

Enhancing Transformable Drone Through Redesigned Self-Locking Joint

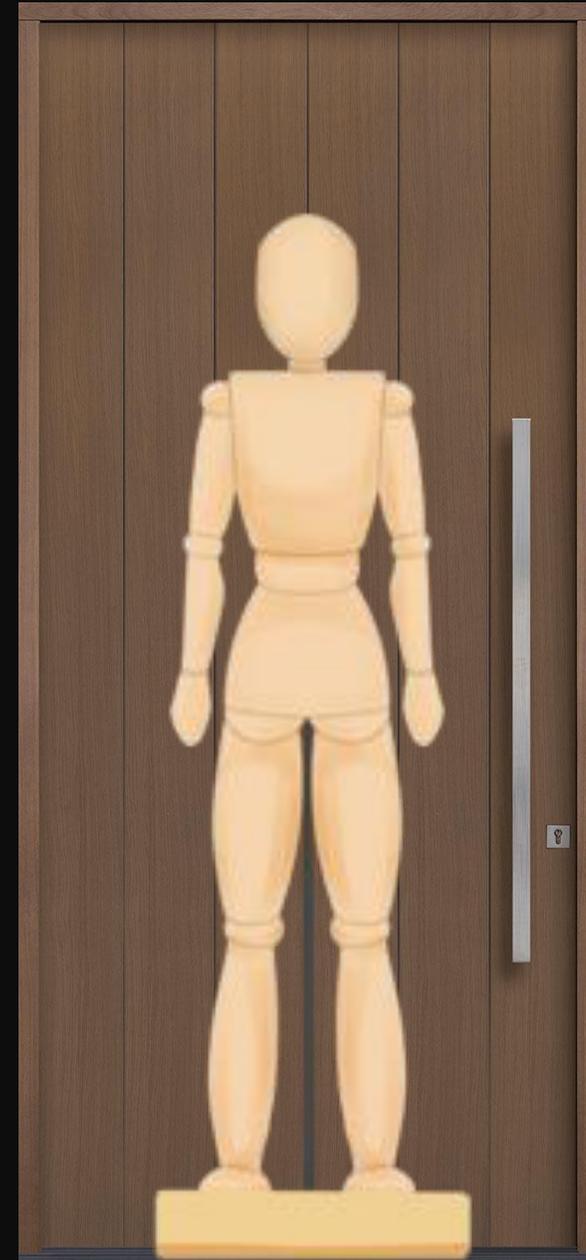
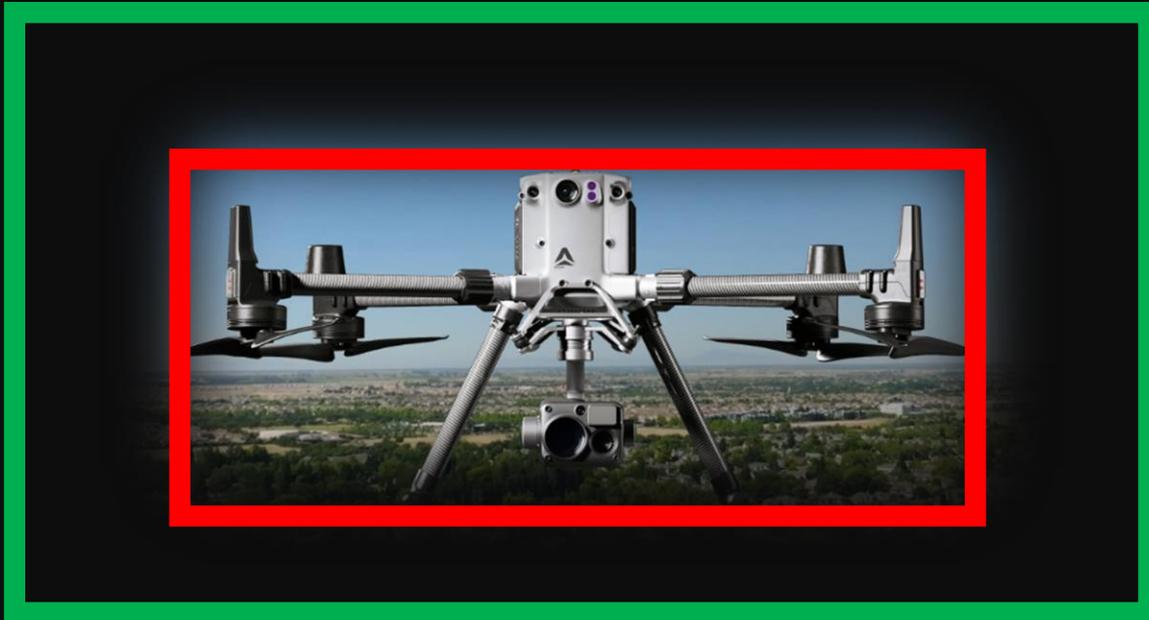
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Problem Statement

The effectiveness of search and rescue operations are affected by the inability to enter hazardous zones or unstable structures due to conventional designs of drones without transformability limited its adaptability to different surroundings.

“The endurance of a single UAV agent is highly limited at present.”
(Lyu et al., 2023)

Clearance Requirement

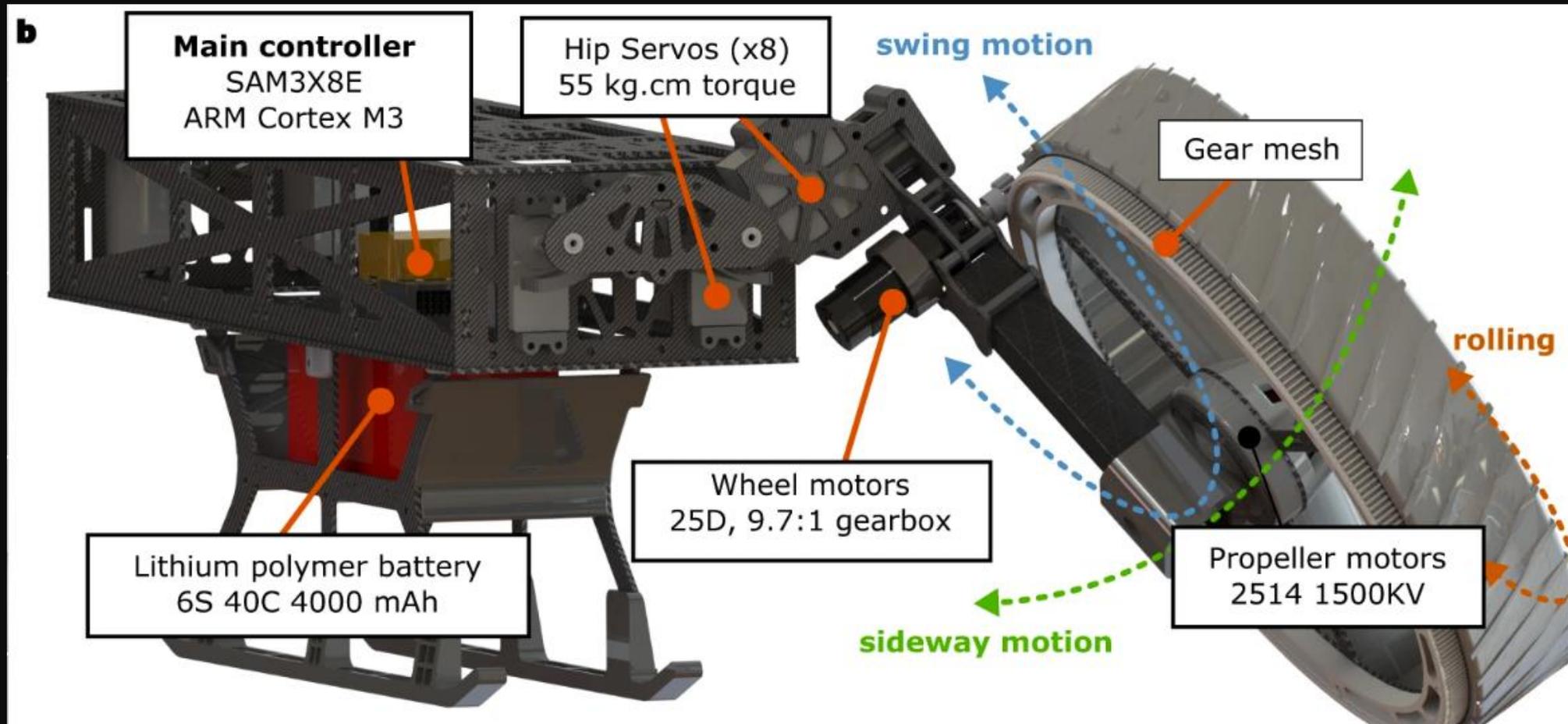




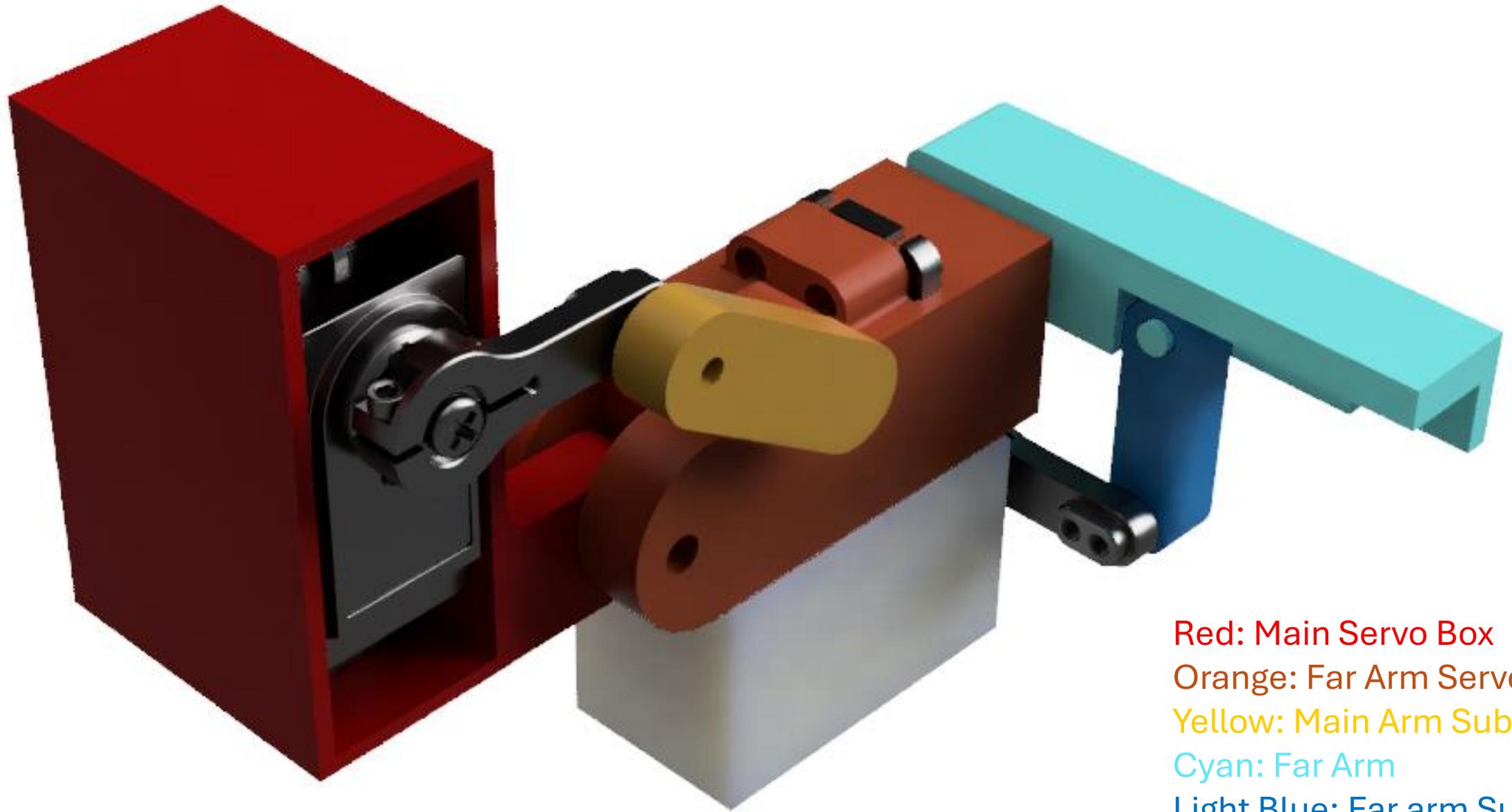
Multi-Modal Mobility Morphobot

Engineering Goal

Improve M4's joint design through Self-locked Multi-link System



M4 Joint Design



Redesigned Joint System

Red: Main Servo Box
Orange: Far Arm Servo Box
Yellow: Main Arm Sub-joint
Cyan: Far Arm
Light Blue: Far arm Sub-joint
White: Far Arm Servo Cover

Testing

Transformability Test

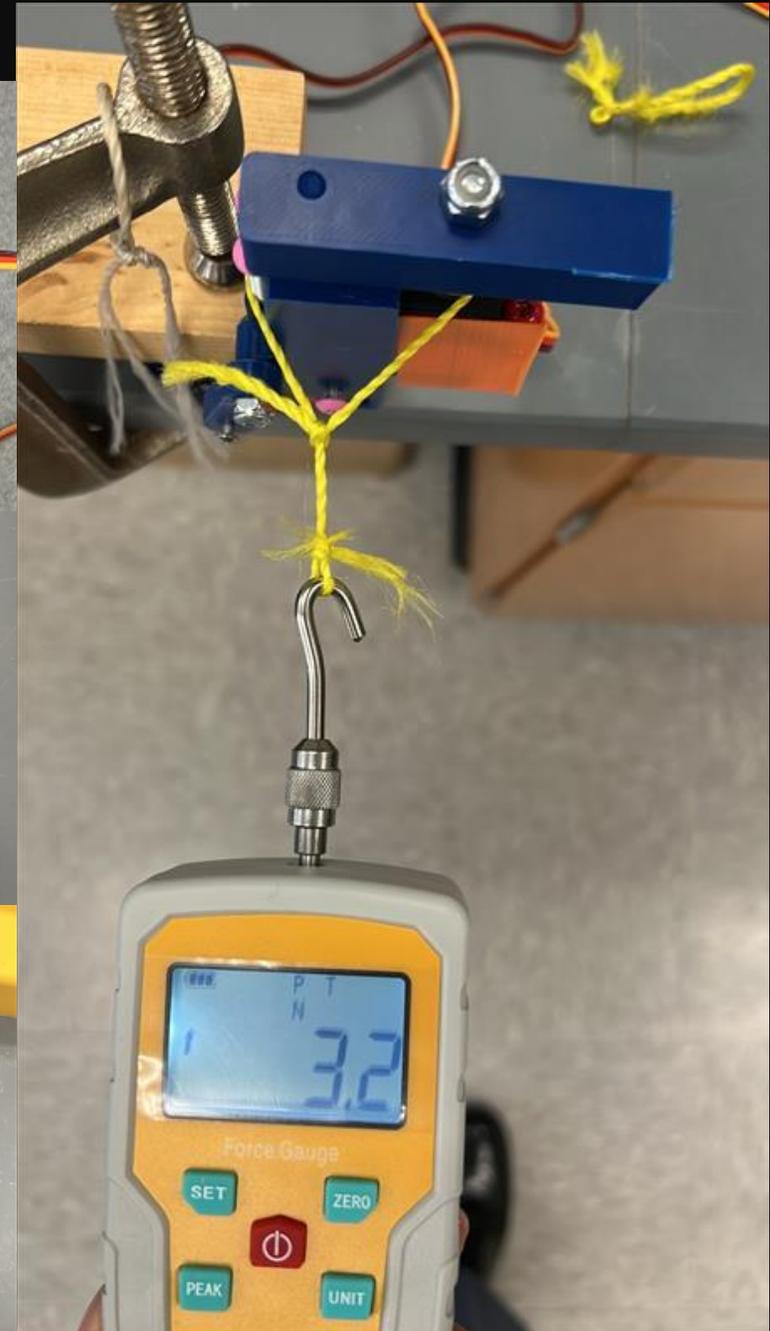
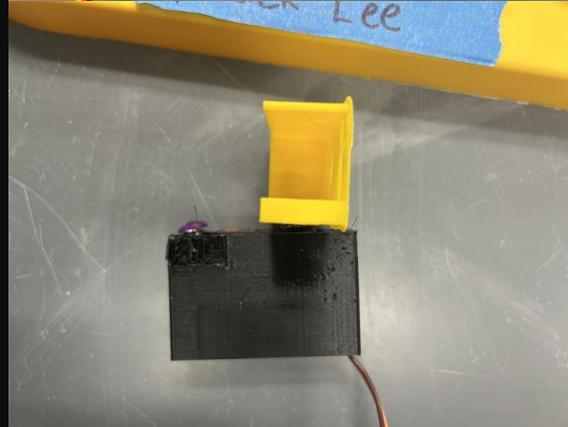
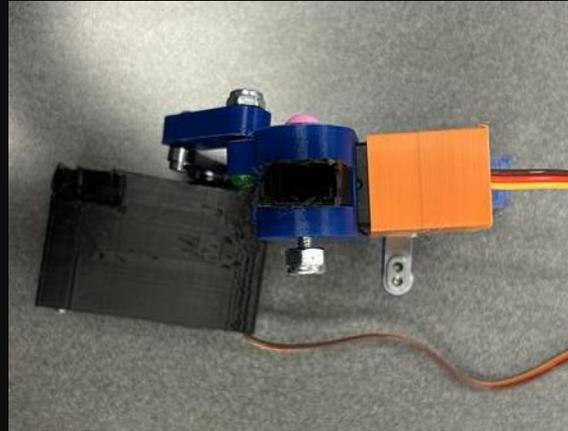
- Ensure device functionality
- Check joint obstructions

Strength & Stability Test

- Ensure device durability
- Check structure flaws

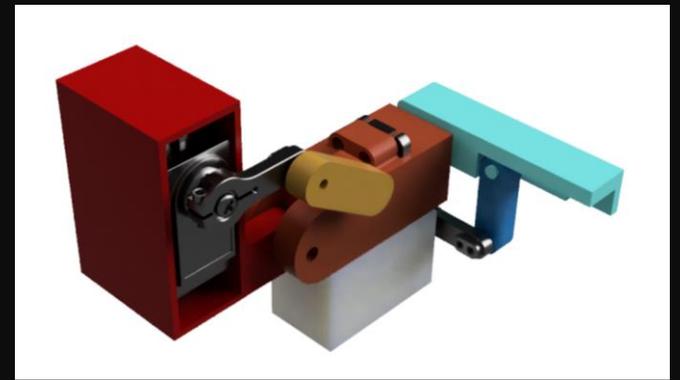
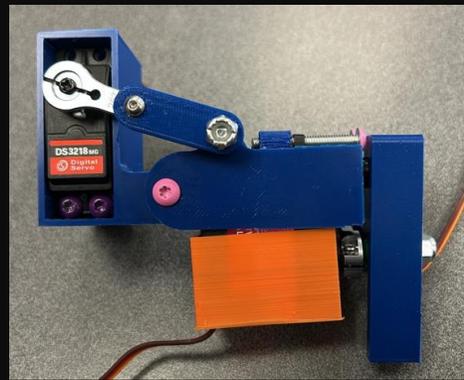
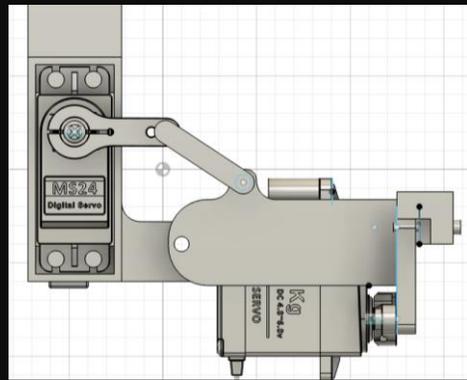
Instantaneous Force test

- Ensure device adaptability
- Check force resistance



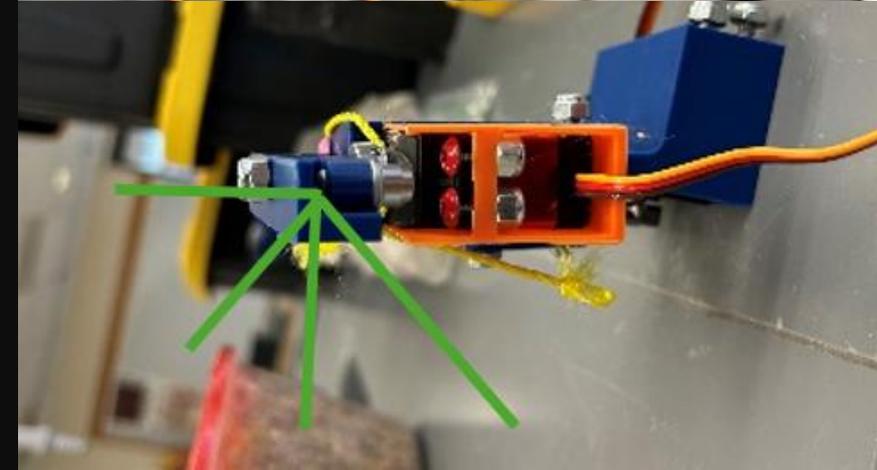
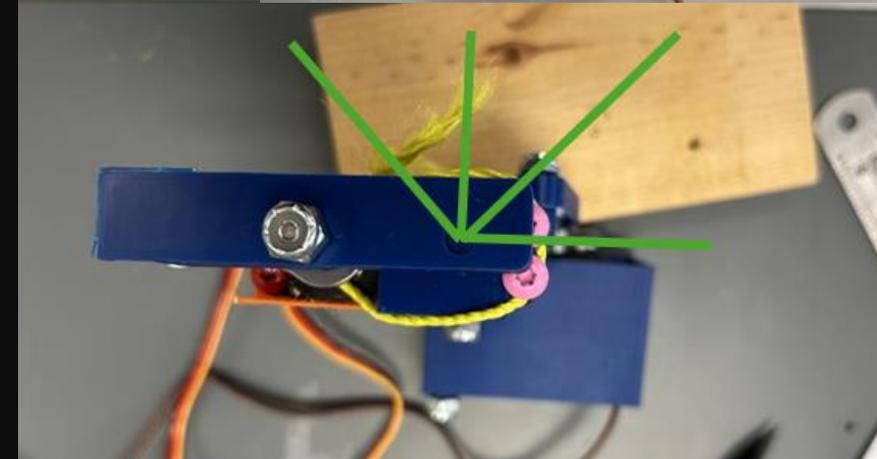
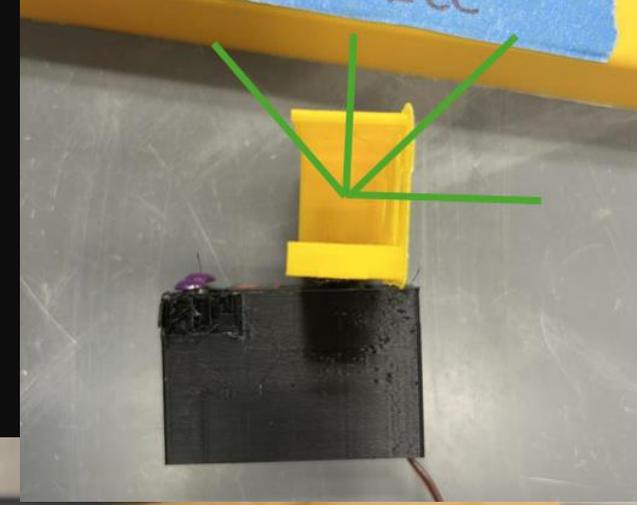
Transformability Test

Iteration	Main Arm Transformability	Far Arm Transformability	Joint Strength(Main/Far)	Self-Lock Capability(Main/Far)
1.0	Not Transformable	Not fully Transformable	Strong/Weak	Locked/Unlocked
2.0	Not Transformable	Not fully Transformable	Strong/Weak	Locked/Unlocked
3.0	Not fully transformable	Transformable	Weak/Weak	Locked/Locked
4.0	Not fully transformable	Transformable	Strong/Weak	Locked/Locked
4.1	Transformable	Transformable	Strong/Strong	Locked/Locked



Strength & Stability Test

Angles (degrees)	Far Arm Max Force (N)	Main Arm Max Force (N)	Control Group Max Force (N)
0	75	140	9
45	69.8	138.1	36.8
90	74.6	90	41.9
135	56.4	92.8	38



Instantaneous Force Test

Angles (degrees)	Device Max Force (N)	Control Group Max Force (N)
0	45.8	5.4
45	74.5	21.6
90	111.1	9.7
135	67.4	19.7

