Introduction

- Teleoperated grasping system for manipulating objects in a lab setting
- Addresses:
  - Contamination
  - Health hazards
  - Flammable & explosives
- Imitates hand motion
  - XYZ and wrist rotation along one axis
- Gripper for imitating human hand grasp

Use Case Requirements

| Category	Status
● Imitate operator hand movement	Achieved
● Grip objects, move them, and place them back down	Achieved
● Be able to grip soft and hard objects (300g weight)	Achieved for hard objects, In progress for soft objects
● Pour liquid from one glass to another	In progress

Design Requirements

Category	Requirement	Status
Movement precision	2mm	Achieved
X/Y axis speed	100mm/s	Achieved
Gripping force	6N	Achieved
Z axis speed	10mm/s	In progress
Force output repeatability	+- 5% for constant input	In progress
Latency	100ms	In progress

Solution Approach & Updates: Gripper

- Original: use torsional springs attached to the gripper motor to control gripping force
- New approach:
  - attach foam blocks to the gripper surface
  - Detect contact with object using limit switch
  - Control force by squeezing the gripper further after initially making contact
  - Measure relationship between force & gripper position using a scale to establish commanded force → gripper movement function parameters
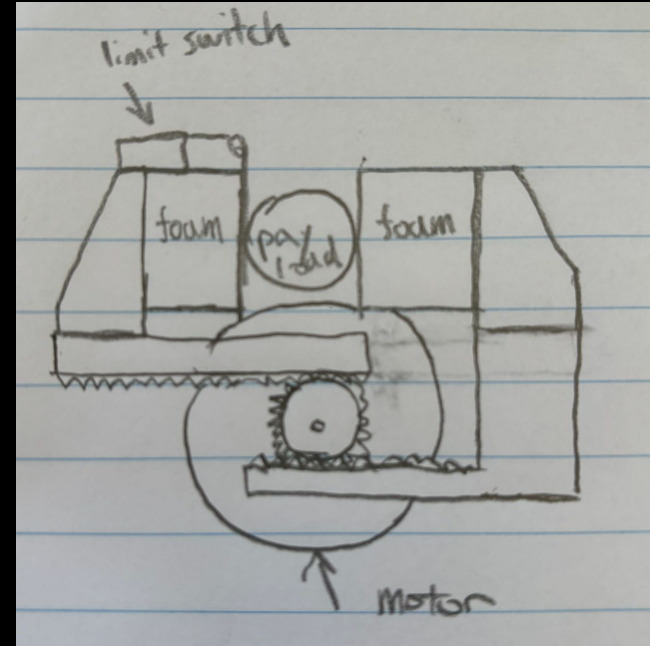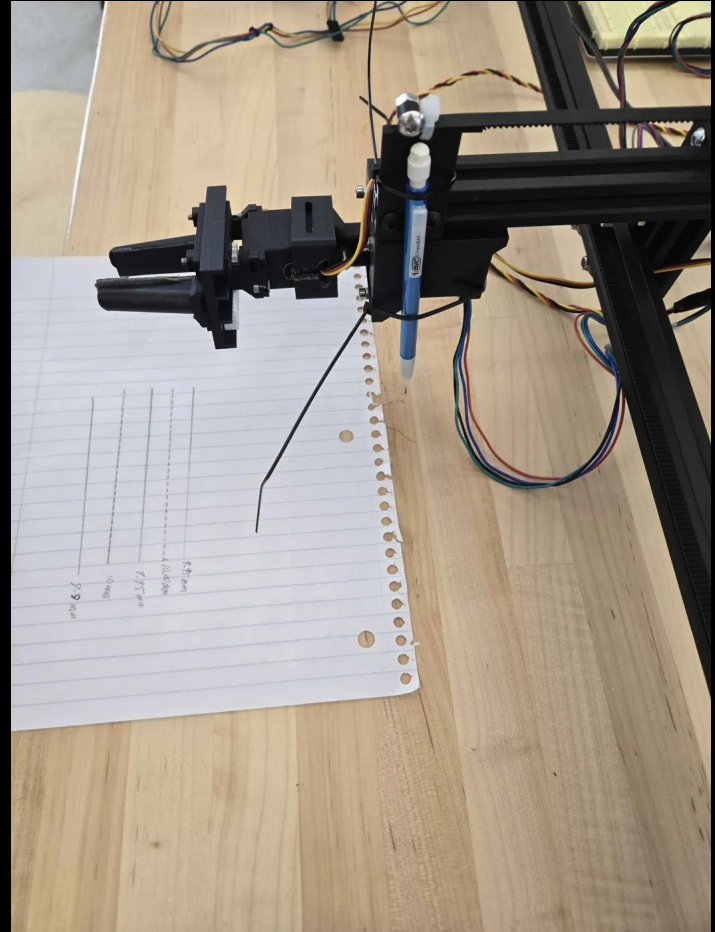
Solution Approach & Updates: Handheld Controller
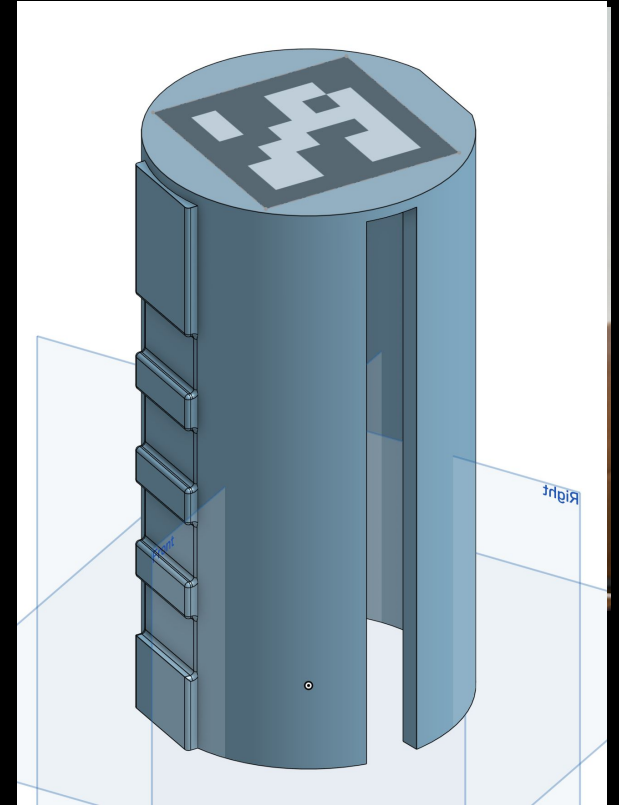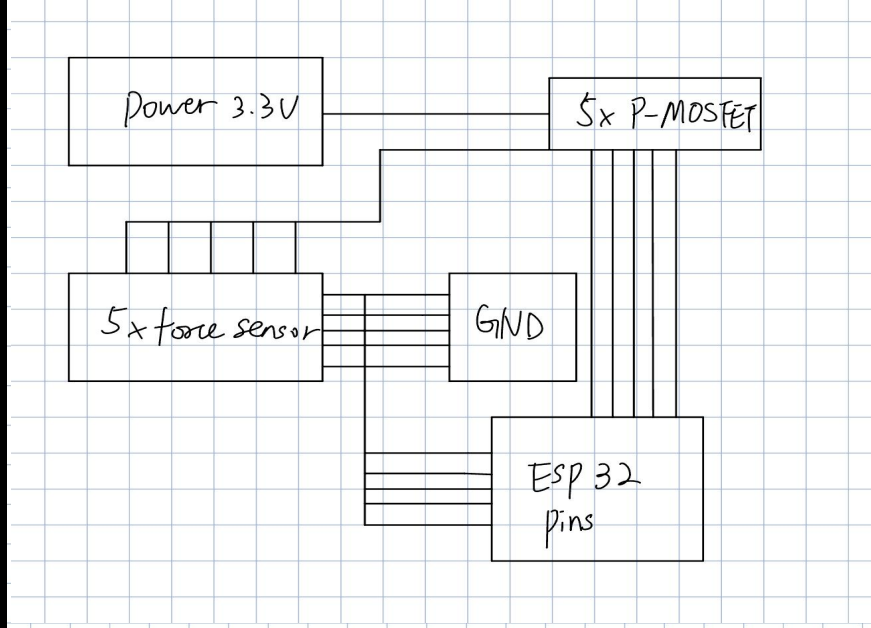
Verification: Movement Precision

- Fix pen to gantry

- Command 50mm linear movements using a test script

- Measure actual distance

- → +- 1mm precision achieved

Verification: Movement Speed

- Video + stopwatch
- Achieved design requirement of 100mm/s speed after tuning motor control software
- However, the high speed made the gantry more difficult to control
  - so we turned speed down to ~30mm/s
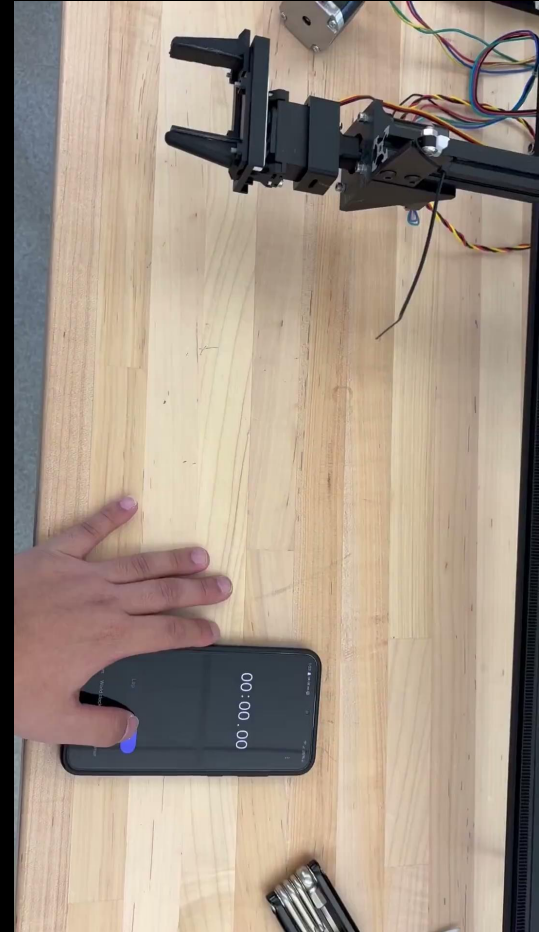
Verification: Grip Force

- Measured via grasping a kitchen scale with the gripper
- Achieved ~9N, exceeding design requirement of 6N

Verification: Latency

- ~300ms system wide
- Almost all of the delay caused by camera stream
  - YUV2 video codec requires buffering multiple frames
- Next step: switch to MJPEG codec, which compresses frames individually
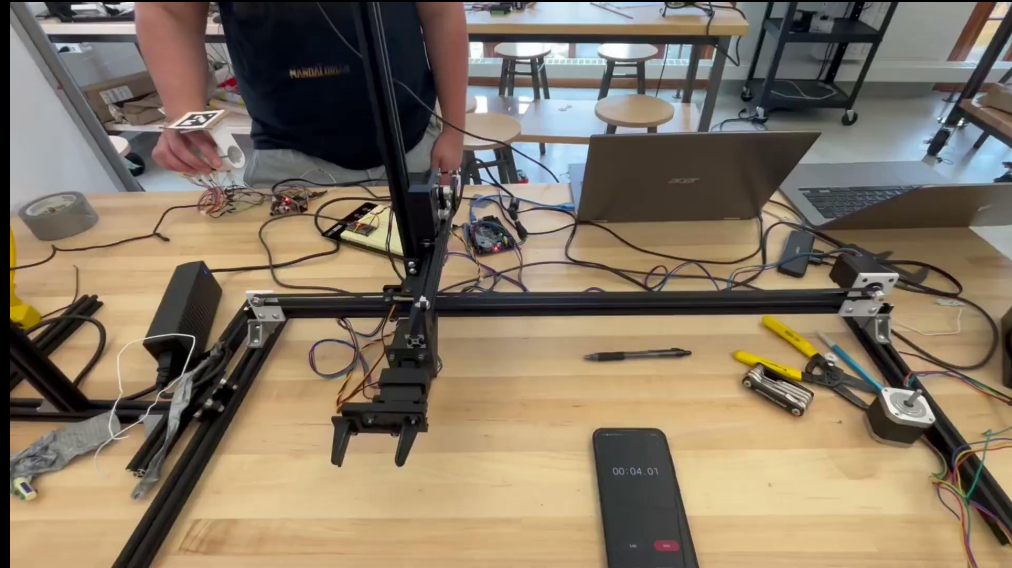
Validation: Pick Up & Drop Objects

- Able to grasp a motor weighing 350g → exceeds requirement
- We did not have glassware to test with, but the motor had a metal finish with similar friction
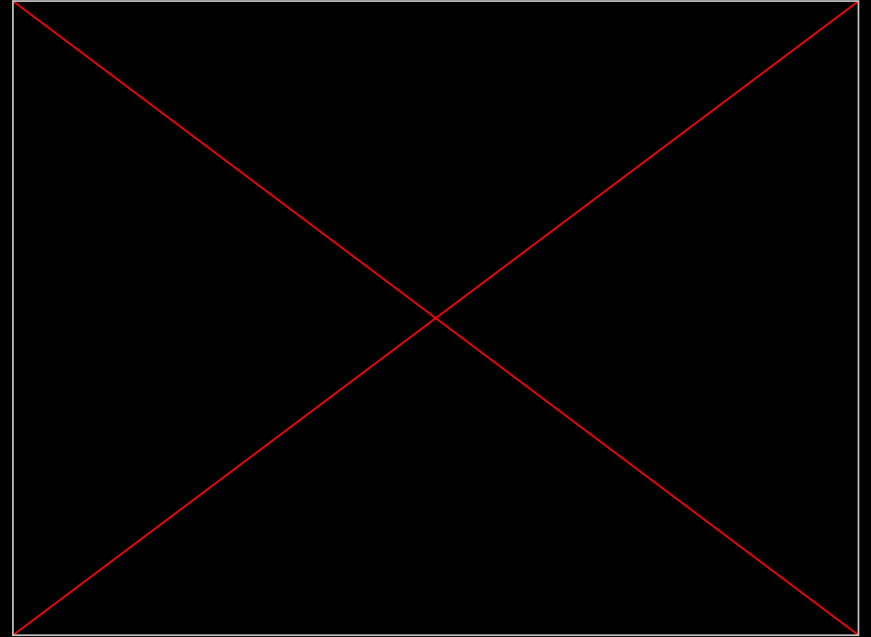
Plan for Final Demo

- Z-axis
  - Assemble Z-axis to gantry
- Controller
  - Rehouse electronics in the new case
- Gripper
  - Add foam block & limit switch
  - Create force lookup table
  - Implement new control software
- Camera
  - Reconfigure streaming codec to reduce latency

Project Management

Legend		
Final Presentations		
Public Demo		
Final Report		
Monday, start of new week		
Task in Progress		

TASK TITLE			Monday, 12/2							Monday, 12/9							Monday, 12/16			
	Sat	Sun	M	T	W	T	F	Sat	Sun	M	T	W	T	F	Sat	Sun	M	T	W	T	F
Jack's Tasks																					
Gantry Z-axis Assembly																					
New Gripper Assembly																					
Leland's Tasks																					
Z-axis Software Integration																					
Update Gripper Control Software																					
Create Force Lookup Table																					
Cary's Tasks																					
Replace Remote Case																					