PenBot: Line-Drawing Robot

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Background

Our PenBot product is a small autonomous vehicle which moves precisely on a flat poster board or whiteboard surface while creating line drawings. According to Purdue University, "Advances in technology continue to push the envelope in healthcare, travel, communication and education. The use of robotic and simulation technologies have proven themselves to be worthy components of available educational resources." [1]

[1] *The use of Robotics and simulators in the education environment. Purdue University Online. (n.d.). Retrieved from https://online.purdue.edu/blog/education/robotics-simulators-education-environment*

Design Requirements

- ❖ Must be autonomous
- ❖ The robot will complete drawings stored on internal memory
- ❖ A jpg or bmp file converter to make a line drawing that can be used by the bot to draw a version of the original
- ❖ An interactive mode where the pen bot can be controlled remotely and wirelessly using a game controller, phone, or tablet
- ❖ PenBot must not exceed $30 in materials per unit
- ❖ Maximum Width and Length = 160mm (no height restriction)

PenBot Chassis
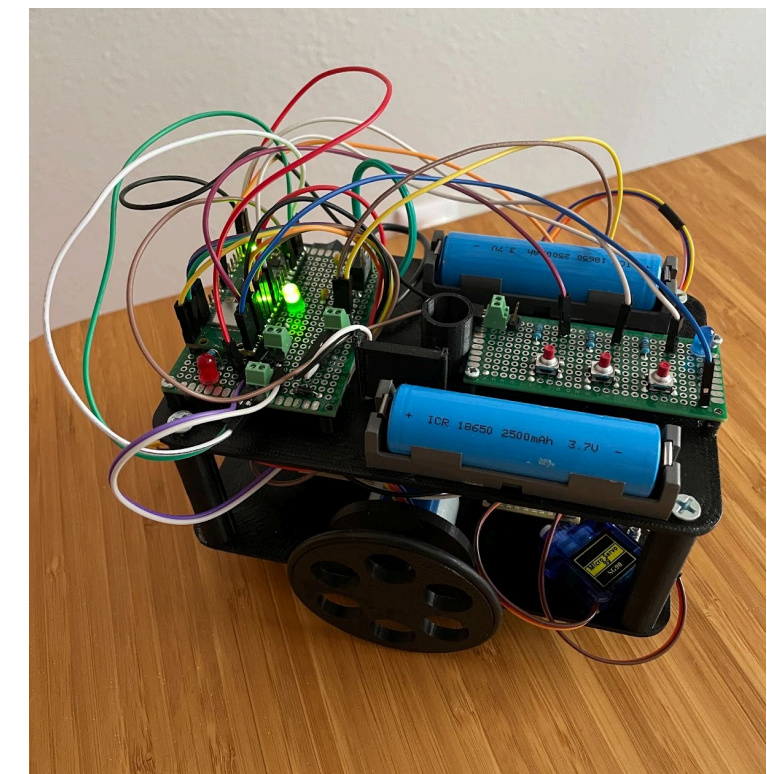
Includes:
- ❖ 3D printed two-wheel chassis
- ❖ Lighted power switch and three image selection buttons
- ❖ Autonomous indicator (green LED on Pico W)
- ❖ Blue LED to indicate when PenBot is drawing
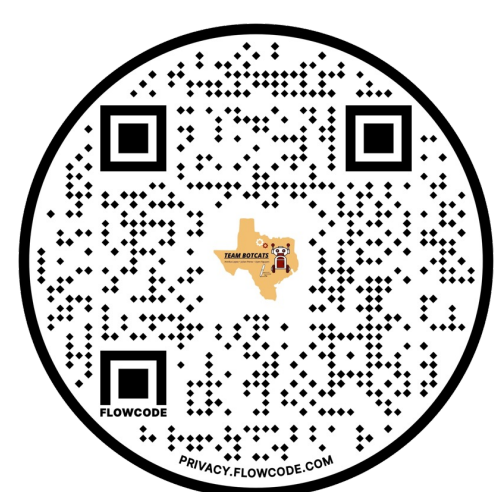- ❖ Pen holder with lift mechanism

The Team
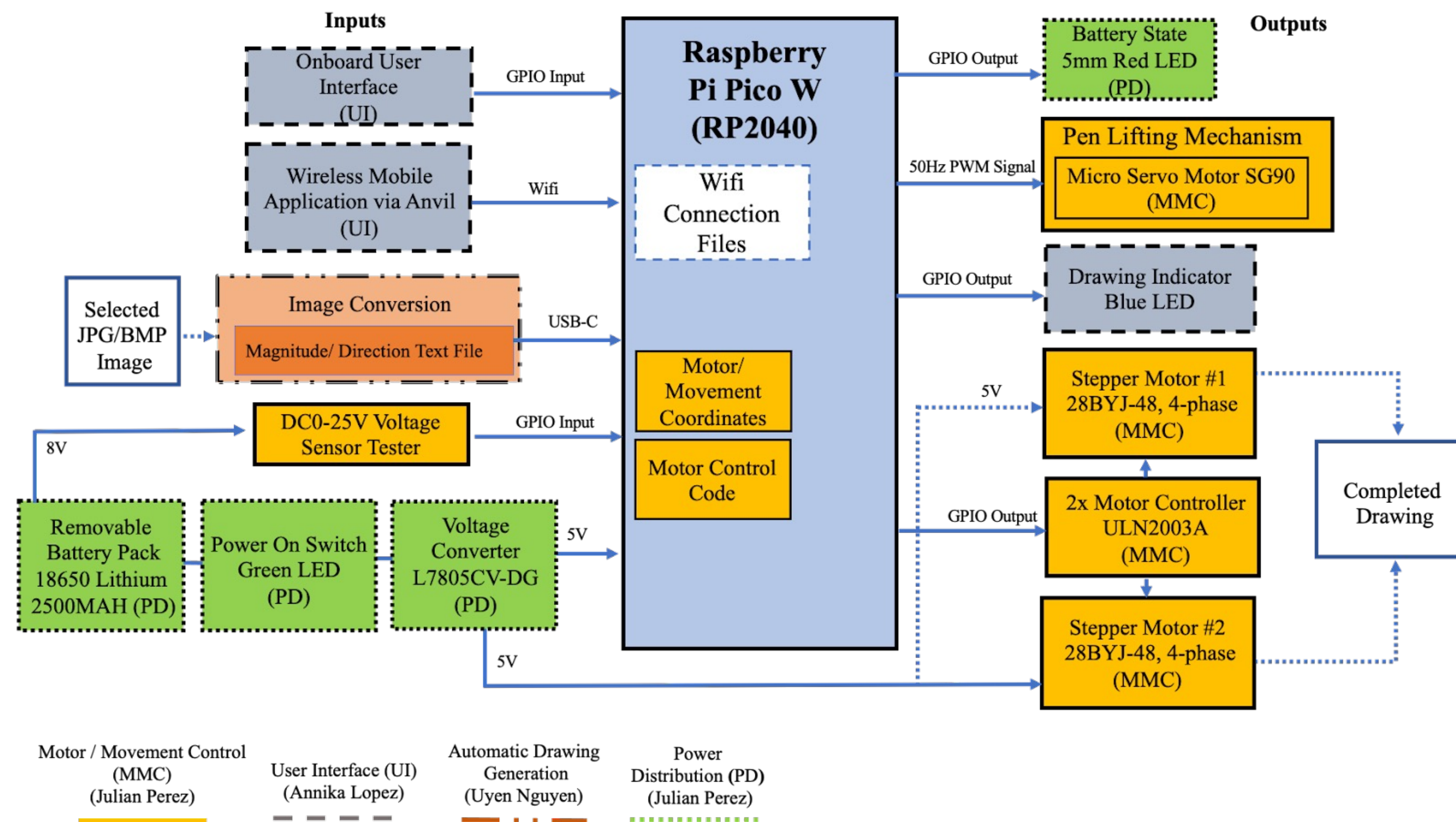

Julian Perez   Annika Lopez   Uyen Nguyen

Acknowledgments

- ❖ Sponsor: Lee Hinkle
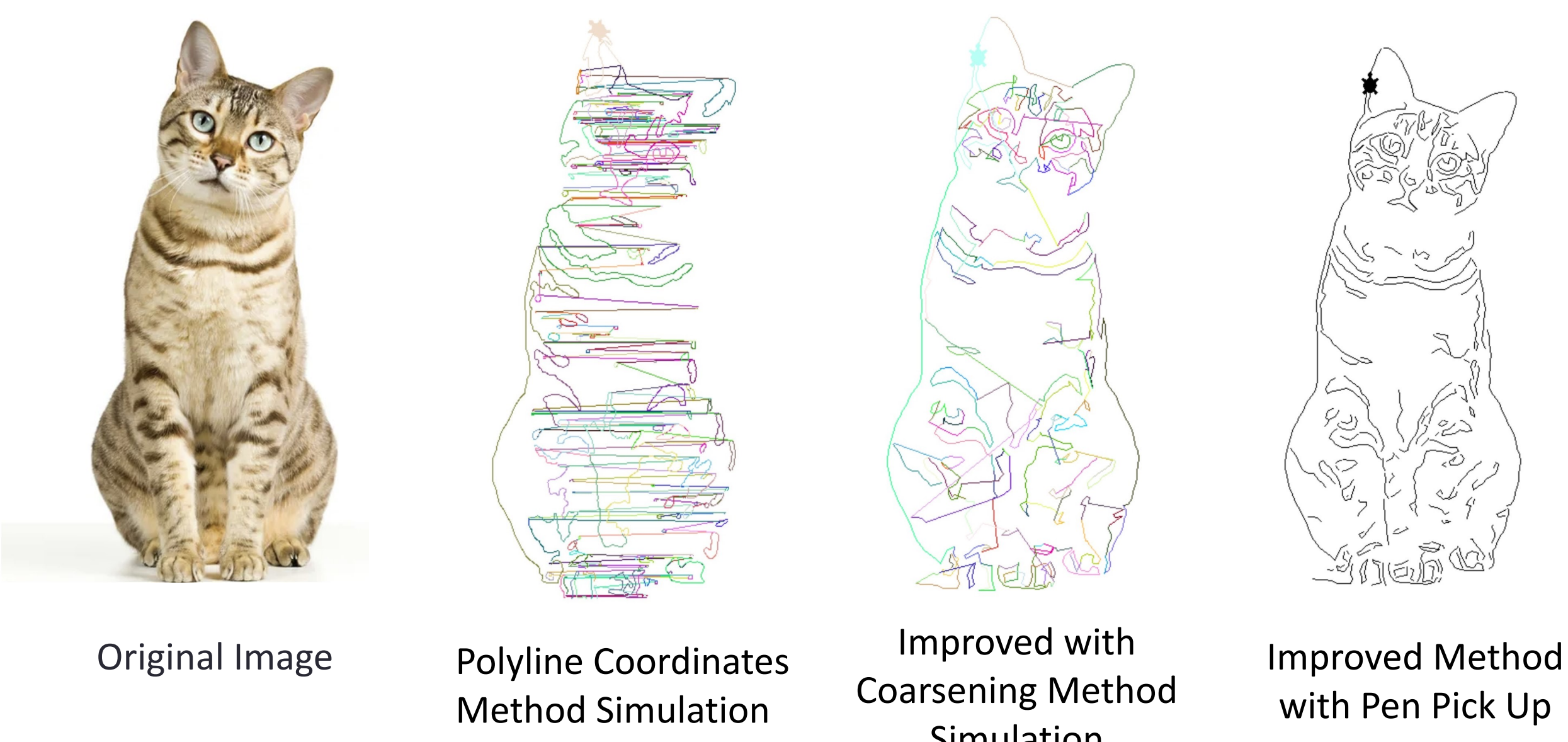- ❖ Faculty Advisor: Mark Welker

Scan to access our App!
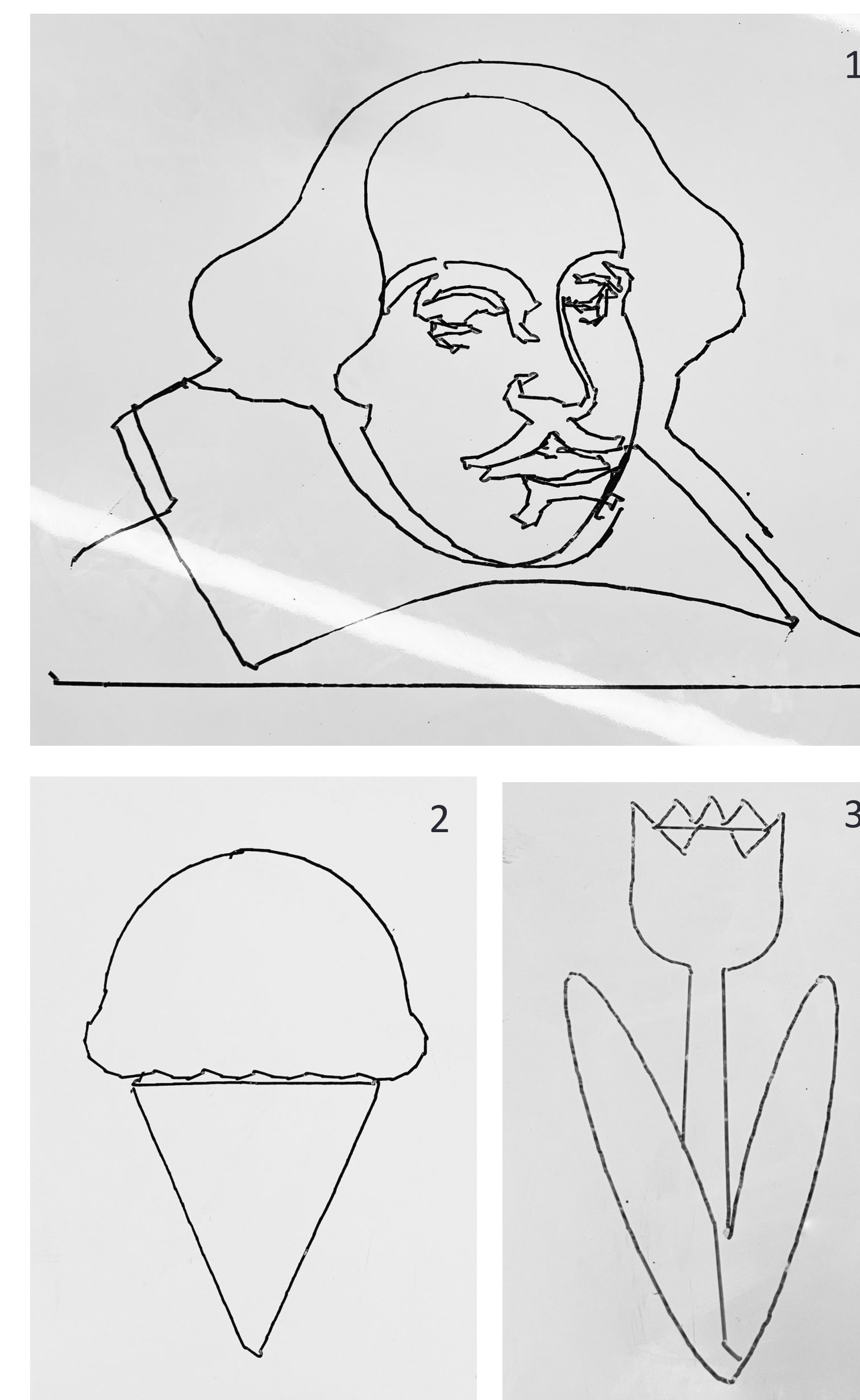

System Block Diagram

Motor / Movement Control (MMC) (Julian Perez)
User Interface (UI) (Annika Lopez)
Automatic Drawing Generation (Uyen Nguyen)
Power Distribution (PD) (Julian Perez)

Automatic Drawing Generation Block Diagram

Original Image | Polyline Coordinates Method Simulation | Improved with Coarsening Method Simulation | Improved Method with Pen Pick Up
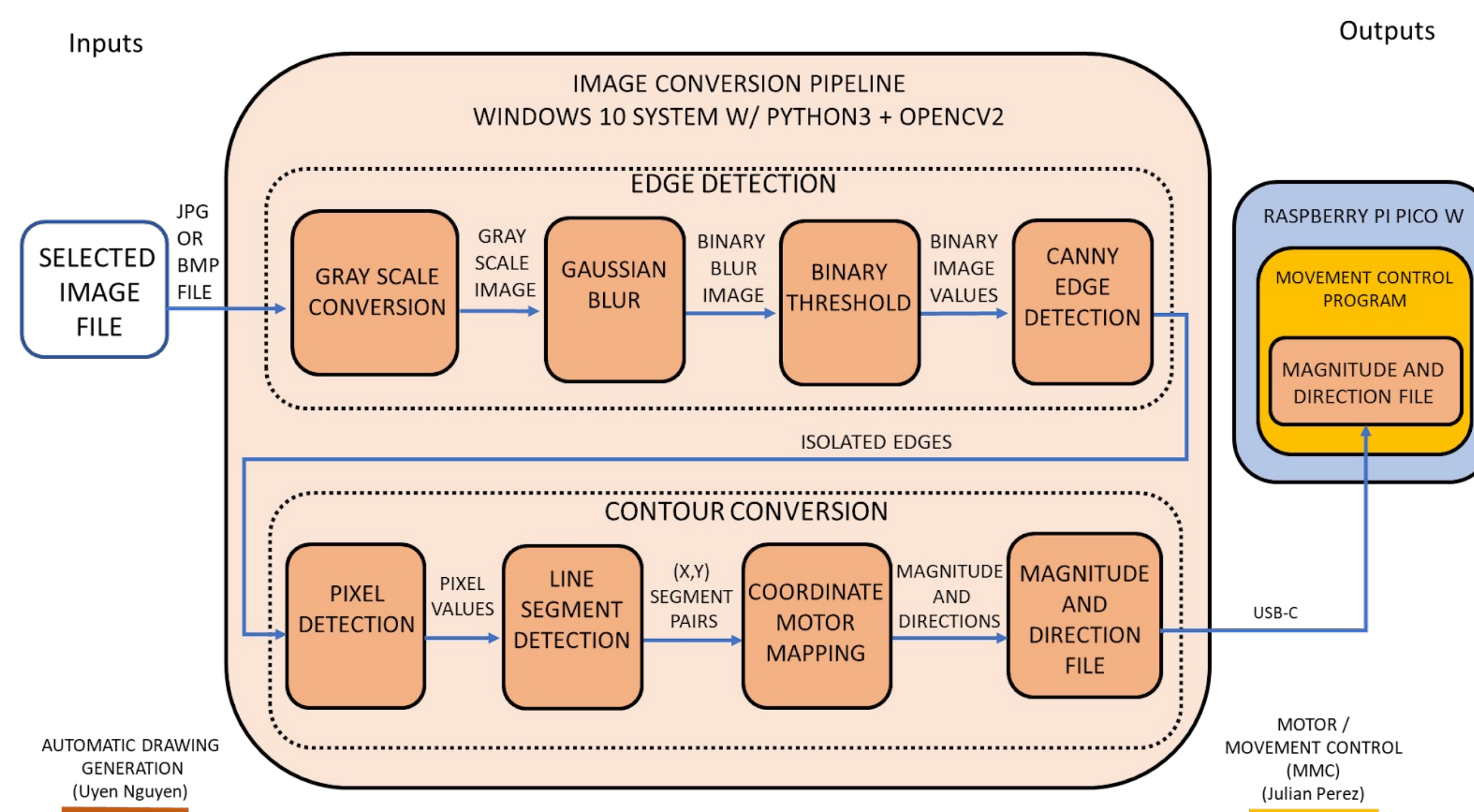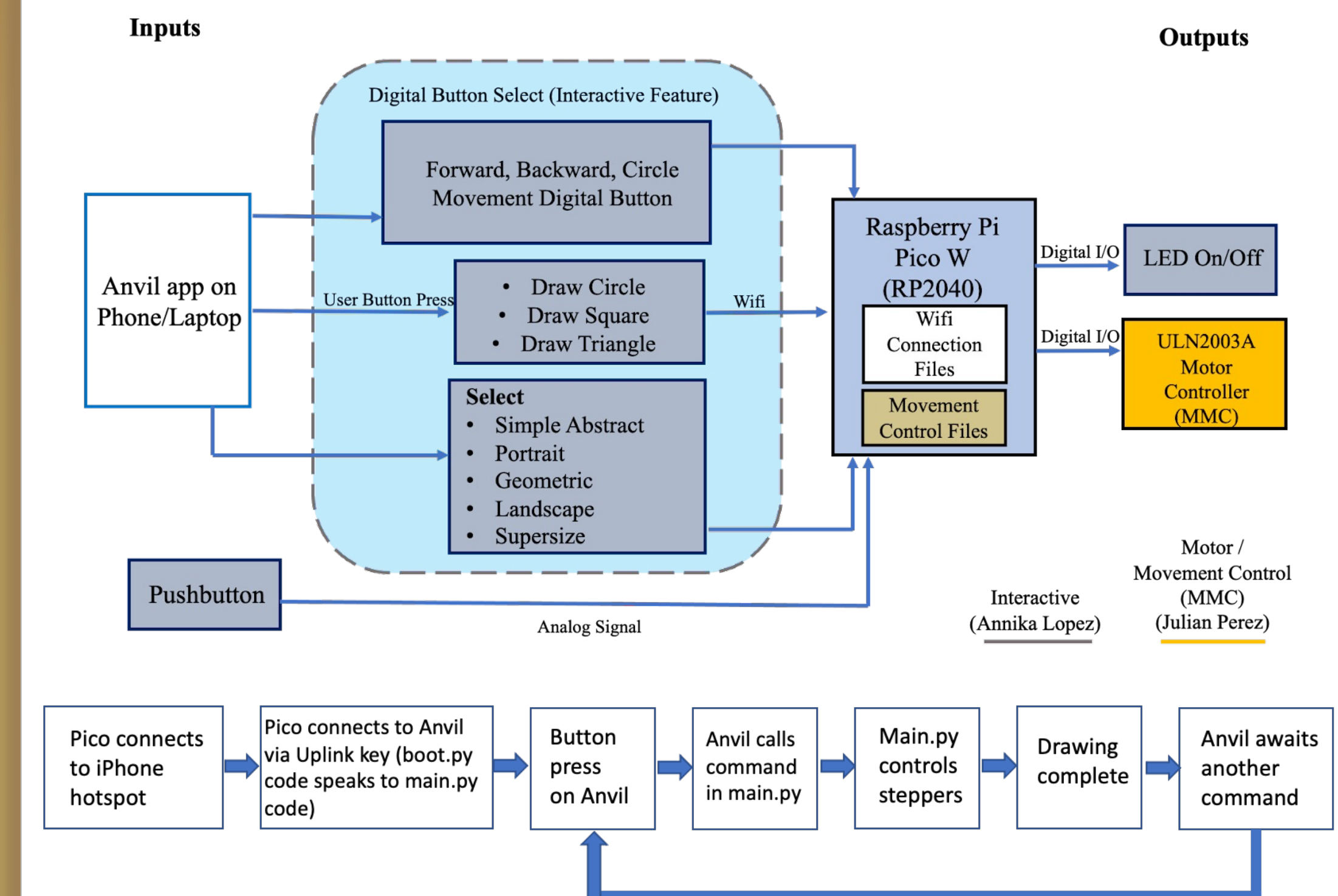
Example Images Completed

Images 1 and 2 display the portrait and simple abstract drawing completed by the PenBot. The tulip in image 3 further shows curved and straight-line drawing accuracy.
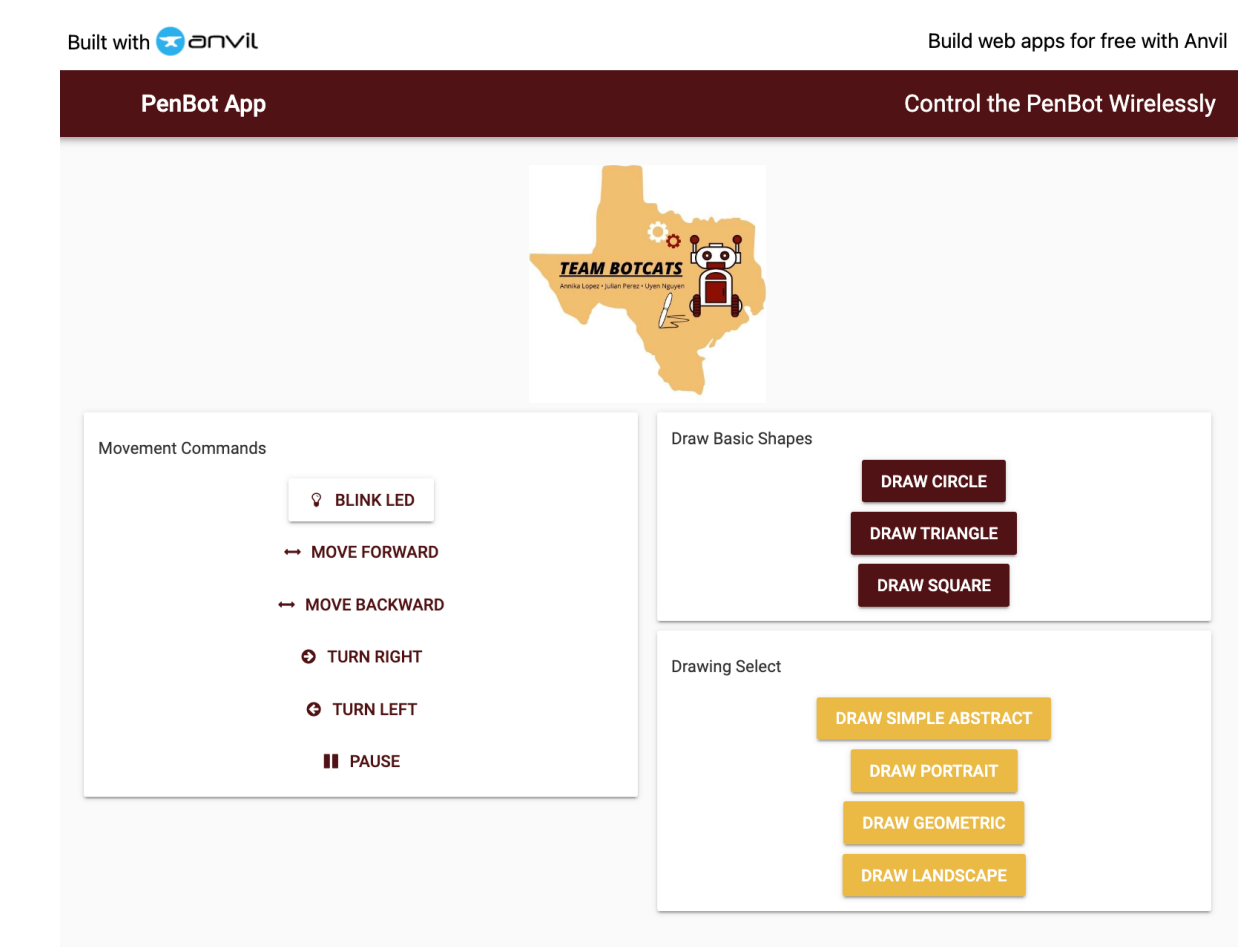

Interactive Feature (Digital User Interface)

Block Diagram

## Ease of User Interface Test Results

Users were given the following set of commands to perform using the digital application, and timed when doing so: *Draw a circle, turn PenBot to the right, draw a backward line, then complete the square.*

User	Press Circle	Complete Test	Outcome
User 1	3.8 seconds	57.9 seconds	**PASS**
User 2	7.0 seconds	63.43 seconds	*It was expected users would be able to read and complete the tasks in under 4 minutes. The longest time to complete was 70.3 seconds.*
User 3	4.5 seconds	70.3 seconds	
User 4	5.8 seconds	64.2 seconds	

Power Measurements

House Drawing

Hrs run	Voltage (V)
0	8.12
1.03	7.78
3.1	7.3
4.05	7.158
5.05	7.06
6.2	6.98
7	6.82
8	6

Battery Life (Worst Case Run)

$y = -0.214x + 8.0733$
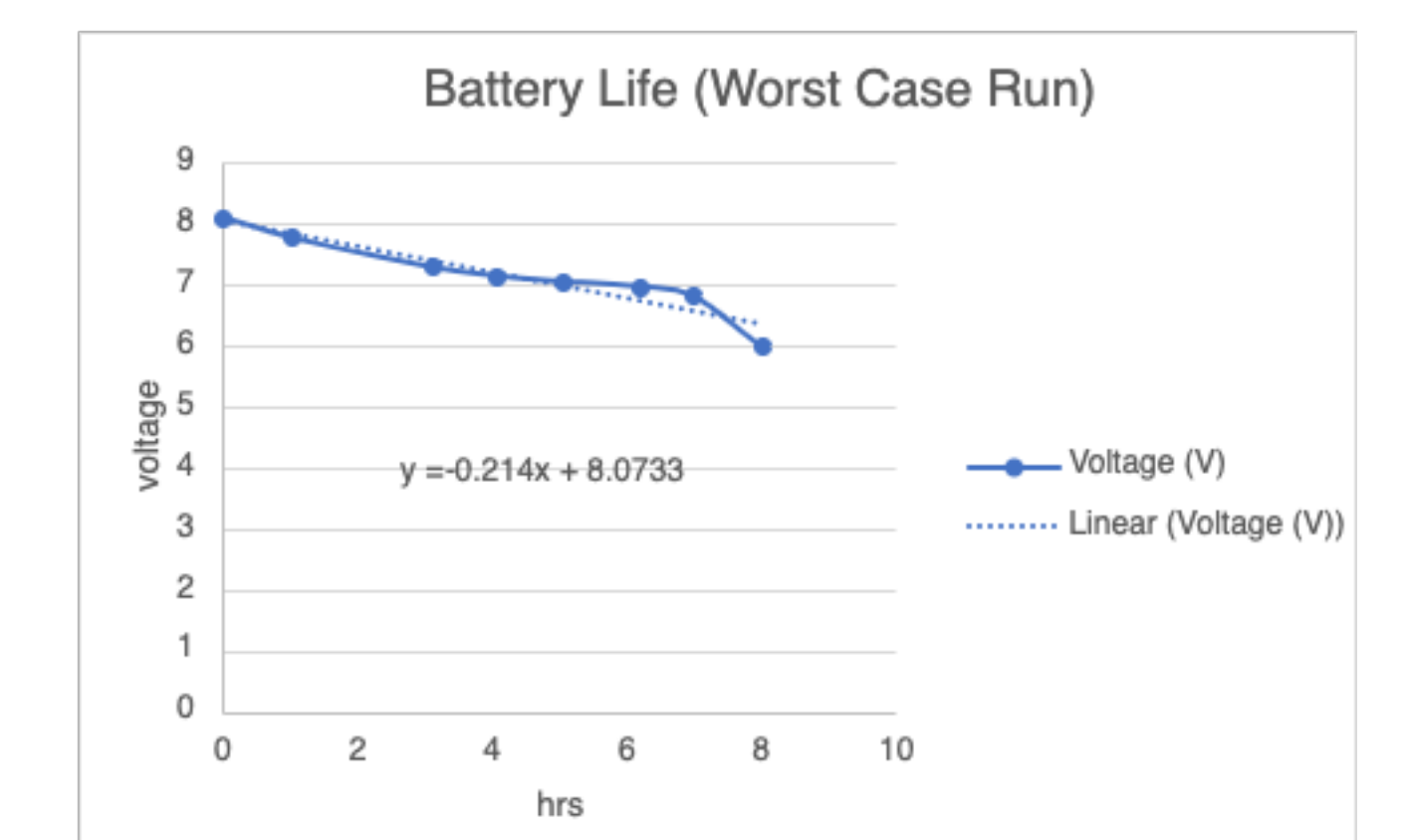
Battery life: Calculated battery life 7.81 hrs based on 400 mA of load. Actual battery life is 8 hrs with a min battery pack voltage of 6.0v. Ran this once with the current microcontroller because to not risk damage to the batteries.