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Design Project User and Product Manual

<Painting Assist>

Submitted by:

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2023–12-09

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0 Introduction

This User and Product Manual (UPM) provides the information necessary for users with minimal motor control to use the Painting Assist Machine effectively and for prototype documentation.

1 Overview

Despite the rapid growth in individuals wishing to pursue art, there are still large barriers that exist for disabled individuals, in art spaces. Our client, The Client struggles with motor function in her left arm, which prevents her from using the typical methods used in acrylic fluid painting. The Client requires an environmentally friendly device that will allow her to secure painting canvas' of various sizes, while allowing her to pivot the canvas, all while only using a single hand.

Our device – The Paint Machine, allows The Client to clamp and control the canvas with the use of a single joystick. The device features an MDFbase, along with a 3D printed electronics cover. The paint collection system is composed of silicone drape, which could be placed over our MDF canvas clamping system.

Currently, there is no mechanized device on the market, that can both clamp and tilt paint canvases. At ArtAble, we hope to change the future of accessible art.

2 Getting started

1. When first receiving your Paint Assist Machine, the device should be removed from the box. Ensure that all components of the device are present before proceeding.
2. Before using the device, the clamping mechanism must be attached to the base. To do this, take the threaded rod and insert one end of the threaded rod into the rocker – two nuts can be used to secure the bottom section of the rod. The top section of the rod can be connected to the paint clamping platform, with an additional two screws.
3. Once the clamping mechanism has been secured, the silicone paint drape can be connected to the bottom of the camping mechanism and the acrylic base.
4. To power on the system, a DC adapter must be connected to the back of the system, and an appropriate power outlet.
5. To adjust the joystick sensitivity, the user can use the up and down buttons on the user interface.
6. To power off the system, the user can hold the power button.

2.1 Configuration Considerations

The prototype for this product consists of 3 primary components - the MDF base, the tilting subsystem, and the paint collection/clamping mechanism.

The base includes a mounting unit, which is able to connect the base of the tiling mechanism to the MDF, with small mounting brackets and screws. Other components such as the electrical hardware, and the joystick are kept on this base.

The clamping subsystem is connected to the plastic rockers, and the bottom of the clamping mechanism. This component can be assembled by securing 4 screws to the threaded rod - one below the rocker, one above the rocker, one below the paint clamping mechanism and one above it.

The joystick controls are connected to the electrical hardware case, via wires. This system sits beside the main body of the system.

The user interface, which includes a digital screen, power button, joystick sensitivity button, and a hardware reset button is connected to the bottom of the base and is encased by a hard plastic shell.

2.2 User Access Considerations

Though the Painting Assist Machine has been designed with artist with physical disabilities that affect motor motion in the hand, ArtAble is able to cater to many different users.

For users that lack motor control of their hands, such as The Client, this prototype allows for easy control of the joystick, however, due to budgetary limits we were unable to mechanize the clamping system, meaning that additional help is needed to insert and clamp the canvas. Further accommodation considerations include widening the range of joystick sensitivity, so users can comfortably use the device, regardless of motor dexterity.

For technical enthusiasts and general artists looking for an innovative way to create Art, ArtAble has included in depth technical documentation to outline any interesting informations about the subsystems. The user-friendly design also allows users of all abilities to use the device with minimal hassle.

2.3 Accessing/setting up the System

To set up the prototype, the procedure is similar to setting up the final product.
First, both the clamping mechanism and paint collection system must be connected with nuts. See section x for more information. Next the DC adapter can be plugged into the back of the Arduino Shield.

To exit the system, the DC adapter must be unplugged, and the paint collection system can be removed by screwing off the nuts. To clean the paint collection system, the plastic drape can be removed, washed, and reused.

2.4 System Organization & Navigation

The primary parts of our system include the base, the paint collection system, the clamping mechanism, and the software/electrical subsystem. For information on the primary subsystems, see section x.

For the electrical subsystem, the parts are secured in a plastic, waterproof case. This case holds the Arduino and Arduino Shield, which are the components that utilize our code to turn the motors. The hardware is powered by a 12v DC adapter which connects onto the Arduino Shield - on the side of the box.

2.5 Exiting the System

To exit the system, the system should first be turned off, before initiating any disassembly. This can be done by clicking the “Power Off” button. It is recommended that the system is unplugged from the source, after powering off the system to avoid future power issues.

To disassemble the system, begin by removing the silicone paint collector, by disconnecting the clips located at the bottom of the canvas clamping mechanism. The silicone drape can be cleaned and stored for future use.

To remove the clamping mechanism, begin by unscrewing the nut located in the middle of the paint clamping mechanism. After doing this, both the clamping mechanism and second nut can be removed from the threaded rod. The threaded rod can be completely removed from the base by unscrewing the last two nuts.

The remaining arts bolted to the MDF base can also be removed by removing the remaining nuts, though it is recommended that these parts are kept together when storing to avoid any lost of components.

3 Using the System

Function	Input	Output
Power Button	Press and hold the 'Power' button.	The system boots on, and the user interface confirms power by lighting a green LED.
Joystick Sensitivity	Press and hold either the up or down joystick sensitivity button.	The system changes the joystick sensitivity to limit or increase the sensitivity based on user mobility.
Reset Button	Press and hold the “Reset” button.	The system resets the Arduino, refreshing the code, and allowing for a smoother run.

The following sub-sections provide detailed, step-by-step instructions on how to use the various functions or features of the <System Name and/or Acronym>.

3.1 <Given Function/Feature>

System	**Expected Behaviors**	**Tips**
Power On/Off	• Press and hold to power on. • Visual confirmation via lit LED.	• If the power fails. Check the DC adapter power connection.

Canvas Clamping Mechanism	• Use a manual handle to tighten until the canvas has been clamped.	• If the canvas is not secure, ensure that it is within the canvas size range. • Ensure that the canvas is aligned before clamping.
Joystick Sensitivity	• Press the up or down sensitivity controls.	• Test the sensitivity controls before each project, to ensure that you like the settings.

4 Troubleshooting & Support

4.1 Error Messages or Behaviors

Each error encountered by the user will have a corresponding message that will appear on the screen. Here are the errors that the user may encounter, and some solutions.

1. Power Error: Power has been lost during operation of the system.
2. Joystick Malfunction: The joystick is not responding.
3. System Overload: The canvas has exceeded the weight capacity.
4. Software Error: Unexpected error with the software.
5. Calibration Error: The joystick has not been properly calibrated.

Here are some solutions to the listed error messages:

1. Power Error: If the power has gone off in the system, unplug the DC adapter, and clean off the adapter. Once this is done, attempt to reboot the system by plugging the adapter back in, and pressing the “Power On” button.

2. Joystick Malfunction: If the joystick has failed to pair with the system, first ensure that there are no obstructions on the wires. After this, reset the system by holding the “Power On” button for three seconds, then power the system back on. If this does not work clean the DC adapter and try again.

3. System Overload: If the system has exceeded the weight capacity, power off the system, so the excess paint can be removed from the silicone drape. Once this is done the system can be powered back on and used normally.

4. Software Error: If an unexpected error has occurred with the software, the software can be reset by pressing the hard reset button on the back of the system, which connects directly to the Arduino. Once this is done, the system can be powered back on, with the “Power On” button.

If the following solutions do not work, ArtAble customer service can be contacted for further instructions.

4.2 Maintenance

Maintenance	Frequency	Procedure
Cleaning	After each use.	Use a clean damp cloth, and gentle soap to remove the excess paint from the silicone drape.
Joystick Calibration	Monthly	Perform a quick calibration check by disconnecting the clamping mechanism and testing the tilting subsystem without weight. Calibrated by adjusting controls to desire.
Software Reset	Monthly	Click the “Reset” button on the electrical box to refresh the code used to run the system.

4.3 Support

To set up the system, users will need various components such as the machine, various brushes, hoses, etc. Users will also need to have access to a power outlet to use the machine. No user ID is required to use the system, however, users wishing to order online must create an account on our website to place and track orders. Users can also refer to the sticker on the back of their machine, for information on their machine model and a QR code to the website, as well as the customer service line. Please note that the model number as well as a receipt will be needed to issue refunds.

Model Number: #####

Contact customer support at: XXX-XXX-XXX

5 Product Documentation

Mechanical Subsystem	Description	Importance	Considerations
Clamping Mechanism	The clamping mechanism secures canvases of varying shapes and sizes, allowing for stable positioning during painting.	Importance: Essential for holding canvases securely during use.	Material Choice: Either acrylic or aluminum will be used in the final product, as MDF is to brittle of a material.
Rocker System	The rocker system allows for 360-degree tilting and 40-45-degree vertical rotational movement.	Importance: Essential for the motion of the canvas.	Material Choice: The primarily body of the rocker subsystem has been created with PLA filament, as the parts have been custom designed.

Painting Collection System	Collects paint runoff for recycling and environmental consciousness.	Importance: Supports sustainability by recycling paint runoff.	Material Choice: SIlicone is used for the drape, as it is easy to clean, and durable.
Joystick	The joystick serves as the primary control interface for our client, The Client.	Importance: Enables control of the system, with minimal motor function.	Material Choice: Plastic from an Arduino thumb joystick, and the casing of a highlighter was used to keep project costs low.

Software Hub	The software allows for the user to control the system.	Importance: This system maps the user controls of the joystick to movements on the rocker.	Material Choice: The material used for this was an Arduino and an Arduino Uno, as our group members are familiar with the Arduino coding interface.

5.1 <Subsystem 1 of prototype>

Clamping Sub-system

This prototype features a central threaded rod on an MDF base for adjusting the gap between two end plates to fit various canvas sizes and shapes. The end plates, with adjustable slots and bolts, can be secured at different positions on the base plate, which also includes a purple component for the tilting mechanism. This design accommodates canvases of diverse dimensions, with the handle on the rod controlling the plate distance.

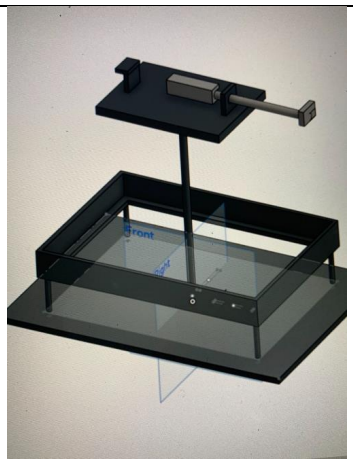
Tilting/Rotating Sub-system

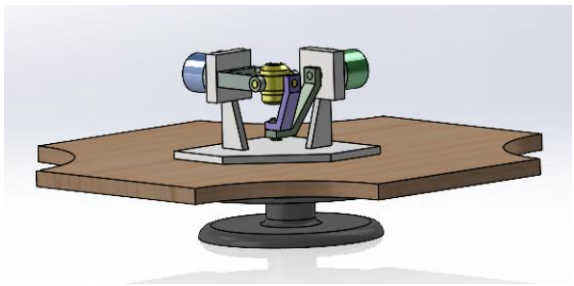
This mechanism employs dual rocker arms and a fork arm linked to motors for multi-axis movement. One rocker arm and the fork arm connect to a central circular part, enabling canvas tilt

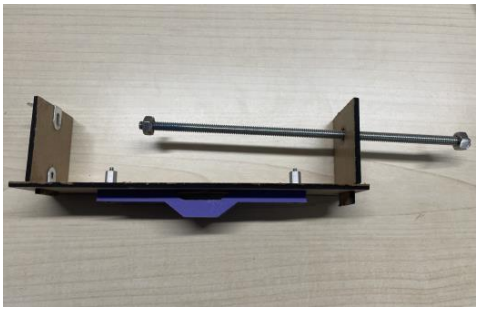
along the X-axis and rotation along the Z-axis. A turntable under the base allows Y-axis rotation. This setup enables 360-degree Y-axis rotation and 45-degree rotation on the X and Z axes.

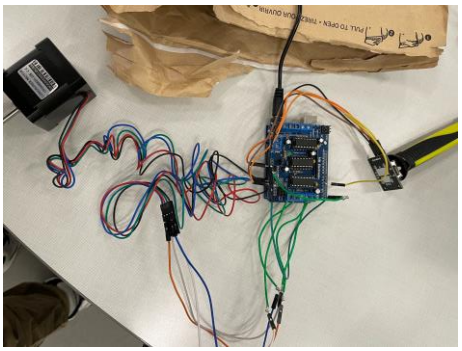
Electrical/Software Sub-system

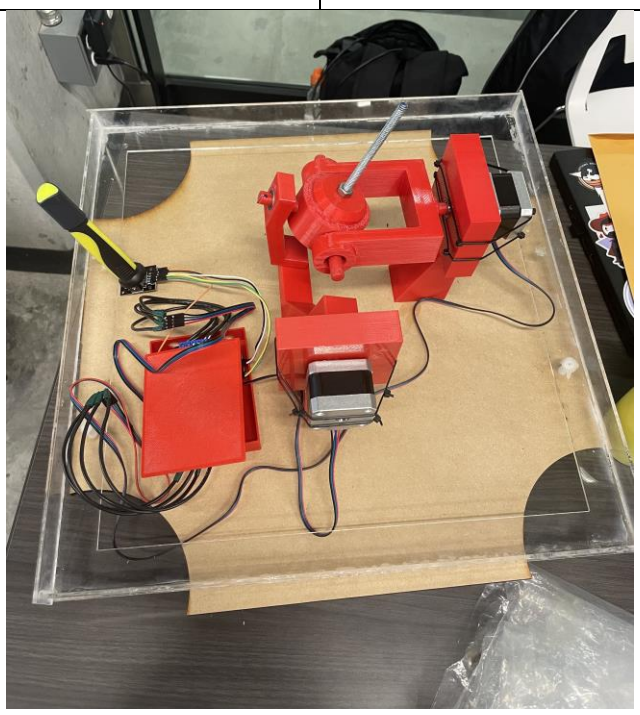
Our software and electrical sub-system, powered by an Arduino microcontroller with a motor shield, provides unparalleled control over canvas orientation. Two high-torque 7.4V stepper motors respond to input from the analog joystick, effortlessly rotating the base up to 45 degrees in both the x and y directions. With a streamlined 9V DC power input for motors and joysticks, and each motor offering an impressive 90 ounces of torque, our device ensures precise and dynamic adjustments for artists seeking a new dimension in their creations.











5.1.1 BOM (Bill of Materials)

Item	Description	Unit	Quantity	Cost	Link
Arduino UNO R3 (Clone)	Microcontroller board	item	x1	$15.25	MakerSpace
Acrylic sheet	Acrylic sheet for the canvas holder bass	24in x18in	x1	$20.0	MAKERSPACE
MDF	MDF for building the base box	12in x 24in	x3	$2.50 x 3 = $7.50	MAKERSPACE
MMOBIEL Nema 17 Stepper Motor	Stepper motors for the rotation	item	x2	$17 x 2 = $34.0	AMAZON
Power Supply Board Module	To fill the power requirements of the motors	item	x1	$10.0	AMAZON
Thumb Joystick	Used to control the device	item	x1	$7.0	MAKERSPACE

5.1.2 Equipment list

Equipment	Description
Clamping Sub-system	
Laser cutting	Utilized for precise cutting of materials like acrylic or MDF, crucial for creating custom parts with high accuracy.
Super glue	Employed for assembling and bonding parts quickly and effectively, ensuring structural integrity
Tilting/Rotating Sub-system	
3D Printer	Used for fabricating complex, custom parts that are crucial for the subsystem's movement mechanisms.
Measuring Instruments	Essential for accurate measurement and alignment, ensuring the subsystem functions correctly
Electrical/Software Sub-system	
Soldering	Key for establishing secure electrical connections, critical for the subsystem's electronic components
Screwdrivers	Necessary for assembling and securing components, facilitating maintenance and adjustments.

5.1.3 Instructions

Clamping Sub-system

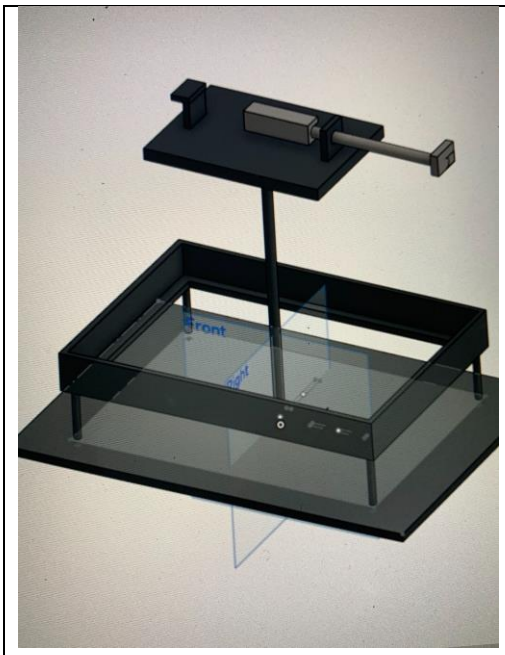
1. Begin by securing the MDF base to the turntable mechanism. This turntable is responsible for the 360-degree rotation of the entire device.
2. Align the central threaded rod vertically in the center of the base and the circle part of the mechanical subsystem. This rod is crucial for adjusting the distance between the end plates and, consequently, the size of the canvas that can be mounted.

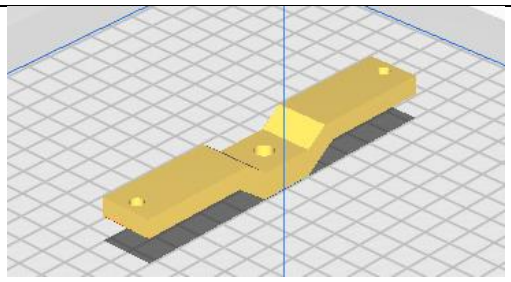
3. Position the end plates with adjustable slots on the base. These plates should be parallel to each other and perpendicular to the base.

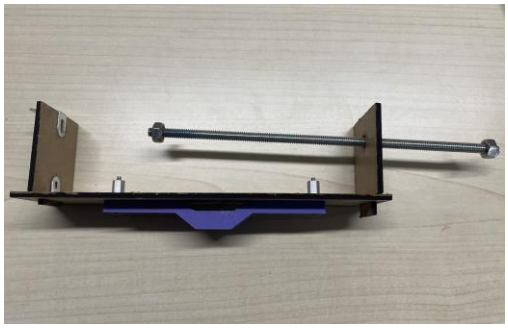
4. Insert bolts through the slots in the end plates and tighten them to secure the plates to the base. The slots allow for movement along the base plate for size adjustments.

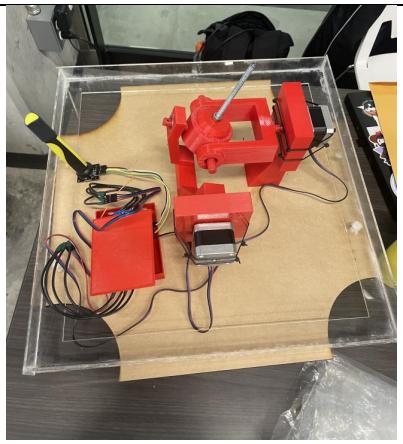
5. Attach the purple component, which is part of the tilting mechanism, to the designated area on the base plate. Ensure it is firmly in place as it is critical for the tilting action.

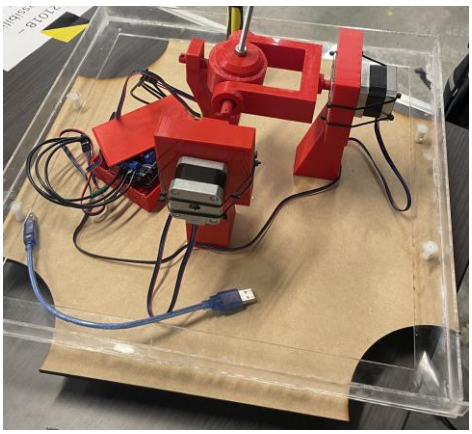
6. Finally, affix the handle to the threaded rod. This handle is used to adjust the gap between the end plates by twisting, which in turn secures the canvas in place.



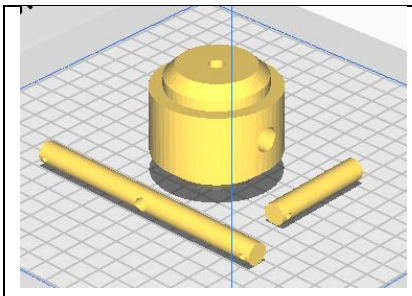




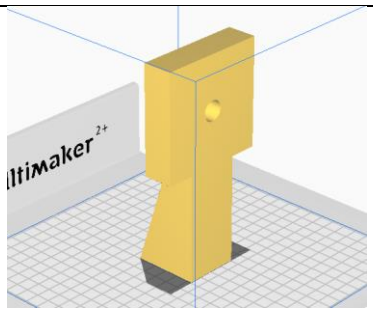




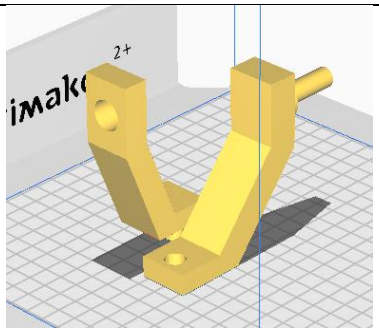
Tilting/Rotating Sub-system



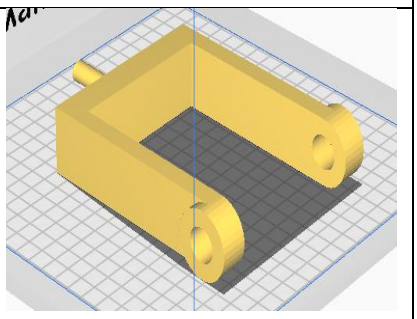
Circle Part and Rods



Motor Mount



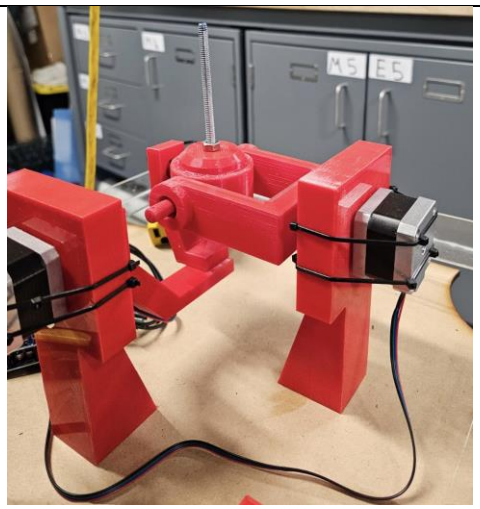
Dual Rocker Arms



Fork Arm

Bearing

Threaded Rod



Tilting Assembly

6 Assemble the dual rocker arms by connecting them to their respective pivot points on the base.

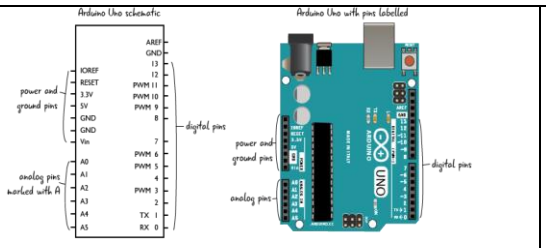
7 Attach the fork arm to the motors, which will drive the tilting and rotating motions of the device.

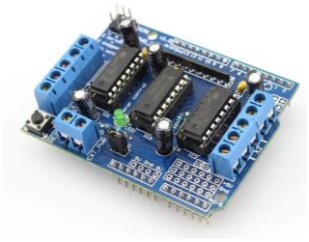
8 Secure the central circular part, which connects the rocker and fork arms, allowing for coordinated movement.

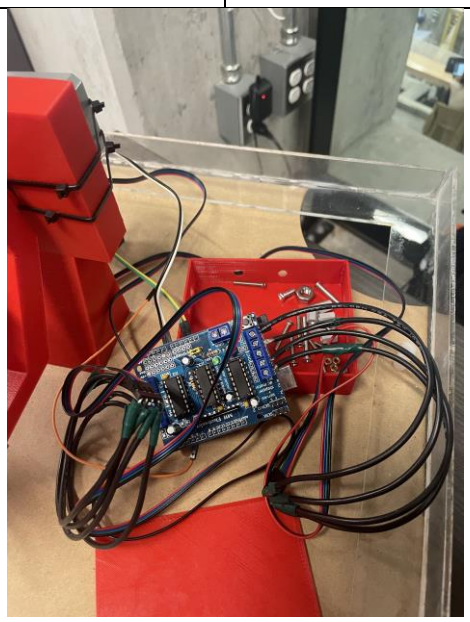
9 Place the turntable component on the MDF base and secure it, which enables the entire device to rotate along x and z axis around 45 deg rotation also the Y-axis, providing 360-degree rotation capability.

10 Ensure that all moving parts are lubricated and move freely without obstruction.

Electrical/Software Sub-system







11 Install the Arduino microcontroller onto the base, making sure it is in a position that allows for easy connection to the motors and power supply.

12 Connect the stepper motors to the microcontroller using the motor shield, which will allow for controlled movement based on the joystick input.

13 Wire the analog joystick to the microcontroller, ensuring that it is easily accessible for the user to operate.

14 Set up the 9V DC power supply, connecting it to both the motors and the joystick. Double-check all connections for safety and reliability.

15 Upload the control software to the microcontroller, which will interpret the joystick movements and translate them into precise movements of the stepper motors.

15.0 Testing & Validation

Refer to the video attached to this document.

16 Bibliography

APPENDICES

17 APPENDIX I: Design Files

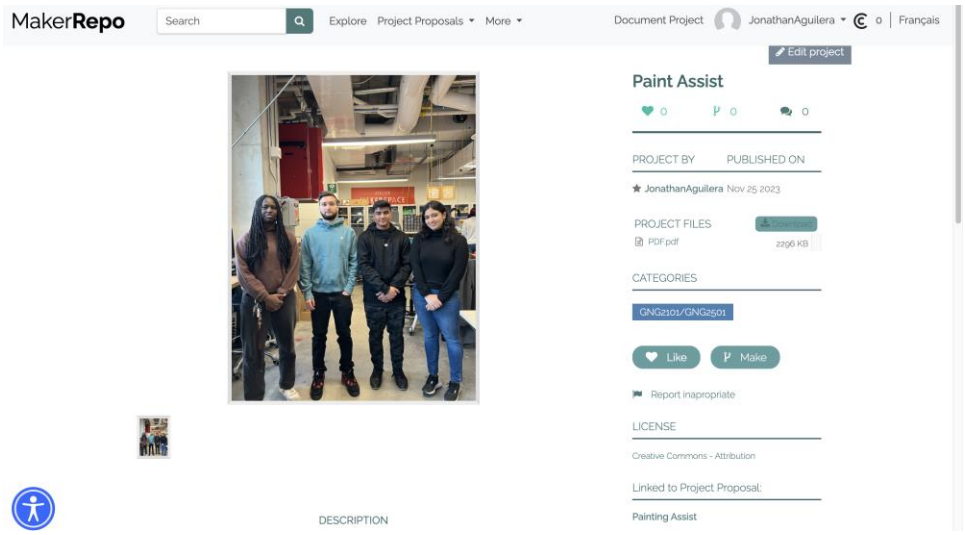
MarkerRepo link:

https://makerepo.com/JonathanAguilera/1898.paint-assist

DESCRIPTION

This client is an acrylic fluid artist. To fabricate her art, she currently uses a motorized device (pictures attached) that was made to tilt based on joystick commands. The pegs hold the inside frame of a stretched canvas and there are different holes to adjust for different size canvases. This device however does not have a big enough range of motion to allow the paint to flow like she would like and cannot accommodate larger canvases.

Your task is to design a device that can tilt a platform as much as possible in every direction and can carry a large enough canvas for this client's needs. It must be operated with a joystick and must be easy to maintain and set up, it should be protected from any paint that may fall. It should also be able to accommodate canvas of different shapes.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Linked to Project Proposal:
Painting Assist
DESCRIPTION

18 APPENDIX II: Other Appendices

Wrike Snapshot:

[1] https://www.wrike.com/workspace.htm?acc=4975842&wr=20#search-results?filters=text%3DPD%253BI%25253AUser%253Bmanual&folderId=-1&searchQuery=PD%20I%3A%20User%20manual&sidePanelItemId=1225680928&sortOrder=14

Conclusions and Recommendations for Future Work:

In reflecting on the project, we acknowledge the successes achieved in meeting the initial objectives. The design process has taught us valuable lessons in the importance of iterative prototyping and user collaboration. The key aspect of user-centric design is crucial for any designer, emphasizing empathy and a deep understanding of user needs. Moving forward, our new objectives and key results focus on further enhancing the device's performance, expanding its capabilities, and simplifying user interactions. Regular testing, user feedback, and continuous improvement will remain integral to our design philosophy. The journey so far has strengthened our commitment to delivering innovative solutions that truly address the client's requirements and challenges.