintenance and support of our product after delivery.

7.1 Technical Support

7.1.1 Description

Technical support should be offered in the form of a website, phone and email contact points to offer after development support and guidance on robot operation.

7.1.2 Source

Customer

7.1.3 Constraints

Time and capital investment after final product development.

7.1.4 Standards

ISTE

7.1.5 Priority

Low

7.2 Manual

7.2.1 Description

A descriptive document highlighting the ideal operation of the robot. It must also highlight any hardware assembly and startup procedures.

7.2.2 Source

Customer, Developer

7.2.3 Constraints

Time, Cost of documentation printing and creation.

7.2.4 Standards

N/A

7.2.5 Priority

Moderate

7.3 Tutorial Videos

7.3.1 Description

Videos describing the operation and interaction with the robot. Videos describing any needed assembly and startup procedures. Videos describing any regular maintenance checks before operation.

7.3.2 Source

Customer, Developer

7.3.3 Constraints

Time, suitable hosting website, access to quality recording equipment,

7.3.4 Standards

N/A

7.3.5 Priority

High

7.4 GitHub Code Documentation

7.4.1 Description

Documentation of source code and supporting code on GitHub for future updates and debugging. Version control of latest code.

7.4.2 Source

Customer, Developer

7.4.3 Constraints

Development after final product development.

7.4.4 Standards

N/A

7.4.5 Priority

High

8 Other Requirements

This tic-tac-toe robot will also include some other service modules that do not affect its actual operation, but can effectively improve the post-purchase experience of consumers. The implementations of these requirements will be placed at the end of all other requirements, and these implementations will only be considered when the time for development is sufficient.

8.1 Parts List

8.1.1 Description

A list of applicable parts that are used by the robot in case a part malfunctions.

8.1.2 Source

Customer, Developer

8.1.3 Constraints

Time, Correspondence with Mitsubishi on product information,

8.1.4 Standards

N/A

8.1.5 Priority

Low

8.2 Software Updates

8.2.1 Description

Regular code maintenance and updates to match the standards. Updates to improve the robot's efficiency.

8.2.2 Source

Customer

8.2.3 Constraints

Time investment after final product development,

8.2.4 Standards

N/A

8.2.5 Priority

Low

8.3 Routine Maintenance Checks

8.3.1 Description

Maintenance checks carried out by a team member after product development. Replacement of robot parts.

8.3.2 Source

Customer

8.3.3 Constraints

Time and capital investment to maintain the robot.

8.3.4 STANDARDS

N/A

8.3.5 PRIORITY

Low

9 Future Items

Later in the future, we can implement more function and features in our system.

9.1 Implementing more games

9.1.1 Description

Since, our system is attached with a rail which can move along the glass wall. Therefore, we can make our system play more than one game of tic-tac-toe at a time on different windows with multiple users.

9.1.2 Source

Sponsor

9.1.3 Constraints

we have limited time and budget. Therefore, implementing more functions can be risky for the project to be not completed.

9.1.4 Standards

N/A

9.1.5 Priority

Low

9.2 Screen display

9.2.1 Description

We can display information like players or robotic arm turns, win or lose status and other information about games in the display screen.

9.2.2 Source

Sponsor

9.2.3 Constraints

The main constraint for this requirement is it requires more budget and more time. This function can be implemented later if we have more time and if we get more budget for this project.

9.2.4 Standards

N/A

9.2.5 Priority

Low