Kwadropus Controls

Congratulations for being chosen to be a NASA HUNCH Finalist for Design and Prototyping. Know that there were a lot of very good teams with great ideas competing for these spaces. Being a Finalist means you are already a winner. There is not a 1st, 2nd, or 3rd place—there are only Finalists. Although HUNCH would like to have all of these projects turned into flight hardware, most won't make it that far. However, some of these ideas may inspire other hardware and equipment. This is like real engineering where any of the projects or ideas in a project that are deemed valuable to NASA could be incorporated into another project. NASA has no intention of taking or stealing ideas. HUNCH has every intention to keep your names attached to those projects so that you and your team retain credit for your ideas and efforts. In general, NASA does not seek patents on space hardware unless there is a use for it on the ground that could be valuable.

Suggestions for the Final Design Review

Houston in the middle of April is warm and humid. The building is air conditioned but there will be lots of people. Rain is possible.

- Look professional.
- Everyone on the team should plan to talk.
- Update your brochure with you latest prototype and information.
- Make sure your QR code works for everyone.
- Update your tri-fold with your latest information—less about early concepts, more about features.
- The better your model looks, the less you have to say.
- Take a video of everything working well so if it fails when you arrive, you can still show functionality.
- You will be sharing a table with another team. Make sure your display will not take up more than half of a 6 ft x 2ft table. There will be some tables with power and some without. We will try to give priority to those who need it for the presentation—video.

Suggestions for Kwadropus Controls

- Have a logic diagram to show your programming
- Organize your motors, wires and sensors on some kind of display so it displays well.
- Keep your display concise.
- Tighten up electrical connections to minimize problems.
- Run your code many times to show that it doesn't jam up and you are able to find bugs in your code.

Next Steps

- Flexible PCB
- 3D casing
- Adding extra sensors for more data
- Updating the program with new features

Criteria/Constraints

Criteria

- Cleaning surfaces in space stations
- Multiple controllers
- Control for 4 arms (3 movement, 1 cleaning)
- 3 motors per arm

Constraints

- Can't damage computer equipment
- Can't interfere with humans

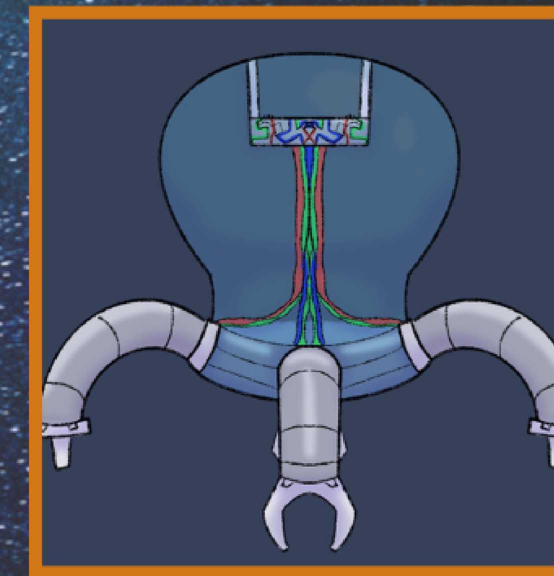
Brainstorms

1. Flexible pcb
2. 3 motors per arm
3. Arduino's communicating
4. Force pressure sensors
5. WiFi communication
6. Lidar / radar detection
7. Mapping out surroundings
8. Temperature sensors to detect heat (humans or electronics)
9. Accelerometer + ultrasonic sensors for 3d rendering

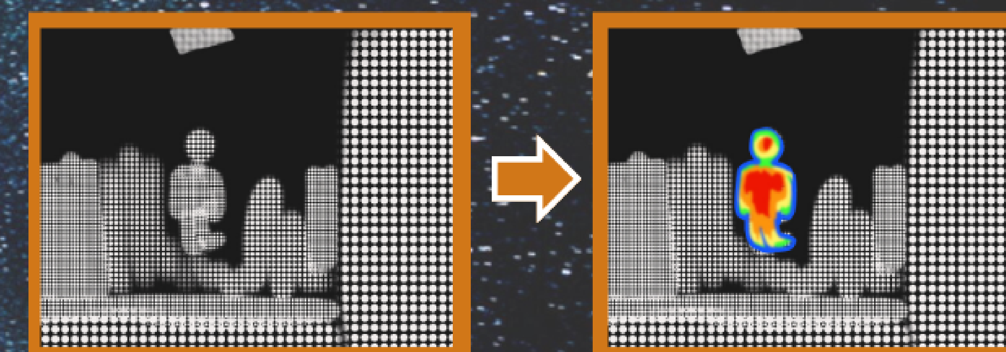
Design Ideas

- 5 controllers (1 Arduino uno, 4 STM32 boards)
- Communicating with bluetooth capabilities
- 3d rendering and tracking with Ultrasonic sensors
- 3 servo motors per movement arm
- Detecting contact with touch sensors
- Flexible PCB boards

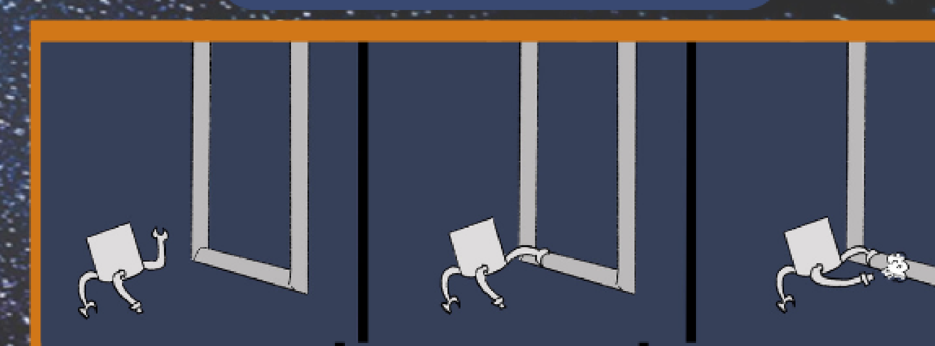
Storyboards



Lidar and Heat Sensor



Cleaning Process



Research

- PCB circuit designs
- Embedded systems designs
- UART communications
- 3d rendering with acceleration and vectors
- Octopus neural network

Test Data

January: 86 tests
- Testing STM32 hardware capabilities
- Measuring mpu6050 with ultrasonic sensors
- Sensor data

February: 73 tests
- Servo motor control
- -RGB sensor
- Bluetooth capabilities
- UART communications

Future tests
- Flexibility of boards

Materials

- **Arduino uno (clone)**
- **Batteries**
- **MOSFET (Metal-Oxide-Semiconductor-field-effect transistor)**
- **Wires**
- **Resistors**
- **Sensors**
- **Motors**
- **H-Bridge**
- **NRF24l01+ bluetooth module**

Commercial Items

- Mosfet - <u>WeiMeet RFP30N06LE 30A 60V N-Channel Power Mosfet TO-220 ESD Rated for Arduino(10 Pieces)</u>
- Sparkfun Tinker kit - Arduino clone + wires, resistors, lights, buttons, switches, battery cases, usb type a to b reversible cable.
- NRF24l01+ - bluetooth module transceiver

CEREBRAL CONTROLS

Andrew Butsch and Savy Snyder

Objectives

- Creating controls for a soft body robot
- Maneuver around rooms in a zero gravity environment
- Should not interfere with humans
- Cleaning off surfaces

Problems

- Space stations collect dirt overtime
- Astronauts are too busy to clean the space station

The Purpose of the Kwadropus

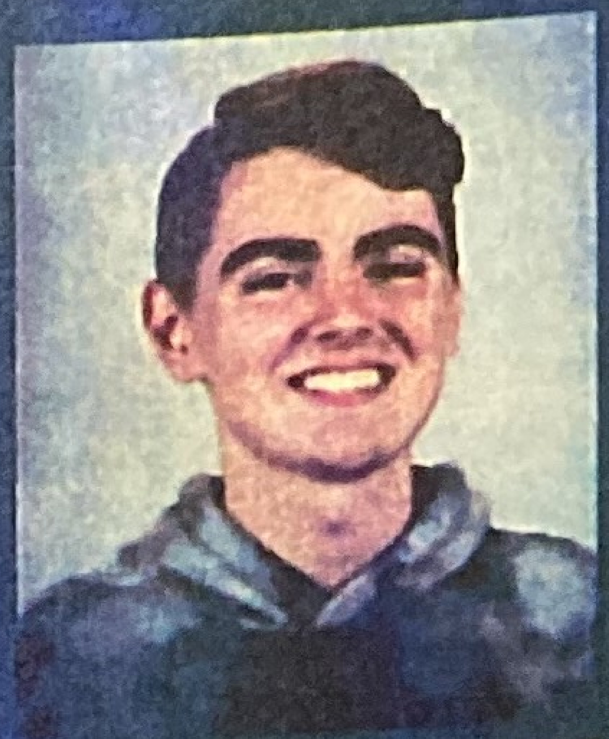
- NASA spends $130,000 per hour on each astronaut aboard the ISS
- NASA and other researchers are interested in replacing astronauts in cleaning the ISS.

Scan for more info about the project!!!

NASA

The Team

Connor Poleon



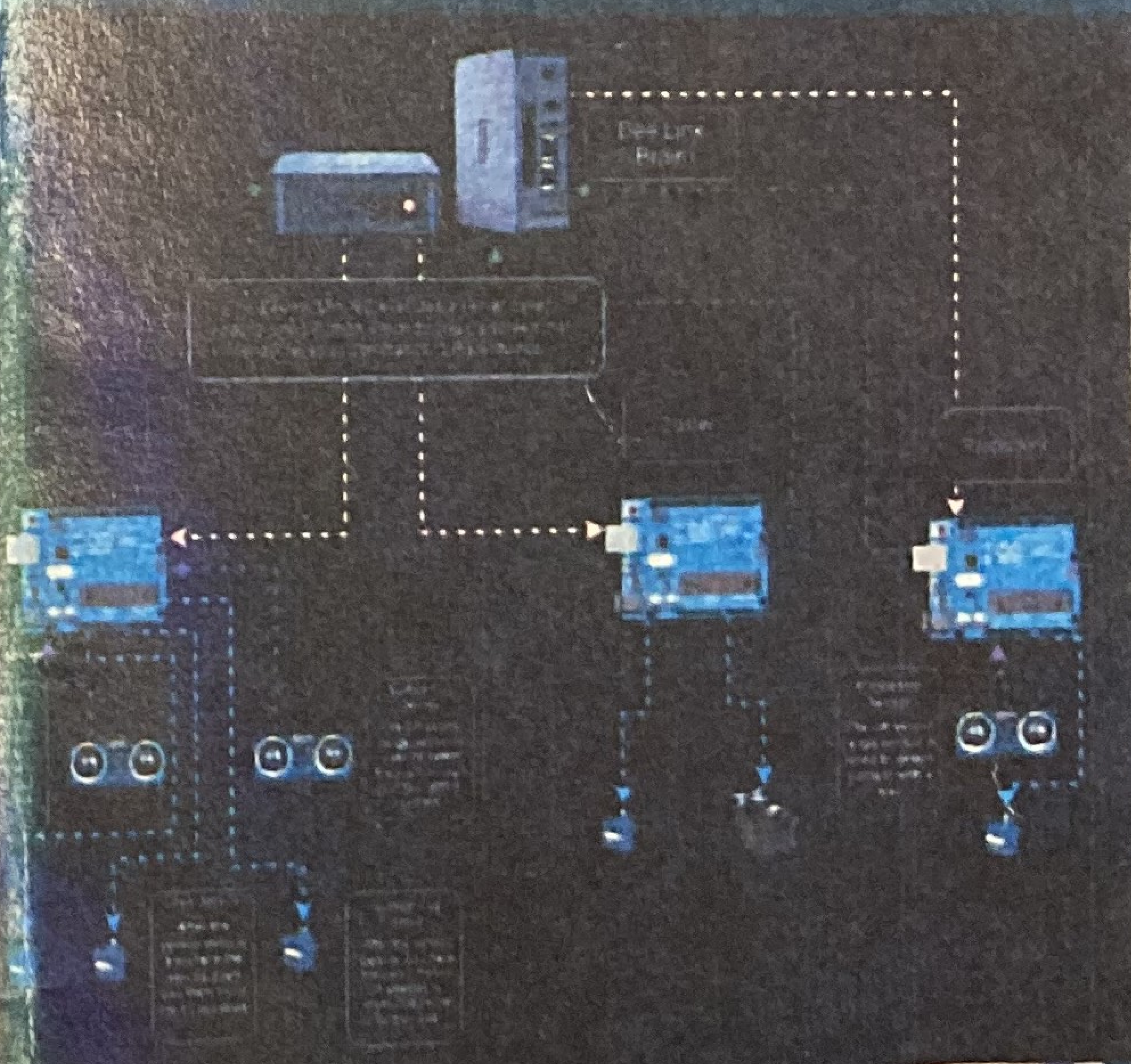
Jay Shoemaker

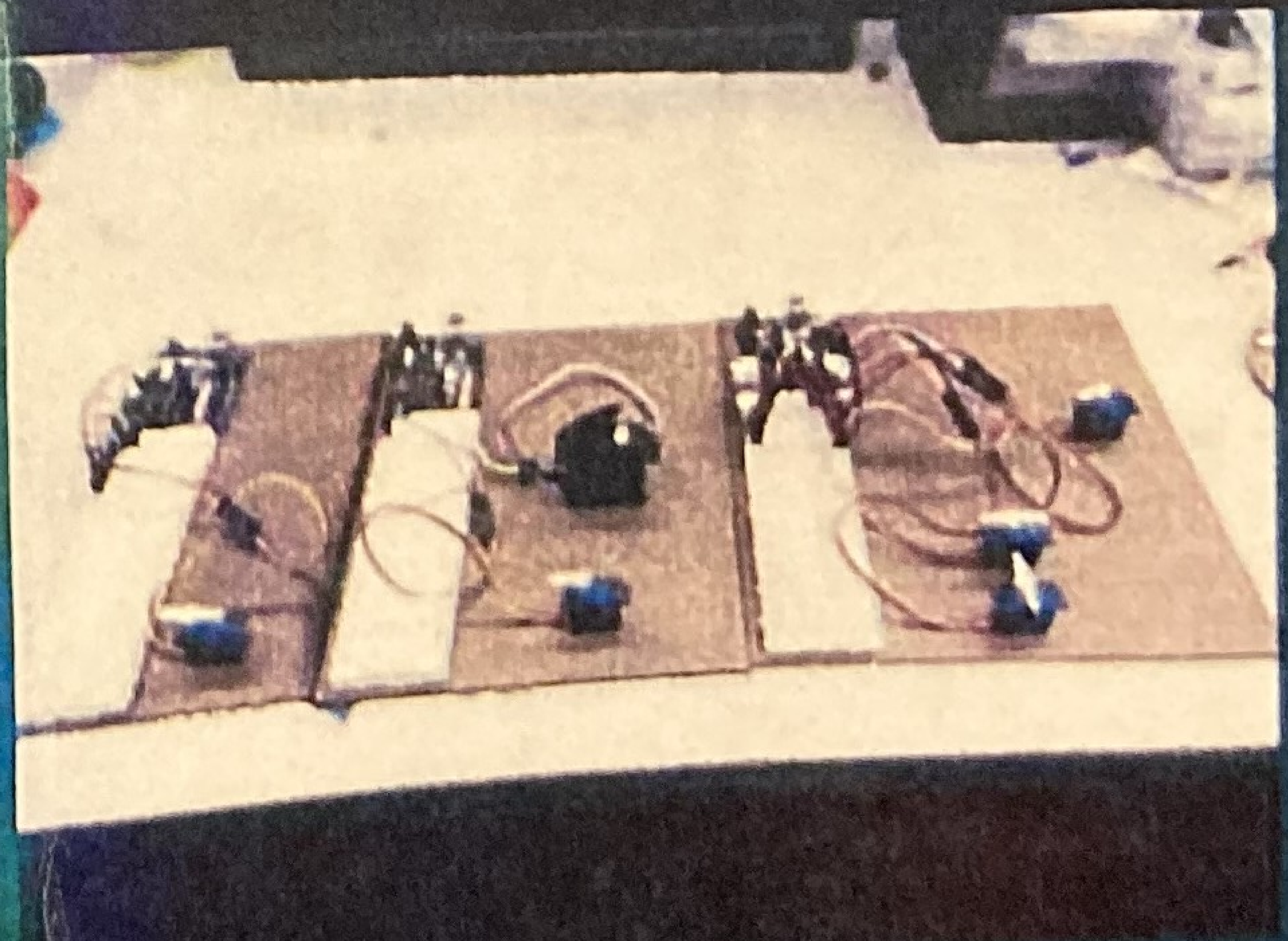
Supervisor

George Ouimet

Frontier Central School District

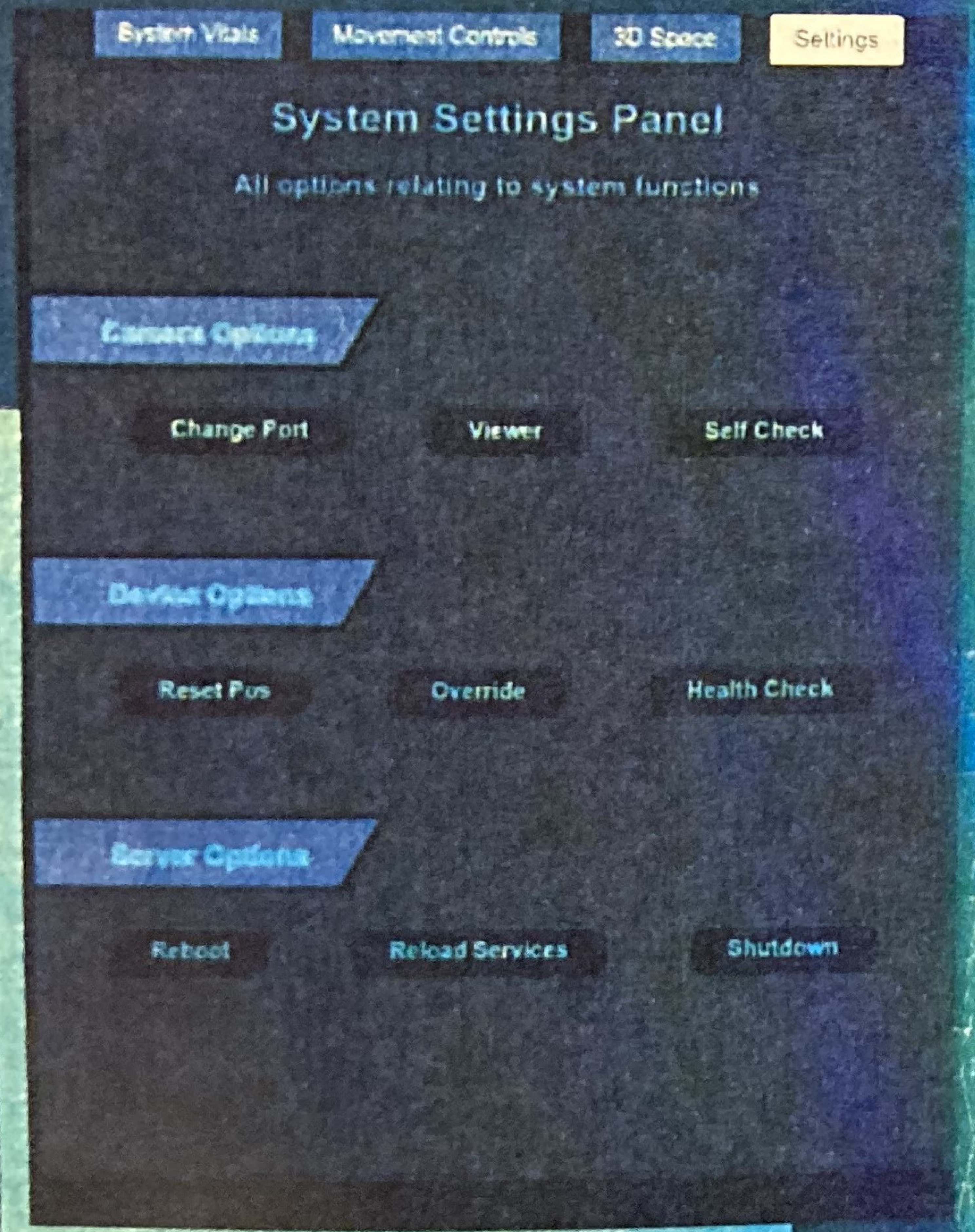
NASA Kwadropus Control Team



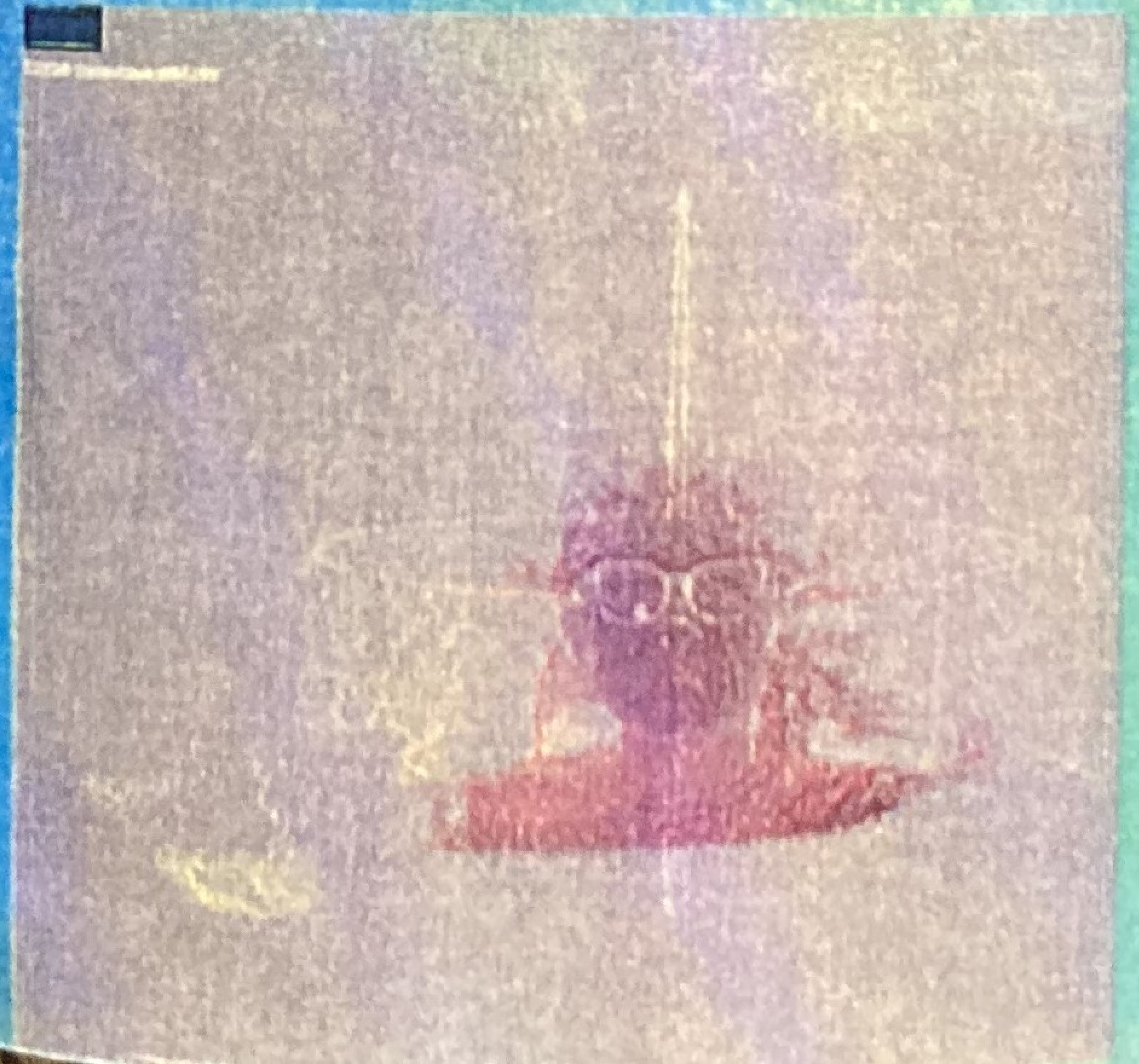


Graphical User Interface

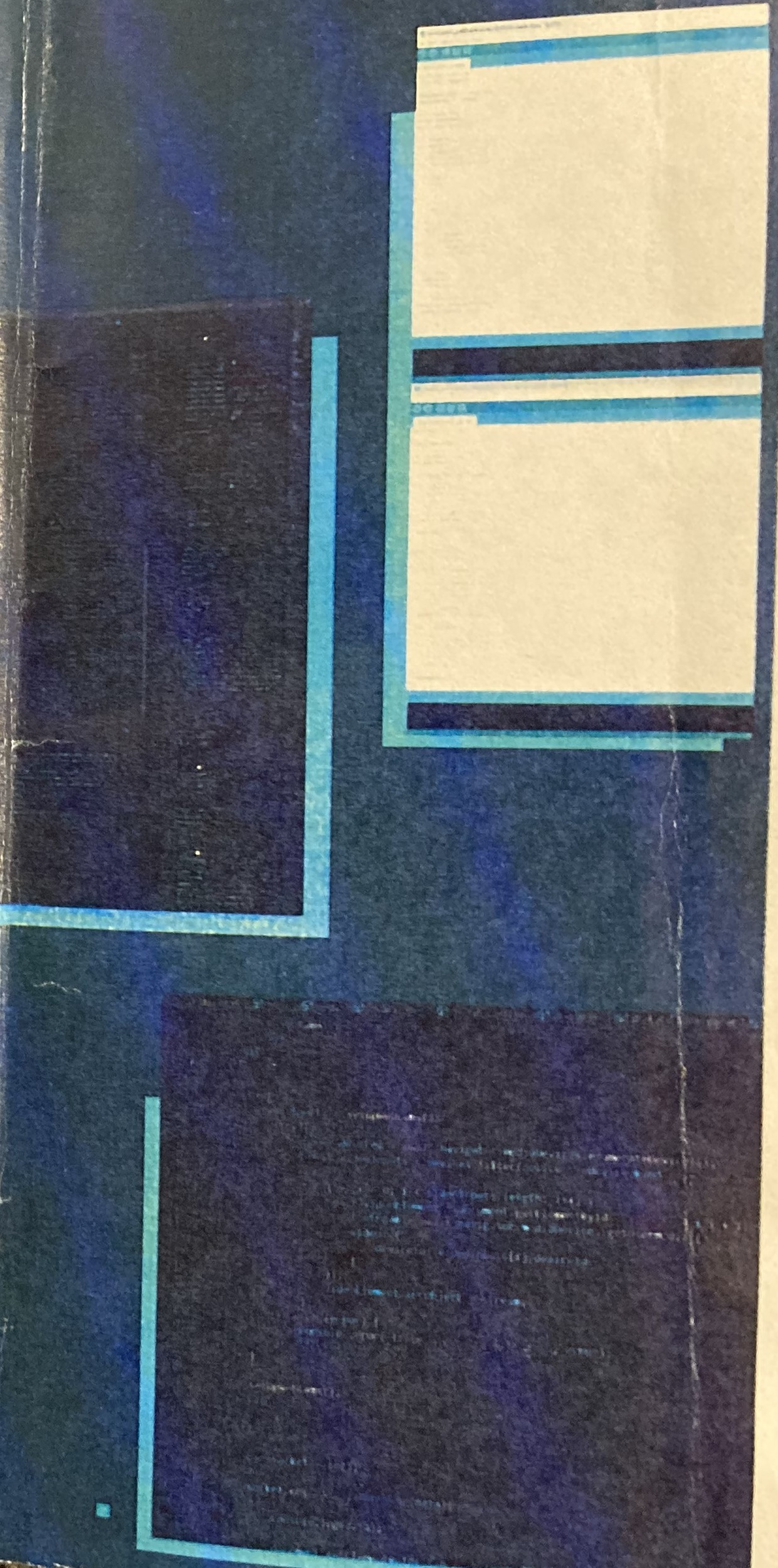
- Web Interface uses HTML, CSS, and Javascript
-
- Web Interface is used to monitor and send signals to the Kwadropus



3D Space

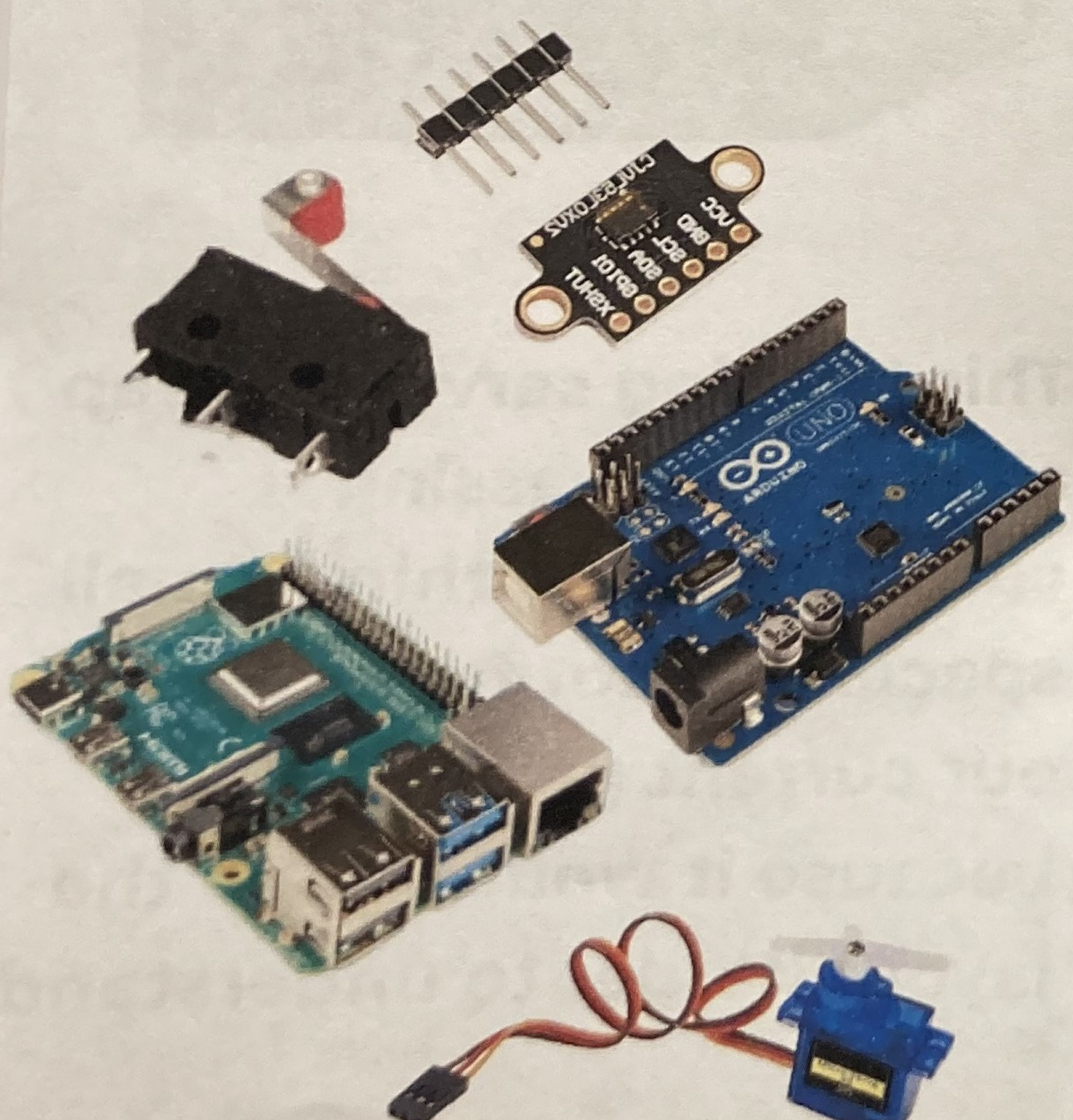


The Code



Materials

- Raspberry Pi 4 (2 GB RAM): $45.00
- 2 x Arduino UNO: $52.60
- Perfboards: $12.99
- Touch Sensors: $7.00
- 6 x Servo motor: $13.98
- LED indicators: $1.99
- 2 x Infrared sensor: $13.98



Contact Us

Lakewood High School
9700 W. 8th Avenue
Lakewood, CO
80215

Ms. Pederson:
173409e@jeffcoschools.us

Nathaniel Laurent:
2109999@jeffcoschools.us

Kayla Kuntscher:
2244298@jeffcoschools.us

VIDEO DEMONSTRATION

Kwadropus Controls

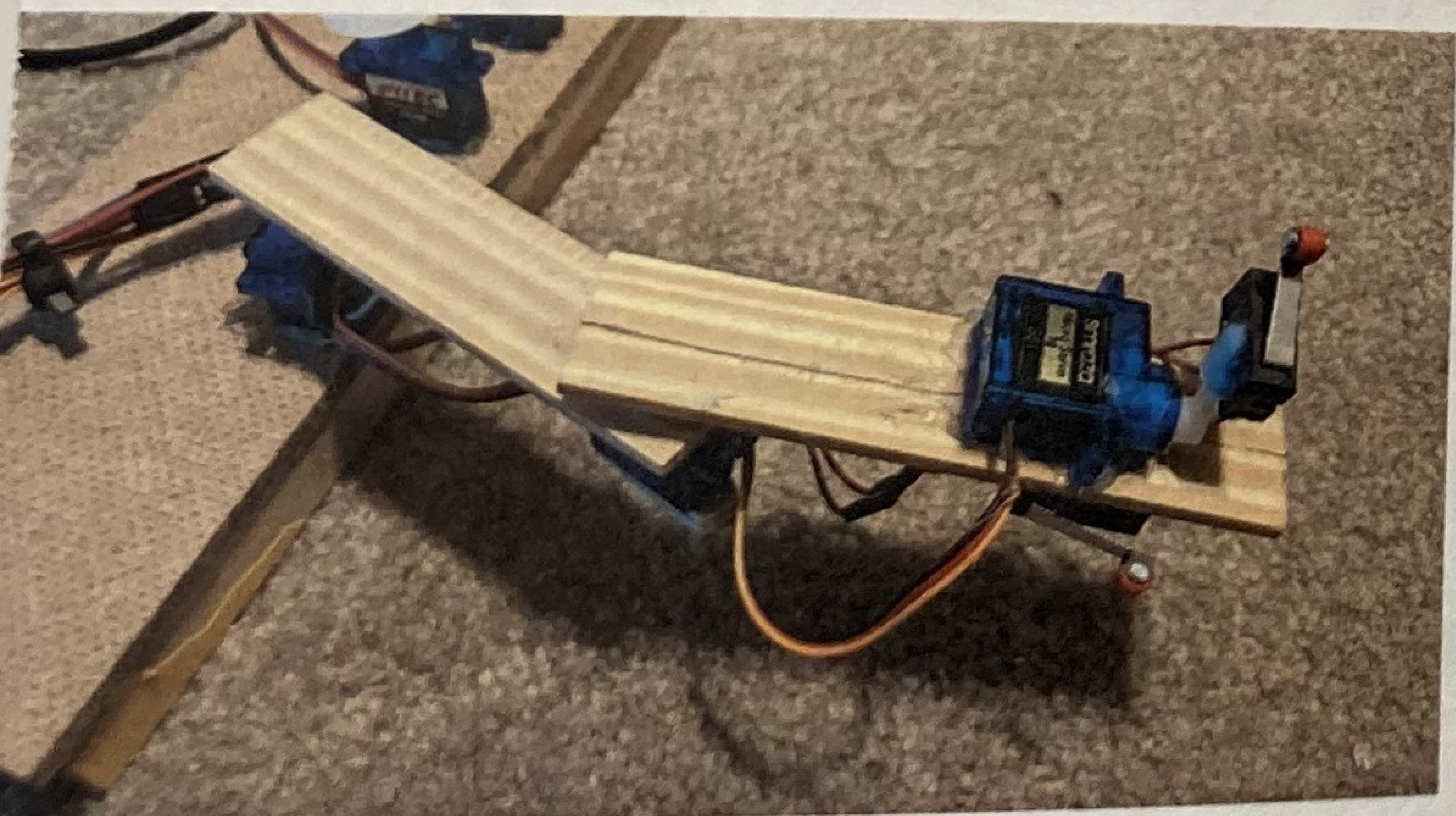
NASA HUNCH

Nathaniel Laurent and Kayla Kuntscher

Lakewood High School
Teacher: Ashley Pederson

Functionality/ Testing

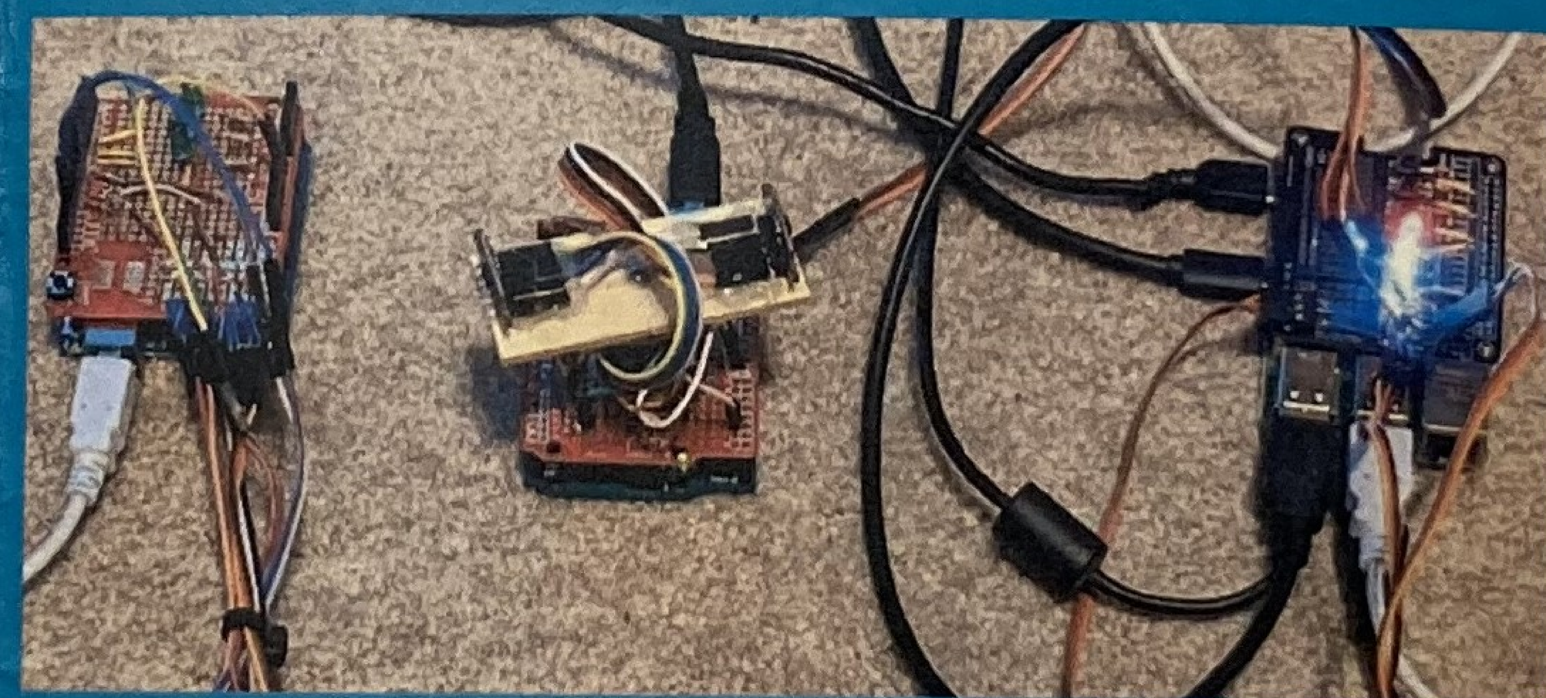
The Kwadropus has a mobility arm, controlled by the Arduino, to help it move, and the arm has a joint for improved flexibility. There is an additional servo to represent suction.



The Kwadropus also has a duster arm and propulsion, controlled by the central brain (Raspberry Pi). The duster is always active, and the propulsion engages when the mobility arm loses contact with the wall.

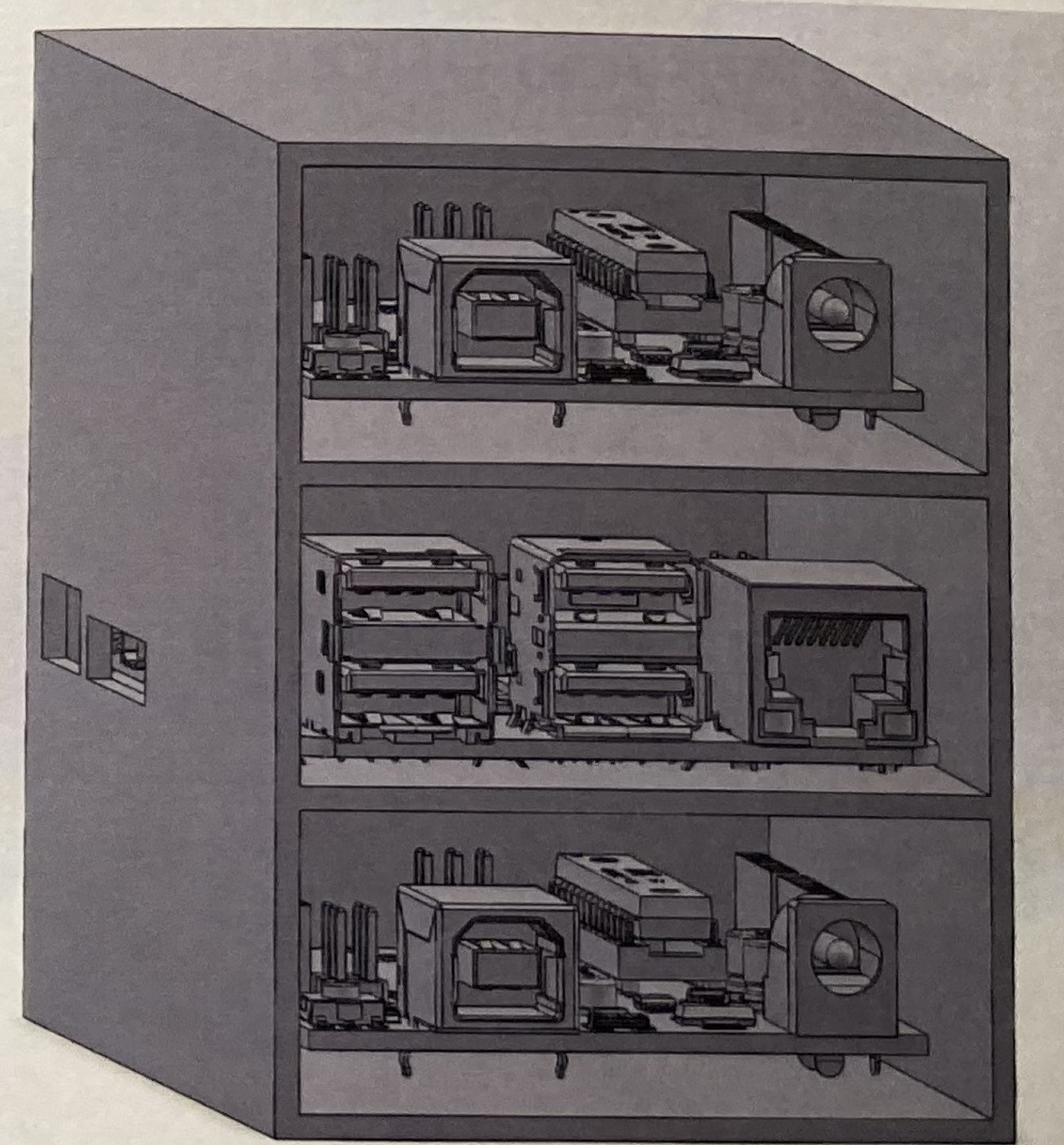
The Controls

The Kwadropus uses a Raspberry Pi and two Arduino boards to distribute control of the movement, dusting, and positioning.



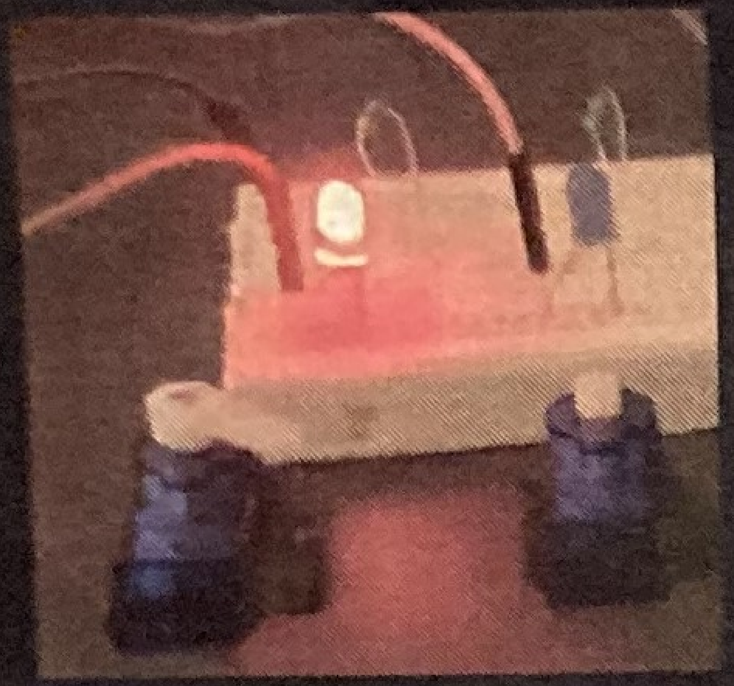
- Arduino controls an arm with one joint
- Raspberry Pi controls duster and engages propulsion
- The Arduino updates the Raspberry Pi on the status of the arm
- Camera/Sensing?

Housing



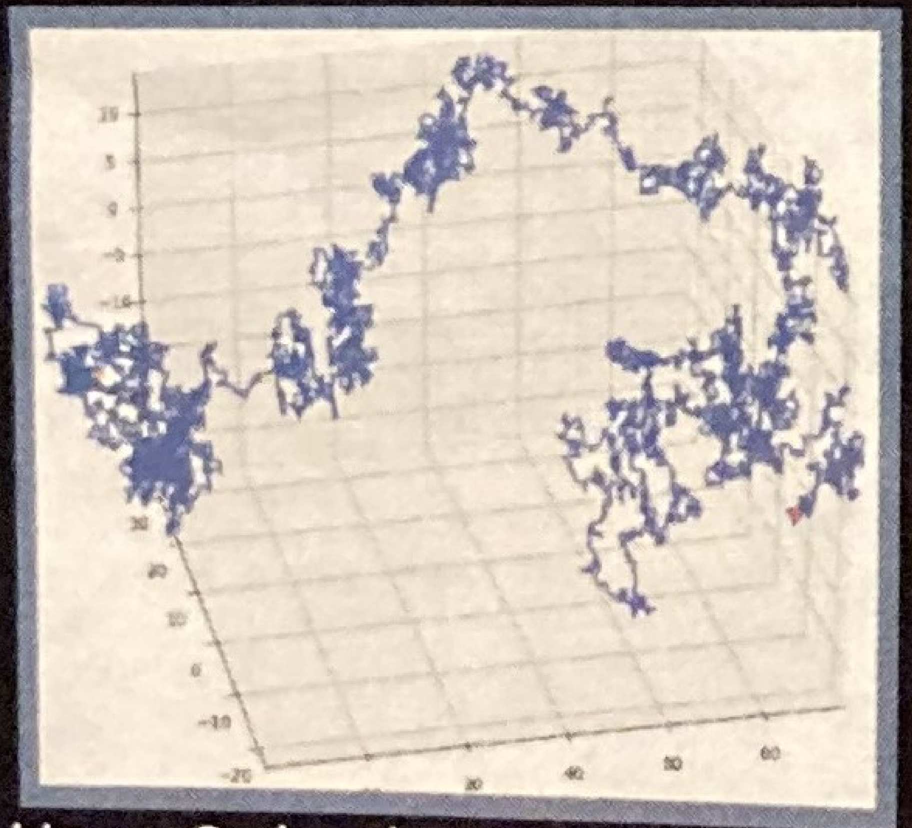
This housing serves to keep all of the processing consolidated within a small space. It is not featured in our current prototype because it would make the layout harder to understand.

Duster Arm



- Two Servos Randomly Move to represent scrubbing and sweeping
- Scrubbing Servo Jitters
- Sweeping Servo is Fluid motion

Randomness



- Uses Spherical Coordinates to simulate randomized pathways in 3 dimensions
- These paths are passed to servos
    - The servos turn based on radians in spherical coordinates
    - The pump shoots in place of a propulson

Putting It All Together

- All systems work interactivly on the control board
- All systems controlled by Main Brain (Raspberry Pi) or Arm Brains (Raspberry Pi Pico)
- All programs written in Python and Micropython
- System designed to be moudle and adaptabile to all hardware

Future Work

- Test more hardware for all arms to be more adaptive for all systems
- Create a module design for the contorl board
- Create a graphical user interface for visualization of data

Google Drive Folder

The CNS Control System

The Engineers:

Syed Hassan

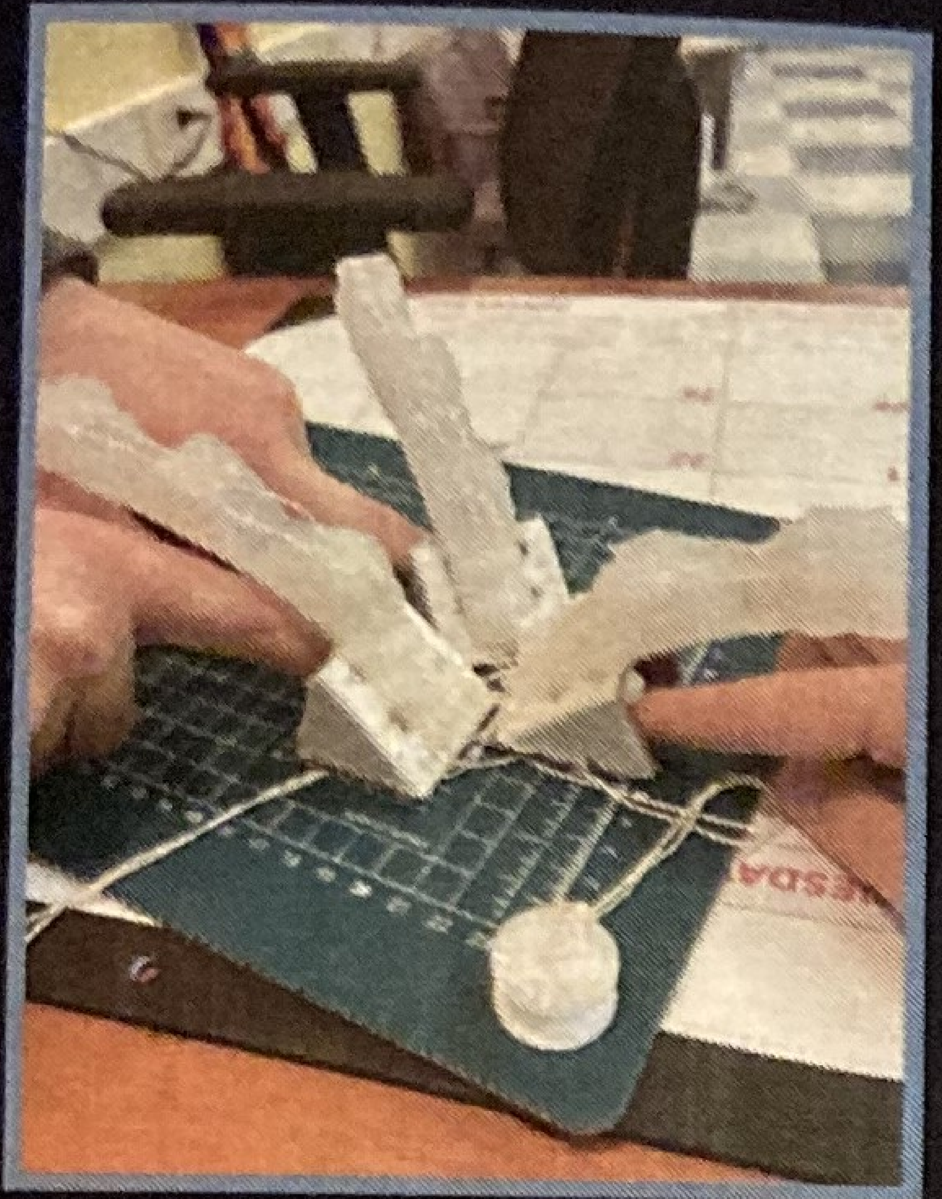
Noah Kay

Cole Weiss

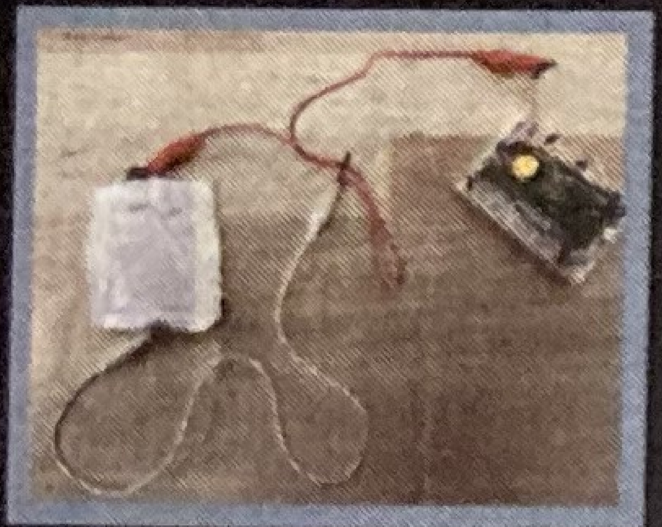
Half Hollow Hills High School East

Mr. Regini

Motion Arm

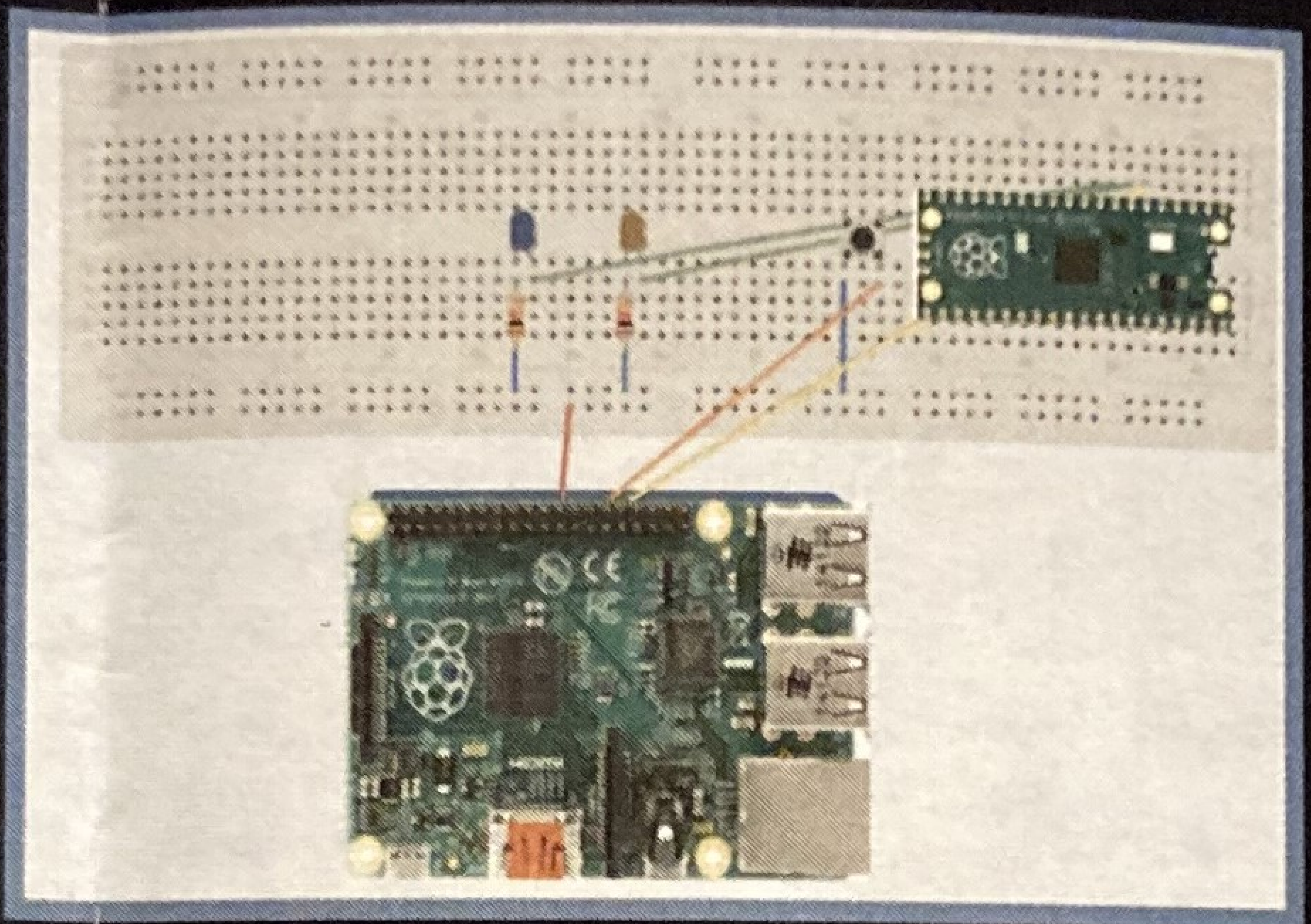


- 3 Servo System representing Motion in x, motion in z, and Grabbing
- Grabbing with Soft Robotic fingers



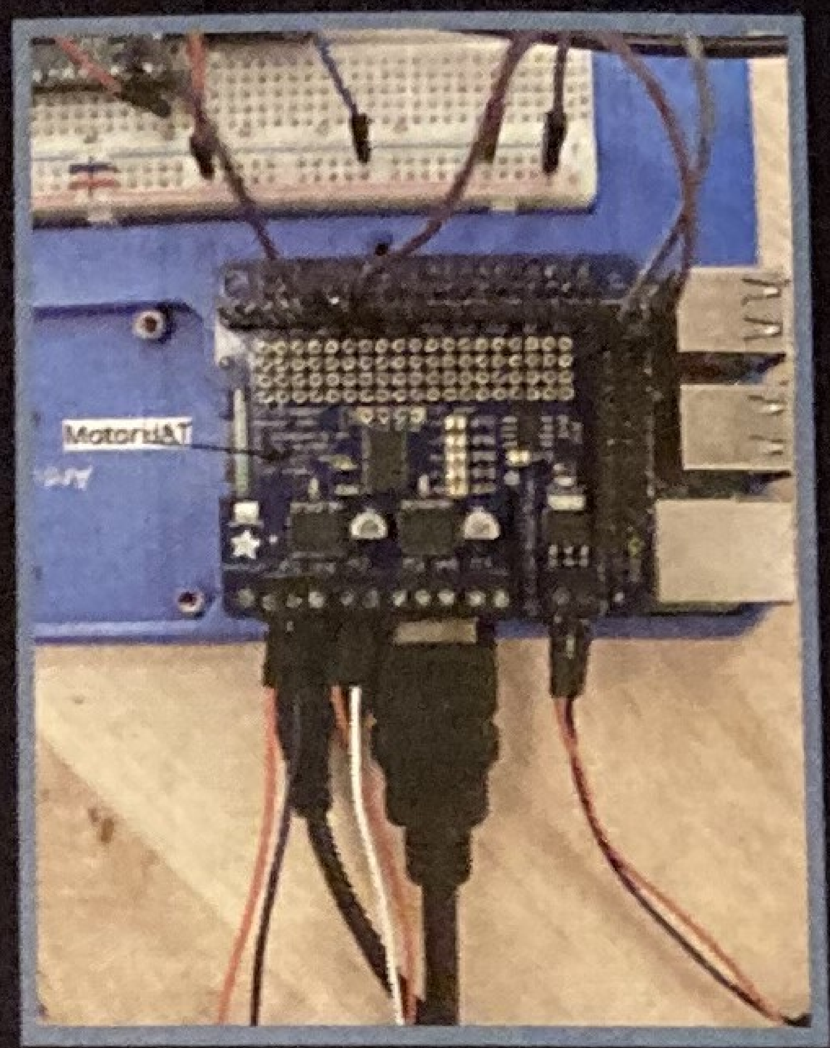
- **Homemade Touch Sensor for motion arm**
- Textile force sensor able to measure how much force it is being touched with
- Uses velostat, a material that varies resistivity when touched
- Textile material allows for customizable shape / size

Interrupt System

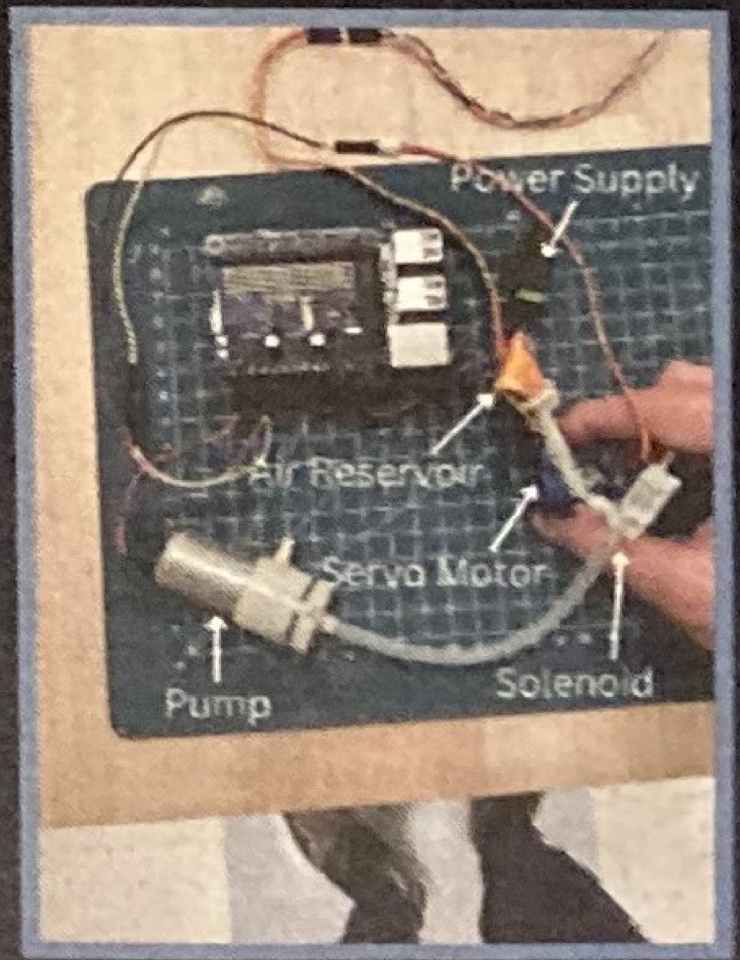


- Makes use of IRQ Interrupt flags
- Acts as an “override system” from the main brain (Raspberry Pi) to each arm controlled by a Raspberry Pi Pico
- An input is sent to the main brain which triggers the interrupt by sending a high value out to the pico.

Propulsion Arm

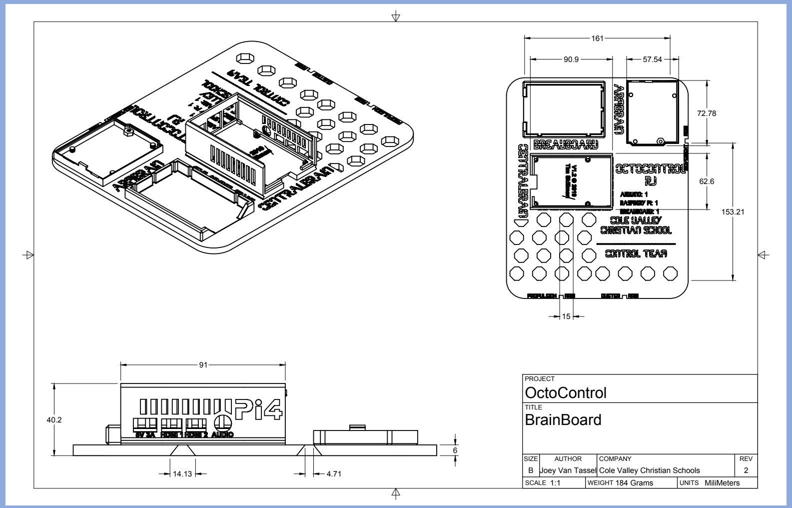


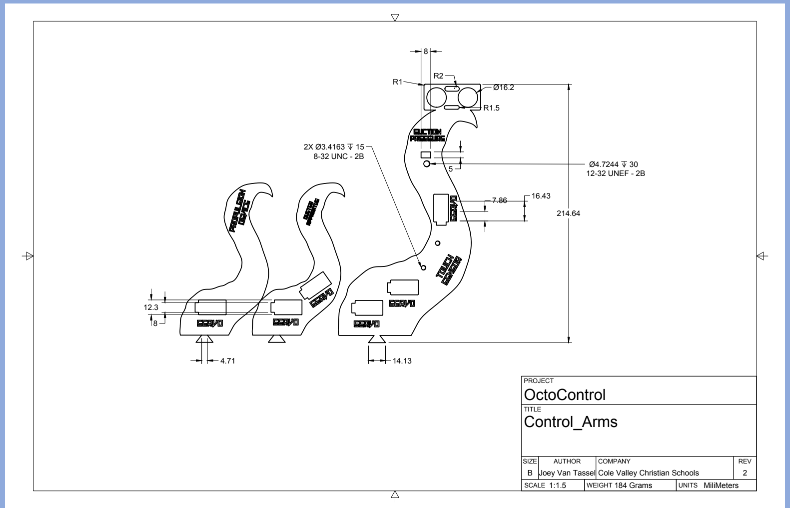
- Adafruit MotorHat used to control DC motors
- One MotorHat can simultaneously control 4 motors
- MotorHats can be stacked for more control



- Balloon repersents Air resvoir to be released
- Makes use of solenoid to be able to inflate and deflate balloon
- Balloon can randomly release air and randomly moves via servo motor

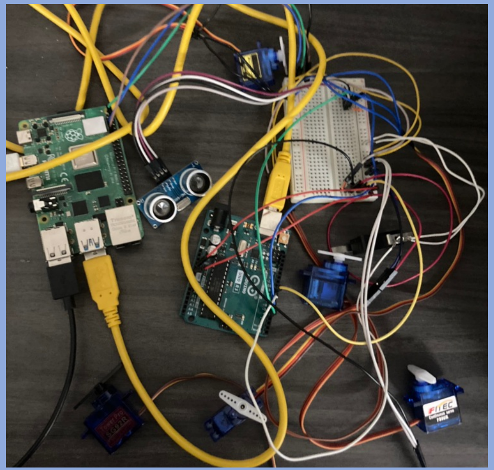
Fusion Casing



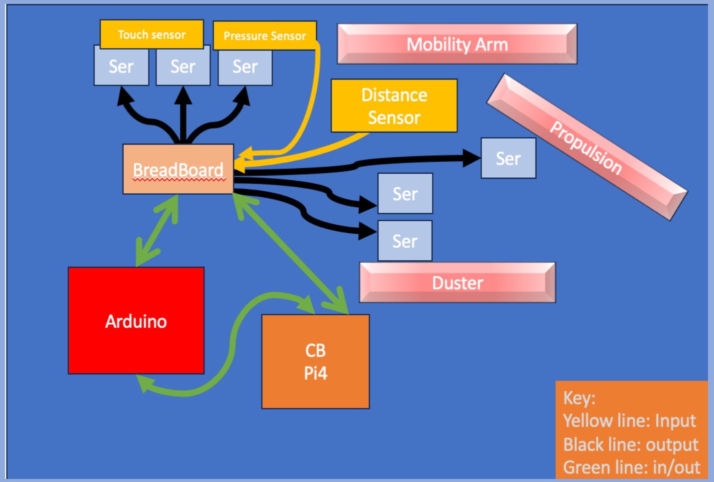


About the Controls

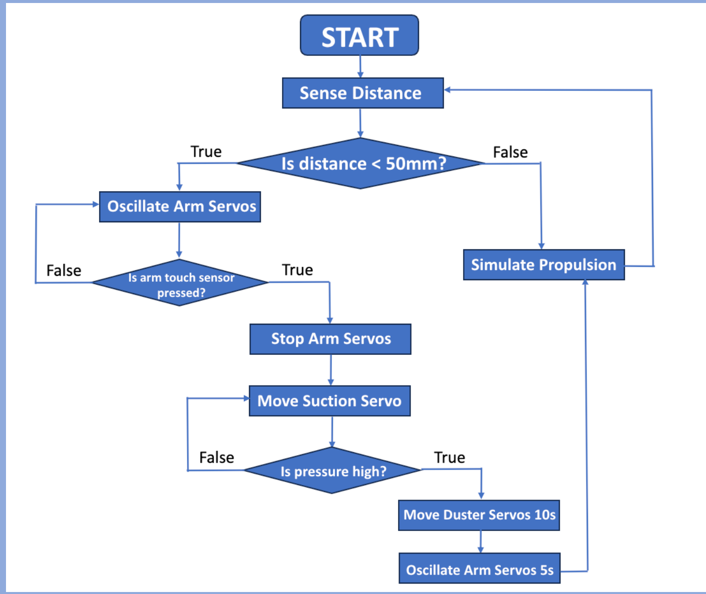
- Arm brain controls:
  - 2 servos for arm movement
  - 1 servo for suction
  - 1 distance sensor
  - 1 touch sensor for arm
  - 1 pressure sensor
- Central brain controls:
  - 2 duster servos
  - 1 propulsion servo
- Propulsion servo responds to distance input
- Arm servos respond to touch input
- Suction servo responds to pressure input



Hardware Flowchart



Code Flowchart



Design Features

- Automatically senses pressure and touch
  - Determines if the suction cup's attachment and arm's grasp of object are successful
  - Continually retries attaching the suction cup until the pressure is high and grasping object by oscillating arms until successfully touched

- Seamless integration between control brain and arm brain
  - All its servos intelligently respond to pressure, distance and touch data and the actions of other servos

Please see our website for more info!

Get in contact with us!

Joey Van Tassel

Joseph.VanTassel@cvcsonline.org

Rinoa Oliver

Rinoa.Oliver@cvcsonline.org

Research: Cleaning Algorithm

- Though not a requirement for the control team, a propulsion servo was added on the control brain to simulate the team's engineered cleaning algorithm

- A KTH Royal Institute of Technology study finds that a randomized path of trajectory, wherein a Roomba performs a turn of a random angle after colliding with an object, is the most efficient of the algorithms tested to clean a room.

- The Kwadropus propulsion arm thus propels forward after cleaning an object at a randomized angle until the proximity to an object is less than 30 mm

The Team

Rinoa Oliver
Coder

Joey Van Tassel
3D Modeler

Works cited:

Edwards, T., & Sörme, J. (2018, June 6). *A comparison of path planning algorithms for robotic ... - diva portal*. KTH Publication Database. https://kth.diva-portal.org/smash/get/diva2:1214422/FULLTEXT01.pdf

OCTO CONTROL presents:

Kwadropus

About the Kwadropus

- Automatically dusts in a zero-gravity environment

- Senses objects in its proximity to grasp onto

- Propulsion arm propels Kwadropus, three grabber arms attach to object with suction cups attached to servos, duster arm dusts object

- Sensors send distance, pressure and touch data from arm brain (Arduino) to central brain (Raspberry Pi)