Deliverable E: Project Plan and Cost Estimate

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Abstract

The Department of National Defense requires an automated, user friendly and cost efficient robotic arm that can provide potential to assist crew members on ships to complete certain tasks with minimal supervision. The design criteria was taken into account when we calculated budget and timeline restrictions. For this deliverable we have laid out a plan for our materials such that we remain within the allotted budget and we accomplish our goals within the specified time constraints.

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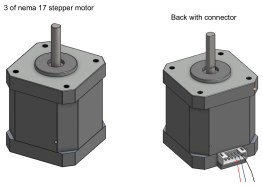
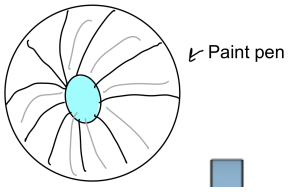
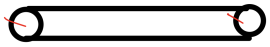
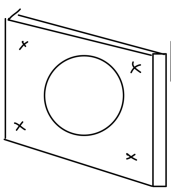
Introduction

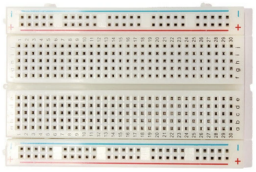
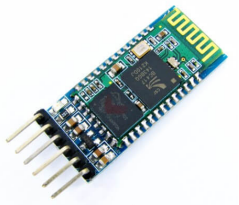
The team has constructed a solid guideline in order to proceed to the prototyping stage. In this deliverable you will be presented with specifics and detailed drawings of the robotic arm project. This includes both software and hardware components required for this build. A Bill of material, equipment list and project schedule has been included to portray the objectives in order to complete this project. All of which will be followed by a prototyping test plan and a portion explaining the risks and contingencies of this project.

1. Design Thinking

1.1 Mechanical

Project	Drawing
Motors	
Paint pen	
2 screws and nuts	Slide pins x2 
4 rod holders to back plate	Rod holer 
Back plate	

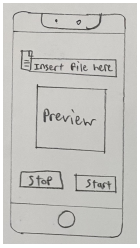
1.2 Electrical

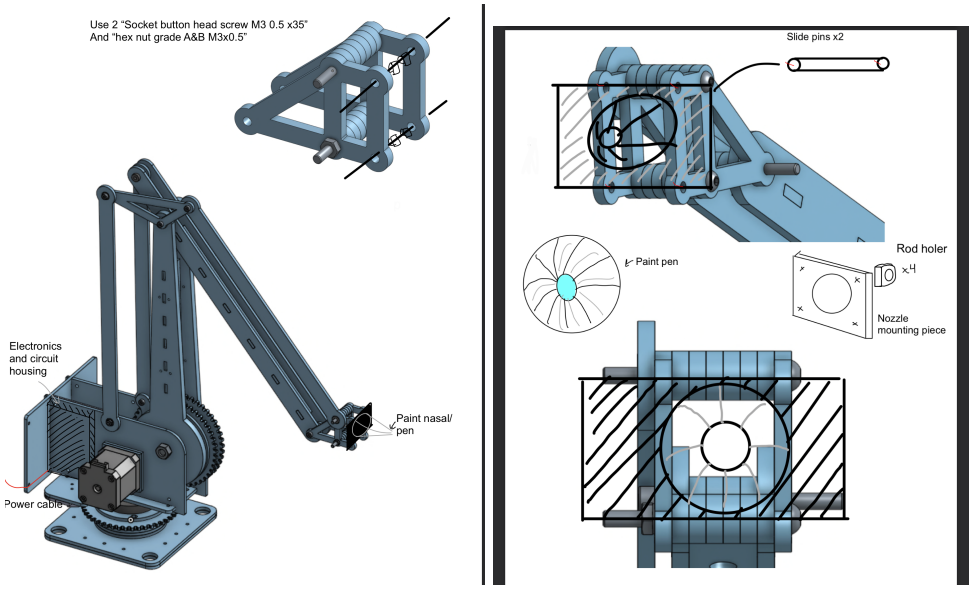
Project	Drawing
Wires	
Jumper cables	
Arduino Uno	
Breadboard	
Power supply	
HC-05 (BT)	

1.3 Software

Project	Concept	Detailed Drawing

Back end code	Creating a code in C++ that takes an image and converts it to binary code. Afterwards, the binary code is translated into x,y coordinates which will have if,else statements for each movement of the robotic arm. The 1's in binary code will represent where to draw and 0's represent where not to draw.	**INITIALISE** variables
		ACCEPT user input for dimensions of the wall
		
		SET sprayer state to LOW
		
		FOR each 'column' of wall space
		IF column is within the specified parameters **THEN**
		ALIGN sprayer x and y coordinates
		SET sprayer state to HIGH
		
		INCREMENT column tracker variable, move applicable axes
		SET sprayer state to LOW
		END FOR

User interface	Using MIT App inventor, an App will be developed which will prompt the user to insert an image then a start button to begin the drawing. This app will be connected to the robotic arm via bluetooth.	



2. Project Management

2.1 Bill of Materials

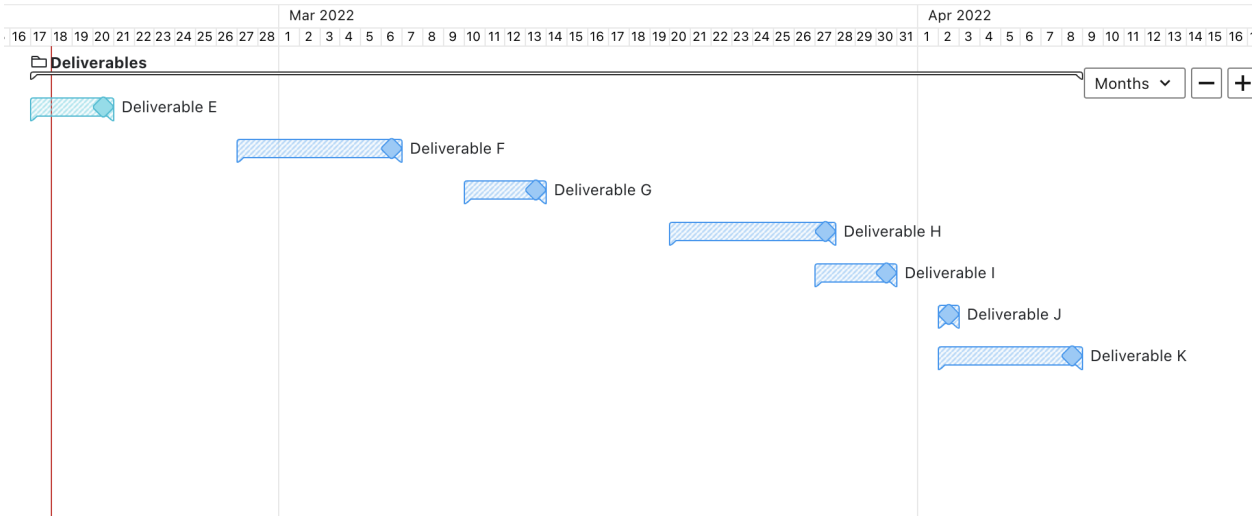
Item Name	Description	Units of Measure	Quantity	Unit Cost (CAD)	Extended Cost (CAD)	Link
Arduino Uno	An Arduino Uno microcontroller will be used to control the robotic arm and end effector.	2.7” x 2.1”	1x	$9.00	$9.00, Might be able to get for free through uOttawa	Arduino Uno
Breadboard	A breadboard will be used to prototype all hardware components.	8.5cm x 5.5cm	1x	$2.50	$2.50, Might be able to get for free through uOttawa	Breadboard
Jumper Cables	To make connections between breadboard and Arduino	4.72in	30x	$0.10	$3.00	Jumper Cables
HC-05	Ability to connect Arduino to Smartphone via bluetooth	26.9mm x 13mm x 2.2 mm	1x	$12.99	$12.99	HC-05 Bluetooth Module
Power Supply	To provide power to the Arduino	9v	1x	$13.99	$13.99 Might be able to get for free through uOttawa	Power Supply
Laptop	To dump the code into Arduino	N/A	1x	$0.00	$0.00	N/A
Total product cost (without taxes or shipping)					$41.48	
Total product cost (including taxes and shipping)					$46.87	

2.2 List of Equipment

Item Name	Description	Prototype #	Source
Personal Laptop	Jaber will provide his personal laptop to use with the Arduino.	1,2,3	Provided
HC-05	Bluetooth Module to allow for remote Arduino control	4	Makerlab
Nema 17 Stepper Motor	Stepper motors to control 3 DOF on the robotic arm	5	Provided
Uxcell40	To make connections between breadboard and Arduino	6	Jumper Cables
3D robot	Full built 3D robot arms	7	Onshape
Power Supply	DC Power supply to provide a constant source of electricity; simulates constant electricity on a ship	8	DC Power Supply Or DC Power Supply
Stepper Motor	Stepper motors will be used to drive 3 degrees of freedom.	9	13V Stepper Motor
MIT App Inventor	To create an app for the user.	10	Mit App Inventor

2.3 Project Schedule

Activity	Work Date	Due Date
Prototype 1 and Customer Feedback	Thursday, March 3rd,2021 (3 days to finish if needed)	Sunday, March 6th, 2021
Prototype 2 and Customer Feedback	Thursday, March 10th,2021 (3 days to finish if needed)	Sunday, March 13th, 2021
Prototype 3 and Customer Feedback	Thursday, March 24th,2021 (3 days to finish if needed)	Sunday, March 27th, 2021
Design Day Presentation Material	Monday, March 28th,2021 (2 days to finish if needed)	Wednesday, March 30th, 2021
Project Presentations	To Be Determined	To Be Determined
User and Product Manual	Monday, April 4th,2021 (4 days to finish if needed)	Friday April 8th,2021



3. Risks and Contingencies

This project presents a few different risks that may oppose the clients needs. It has been determined that the robot may face difficulty drawing smoothly as it was initially intended to go from left to right from top to bottom row. The drawing will be inconsistent as there will be moments the robot will lift the marker whereas a human would continue drawing, overall leading to diminished quality. To combat this issue we will code the robot to identify parts of the drawing where it connects and identify the priority movements. E.g instead of left to right then down one row and repeat, program the robot so it identifies where the marker does not need to be lifted and prioritize that over left to right movements.

The main issue is certainly the robot's movements and which order it shall be in terms of coordinates. Along with the fact that the team has not yet been able to identify an end effector that will be able to place a pen perpendicular to the drawing surface. There have been a few options left on the table which will be tested for efficiency during prototyping and based on that the most effective end effector design will move forward towards the final design.

4. Prototyping Test Plan

Test ID	Test Objective(*why)*	Description of Prototype used and of Basic Test Method*(what)*	Description of Results to be Recorded and how these results will be used (*How)*	Estimated Test duration and planned start date (*when)*
1	Ensure the robotic arm works as intended	Using the given robotic arm and testing by using sample code in C++	Logged into a document; must be done first before we go forward with mounting systems	As soon as the arm is given to us; ~1 day
2	Ensure the end effector paints effectively	We will test the end effector by hand to ensure paint flow	Drawn onto a piece of paper for safekeeping and width sampling	~2 days
3	Ensure the end effector mounting system works	The vise-like mounting system will be used with the end effector	Checked off Wrike; ensuring the arm and end effector work together is crucial to the drawing component.	~3 days
4	Ensuring the end effector and arm work together with the code	The end effector will be mounted and the code will be run	Github will keep track of pull requests and we can use this to finalize our minimum viable product.	~2 weeks
5	Images will be uploaded into the arm	Uploading images is the final step to fulfilling client wants	We will document each image drawn, regardless of whether or not it worked, and modify the code so the image output is clearer	~2 weeks