UF Herbert Wertheim College of Engineering
UNIVERSITY of FLORIDA

Group 451M

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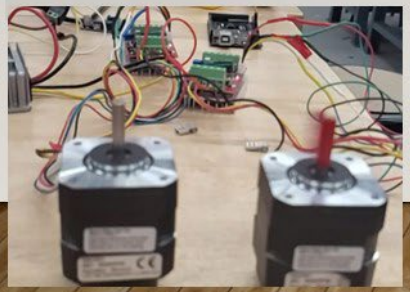
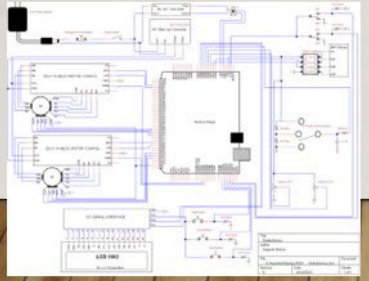
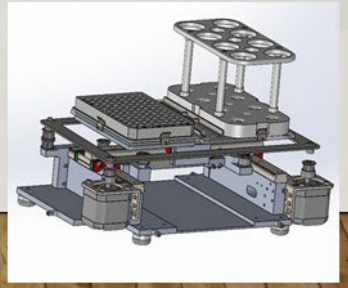
Brief Overview

- Introduction
  - Hedgehog Concept
  - Who we are and what we did
- Design Overview
  - Full View & CAD Model
  - Key features of the model
- Testing Outcomes
- Modified changes
- Cost Summary
- Future of ShakeGenius

ShokeGenius







Our Principals (Hedgehog Concept)

"Shaking your expectations beyond the norms of standard laboratory equipment."

Economic Probability:

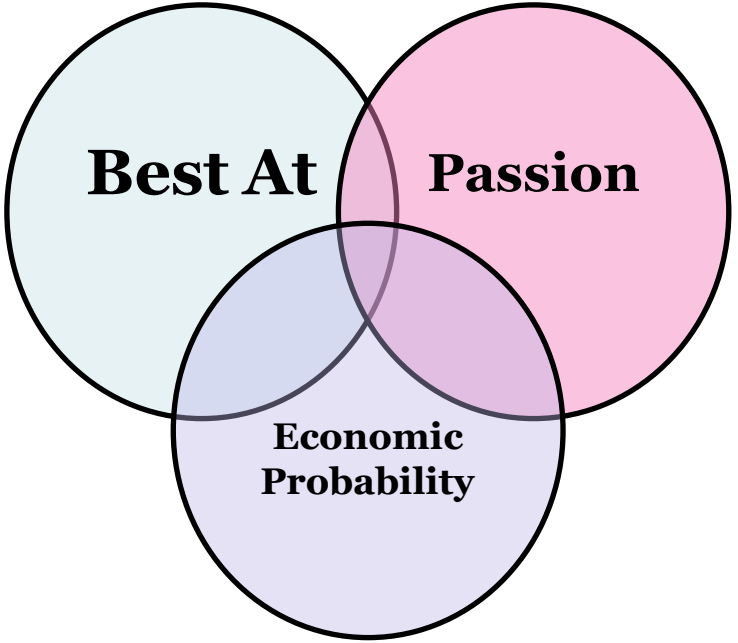
Maintaining a low cost, whilst using high-quality materials and production expectations.

What We're Passionate About:

Creating ease-of-use models for any operator.

What We're Best At:

The use of feasible and operable parts to meet our consumers' everyday needs.



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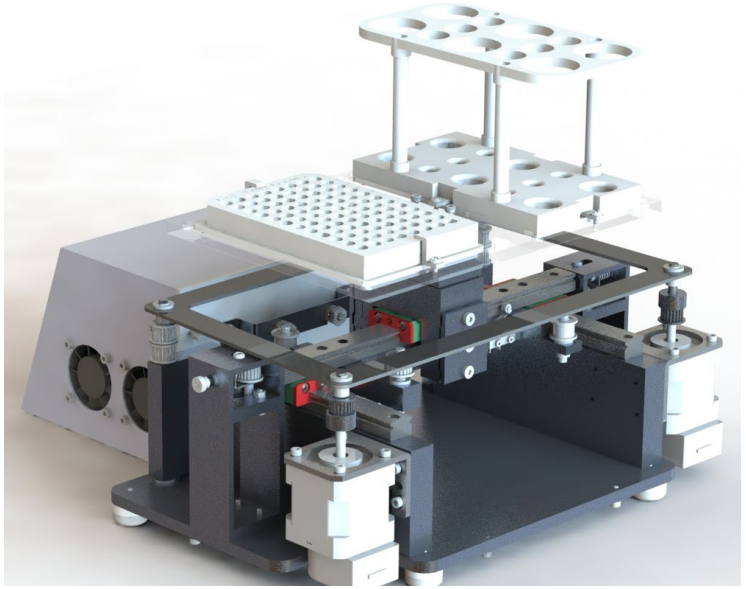
Design Overview

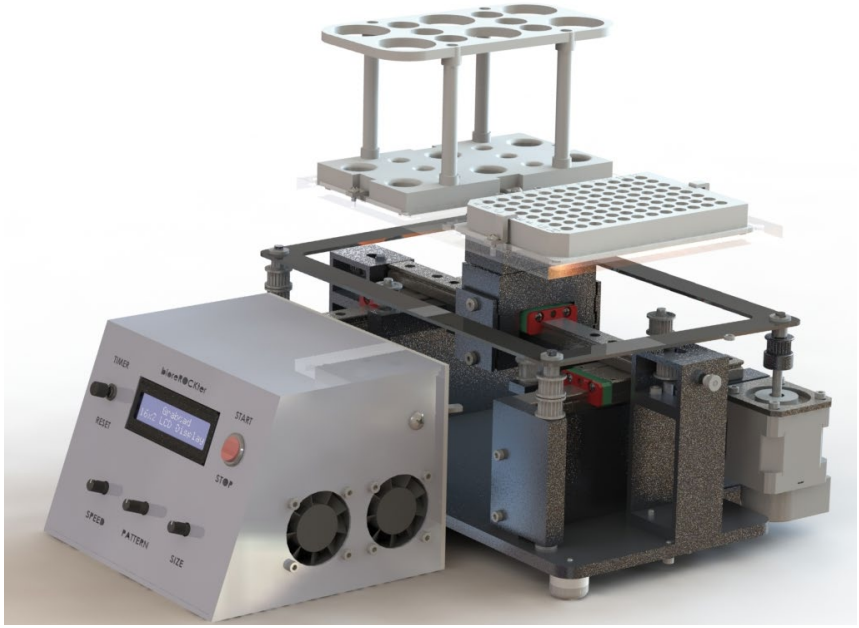
Design Overview

ShakeGenius is a cutting-edge shaker table meant to cater to every need. Featuring:

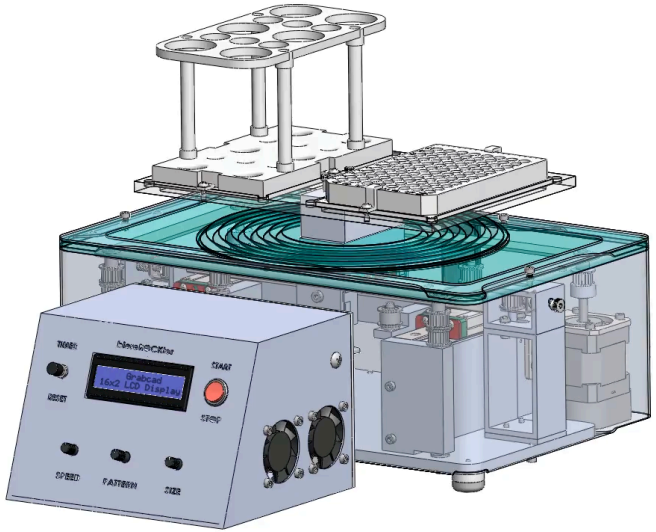
- A Core XY movement system
- Unique Waterproof enclosure
- User friendly interface for ease of operation

Our Design





Our Design



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Operational Features

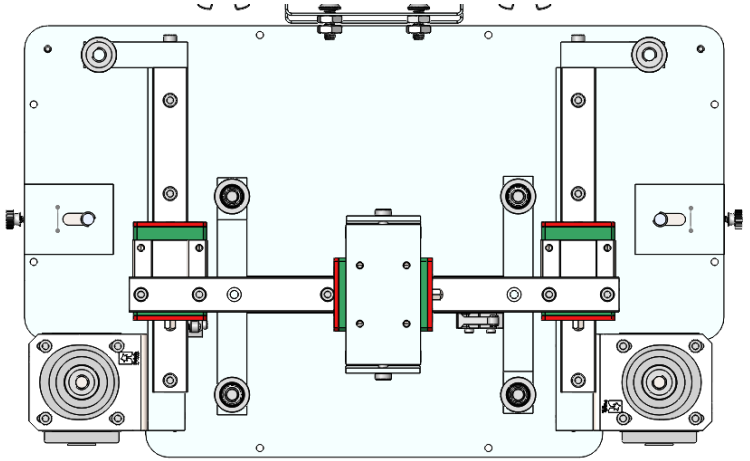
The Core X-Y System

A standard movement technique for 3D printing

Details

- The heavy motors are not being moved, causing less vibration
- Code uses limit switches at -y and +x boundaries to center itself before running
- Code separates unit circle into segments of equal radians
- Unit circle is scaled by user's specified orbital diameter
- Time of travel for each segment is calculated using user's specified orbital RPM

Schematic



Core X-Y System

Encoder system

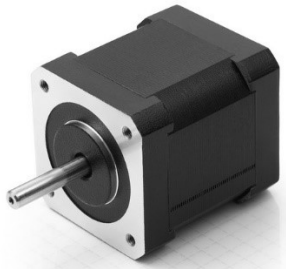
- Encoders used to find carriage's current position
- Encoder reads a 1000 clicks per rotation, gives carriage positioning accuracy within $\pm$ 0.047 $mm \pm$ 0.047 mm
- 

Motors

Nanotec Brushless DC Motors DB42S01

Details

- 48V rated voltage, 31W rated power, 0.88A rated current
- 21.2 oz-in peak torque (7.1 in-oz rated torque)
- 6000 rpm



Motors

Pros & Cons of Selected Motors

Pros

- Lightweight (0.5 lbs)
- Compact (1.7 x 1.7 x 1.6 in)
- NEMA 17 Compatible
- Temp. Resistant (130C Insulation)
- Compatible encoders sold bundled from Nanotec

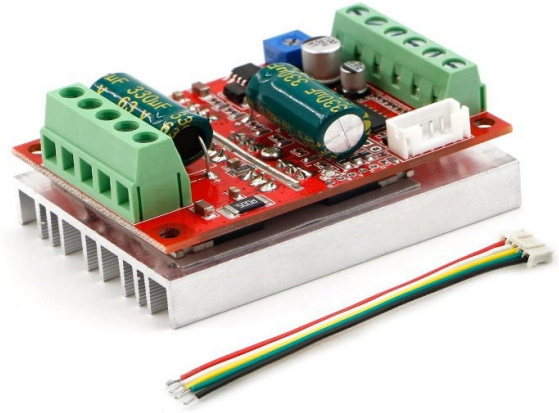
Cons

- Needed an entirely new control system
- New code (3-phase brushless vs previous stepper motors)
- New motor controllers
- New power delivery system (48V)
- No water-resistance rating was provided by the manufacturer
- Encoders needed without the easy precision of steppers

Motors

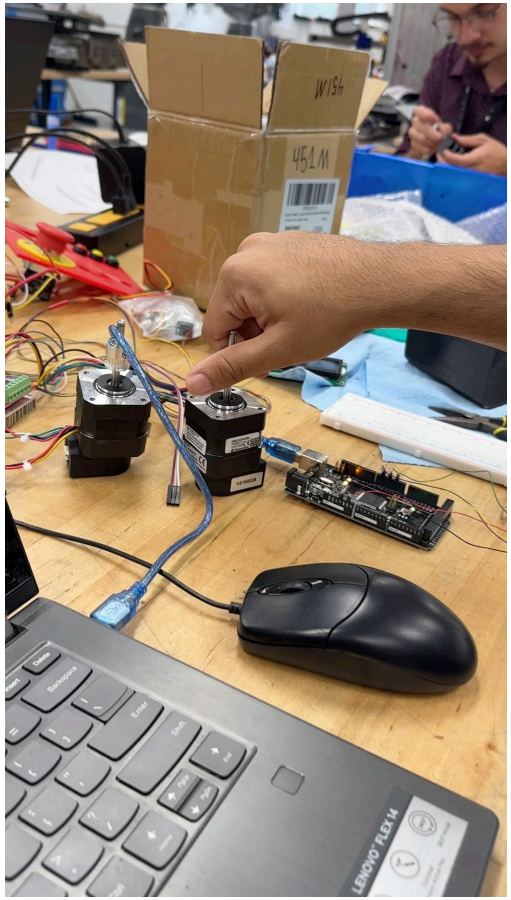
Motor Controls

Controller



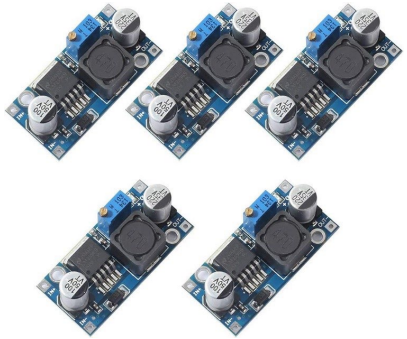
Details

- The motor controllers used are the ZS-X11H brushless dc motor with hall sensor controllers. They include directional control, pwm signal control, break control, and are rated for a maximum of 60V making them perfect for our 48V motors. The integrated heat sink also allows for passive cooling during long times of operation.


LENOVO FLEX M

Power System

- The entire system is powered by a standard 24 V 5 Amp power supply
  - Stepped up to 48 V 5 A to power the motors via a boost converter, ensuring motors run at desired speeds and torques.
  - Stepped down to 12 volts via a buck converter to power the Arduino and UI electronics.



Power System

- The boost converter used had an efficiency of 96% and stable output to DC 48V 5A 240W output.
- It also advertises built in over-current protection, over-voltage protection, over-temperature shutdown, short circuit protection, output reverse polarity protection, and is IP68 waterproof (even though UI doesn't get wet).

User Interface

An easy-to-use model with simple buttons and visible screen

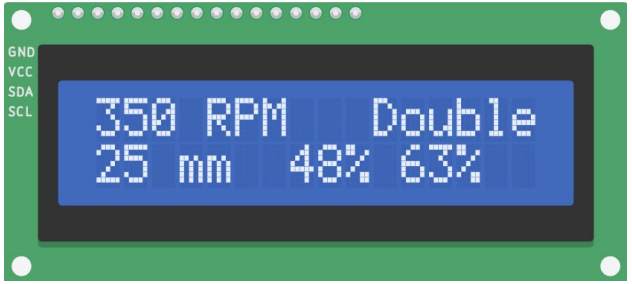
Details

- Features power on/off, start, pause, stop, emergency stop, 3 potentiometers: speed, rpm, orbital pattern, and LCD screen
- Allows user to set shake time and initial speed, rpm, orbital pattern before shaking
- Speed, rpm, and orbital pattern can be freely changed while running
- User can switch between 'normal' view mode and OD/FI mode, which replaces elapsed time with OD/FI percentages

Video Sample

User Interface

Sample Screens

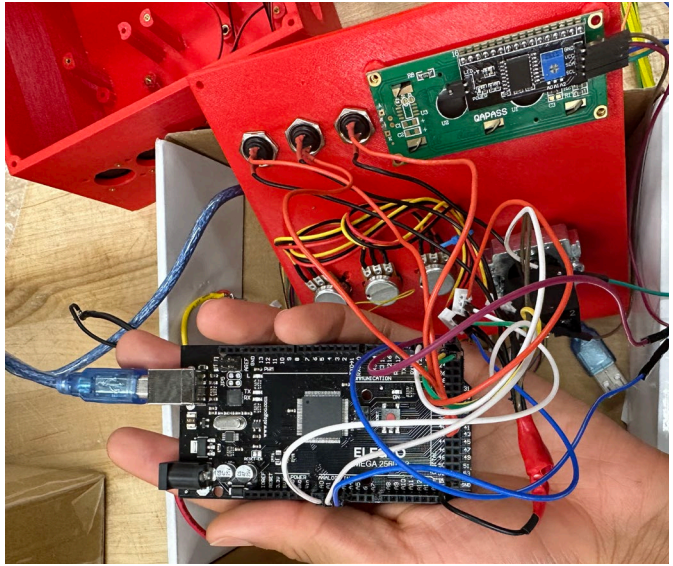


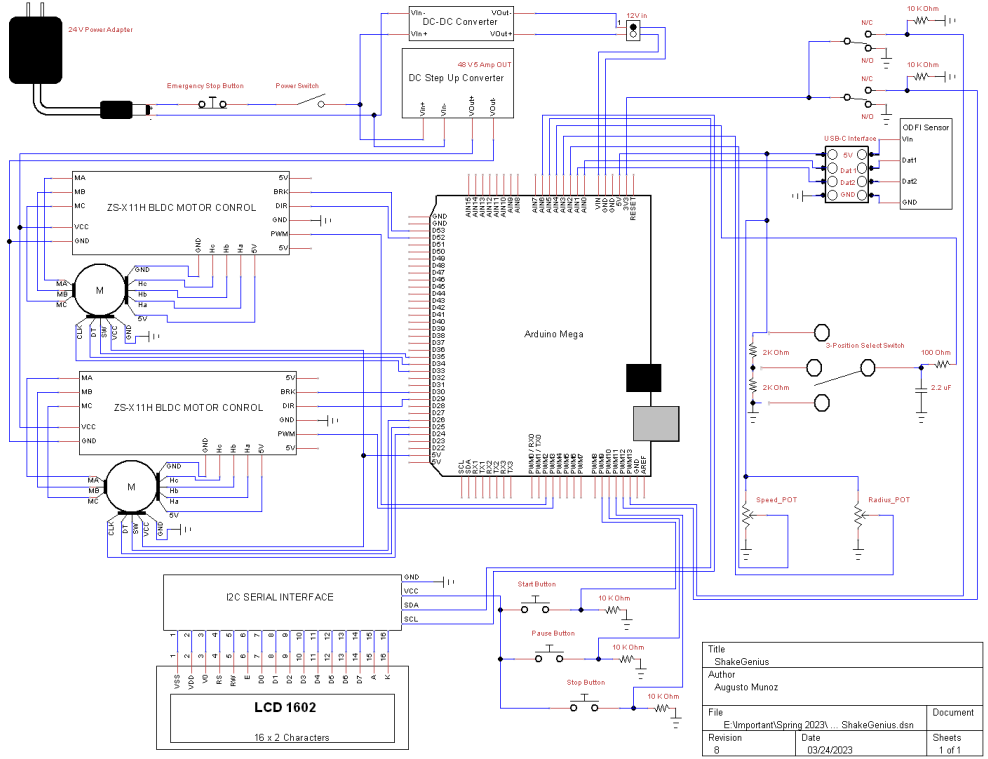
Controls of the System

"The Brains"

- An Arduino mega controls the shaker table, which produces the necessary pwm signals for the motors.
- Checks and changes the status of the shaker by taking the button, potentiometer, and sensor data.
- Used to power all low current 5-volt electronics (tmp36 sensor, 5v relay, LCD screen, rotary encoders).

Electrical Schematic



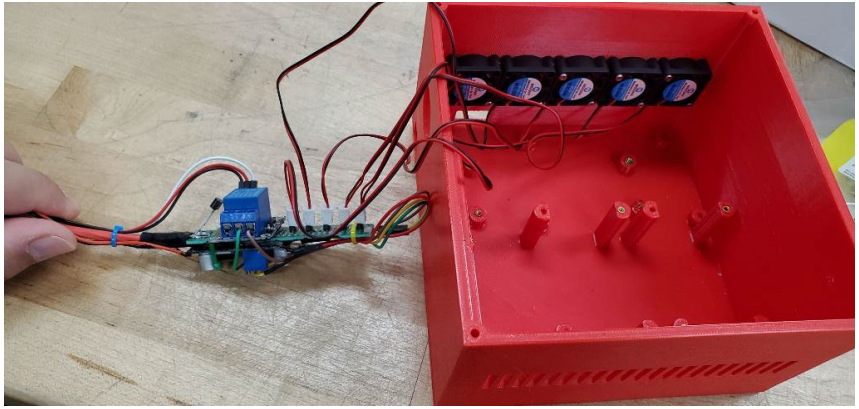


Additional Features

Cooling system & Safety

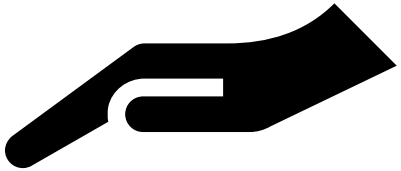
Cooling

- The cooling system is composed of five hydraulic bearing brushless 25 mm cooling fans rated for 5v.
- Fans are enabled when the temperature rises above 60 C due to buck converters' max temperature of 85C



Additional Features

Cooling system & Safety



Safety

- The UI has a rubber waterproof umbilical cord that connects with the shaker table ensuring no electronics get wet from the shaker moving.
- All components are fastened to the UI in order to reduce damage to electrical components when the UI is dropped or shaken.

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What Sets the ShakeGenius Apart

Waterproofing

Silicon Covering

Details

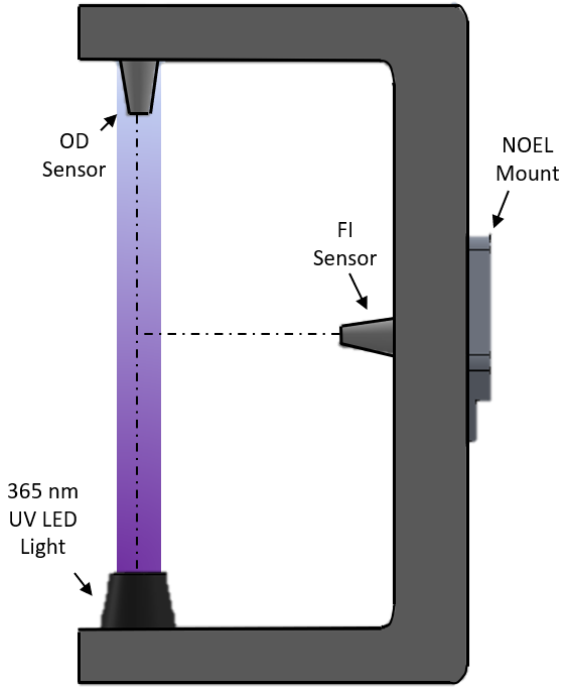
- Used self-degassing 2-part silicone as the material.
- Accordion-like geometry to seal the enclosure without sacrificing table speed/Motor torque

Troubles in Creation

- Total of 5 attempts until a successful attempt
- Reoccurring issues: air bubbles and uneven thickness
- Solved by: Decreasing fill time, additional air evac, leveling, and multistage filling.

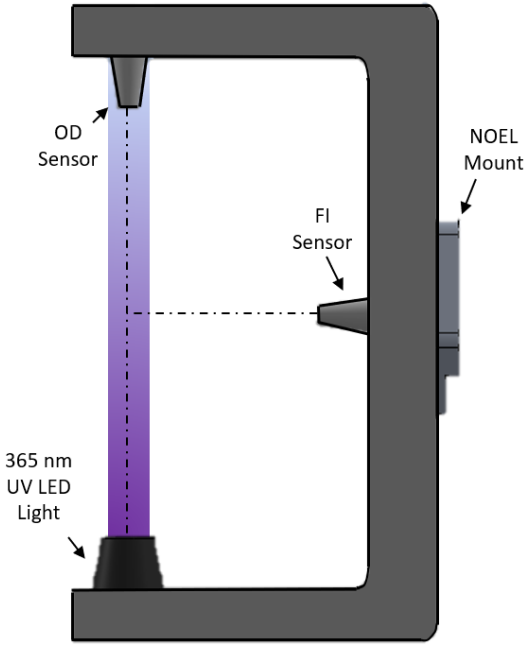
OD/FI System

- Uses the top assembly of a 365 nm UV flashlight.
- The UV light requires 1.5V to operate, so the sensor has a buck converter inside it to drop the 5v of the Arduino to 1.5 V.
- The body of the UV light is made of aluminum which acts as a heat sink to keep the led cool under extended operation.
- The sensor interfaces with the shaker table via a USB cable that connects the NOEL mount to a USB hub in the UI box.
- The cable is composed of one 5V wire, one ground wire, and 2 data wires.
- One wire for OD and one for FI.

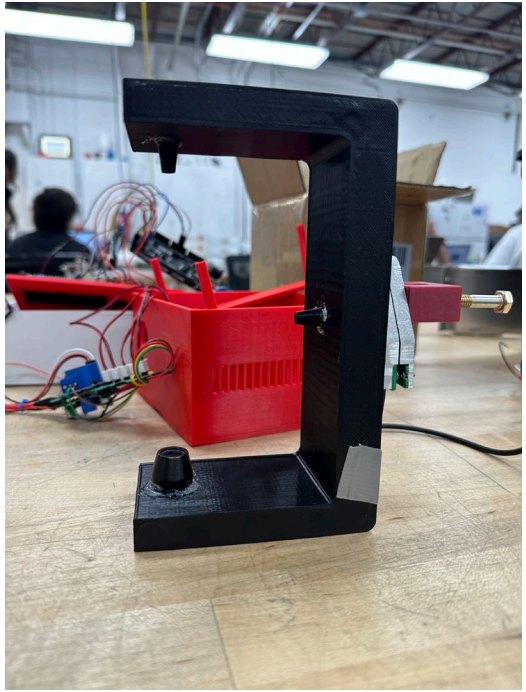


OD/FI System

- Both the OD and FI values are measured from a PDV-P8104 photoresistor.
  - Optical density is based on how much light is read by the OD sensor.
  - Fluorescent intensity is based on how much light is read by the FI sensor.
- Sensor housing is made of PETG for heat and water resistance.
- The OD/FI values are read, averaged, and mapped into a scale from 0 to 100.
- The housing has an easily accessible inside via a lid kept on by m3 screws and heat inserts.



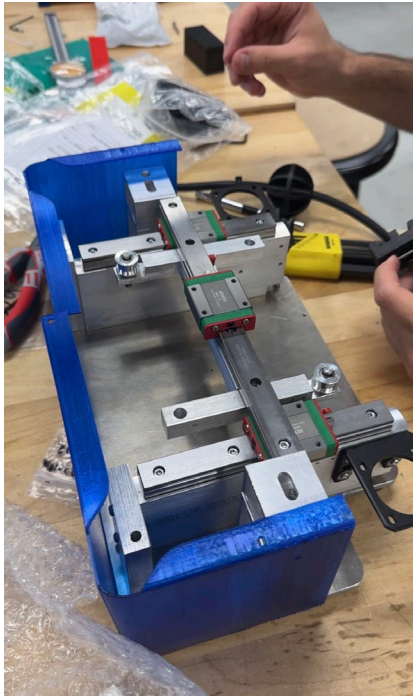
In Person OD/FI system



Mechanical Design Aspects

Adding Structural Rigidity

- Reduce # of 3D-printed and plastic structural parts
- Use Stainless Steel for thin parts, pins, rods
- Ensure aluminum parts are structurally sound enough for prolonged use



Mechanical Design Aspects

Medical Grade Equipment

- Stainless steel vs. other steels
- 6061-T6 Aluminum Alloy
- Silicon rubber vs other rubbers

Design Changes

Ease of Manufacturing

- Many parts were modified after Milestone 1 to improve the manufacturing of certain designs
- Nominal stock sizes used