



# Leonardo Da Robot

## Team D0

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# Overview

- A robot that paints a picture on a sheet of paper
- Looks at a digital image to draw
- The goal is to paint an image which looks like it's been painted by a person
- ECE areas:
  - Software systems
  - Hardware systems



## Requirements

- Receive an input image of any size, render a likely output of the final painting from this image
- Creates a final painting that is visually similar to the source image
- Ability to paint colors from a set palette size, ~ 8 colors
- Operate in under ~5 hours in worst case
  - Function of image size and complexity



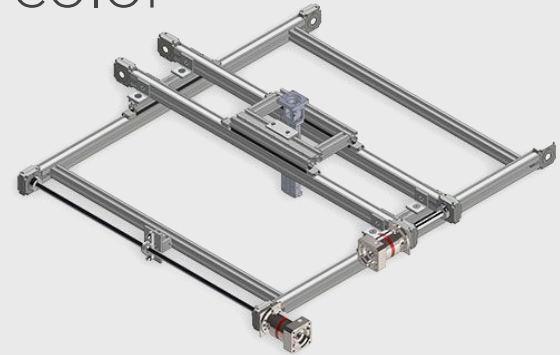
## Challenges

- Constant drawing environment
- 2D axis system that accurately moves a paintbrush
- Mixing colors to make new ones
- Calibration and resetting
- Water and electronics



## **Solution Approach**

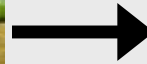
- Cartesian gantry - 2D axis system to move paintbrush
- Raspberry Pi to control stepper motor and servo
- Fixed palette and water well on side of paper
- Blending of colors possible through water color





# Software Algorithm

- Mean shift image segmentation
  - Edge and color detection
- Use objects to describe stroke characteristics





## Painting Algorithm

- Clean brush in water -> dip in paint well in palette -> draw strokes on the paper
- Paint from low to high detail
- Recalibrate brush position occasionally



## Technologies

- Primarily developed in Python
- Image Processing
  - Matlab
  - PIL libraries
- Hardware Control
  - Gpiozero
  - RPi.GPIO





## Testing + Verification

- Use various sized image inputs, and verify renders are consistent
- Use ~15 benchmark images
  - Starts easy and gets increasingly complex
  - Score paintings using structural similarity index

**SSIM: .3926**



# Testing + Verification

Maroon #800000	Brown #9a6324	Olive #808000			Teal #008080	Navy #000075			Black #000000
Red #e6194b	Orange #f58231	Yellow #ffe119	Lime #bcf60c	Green #3cb44b	Cyan #46f0f0	Blue #4383d8	Purple #911eb4	Magenta #f032a6	Grey #808080
Pink #fabebe	Coral #ffd8b1	Beige #ffac8		Mint #aaffc3			Lavender #e6beff	White #ffffff	

- Use color sample image to test color performance
- Use increasing complexity benchmark to test for time vs complexity performance
  - Ideally any image can be done within ~3 hours

A paintbrush with a white frame containing the text "Division of Labor" is positioned over a colorful abstract painting. The painting features a mix of green, red, blue, and purple hues, with a prominent purple area at the bottom. The brush is angled diagonally across the frame.

## Division of Labor

- Chris  
Image Processing + Stroke  
Algorithm + Designing Tests
- Eric  
Hardware Interface + Routine  
Developments + Motor Setup
- Harsh  
Mechanical Design/ Assembly  
+ Calibration + Optimizing  
Algorithms

# Capstone Schedule

