DEPARTMENT OF MECHANICAL ENGINEERING

TEAM 29
The Claw

A. JAMES CLARK SCHOOL OF ENGINEERING

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Problem Definition

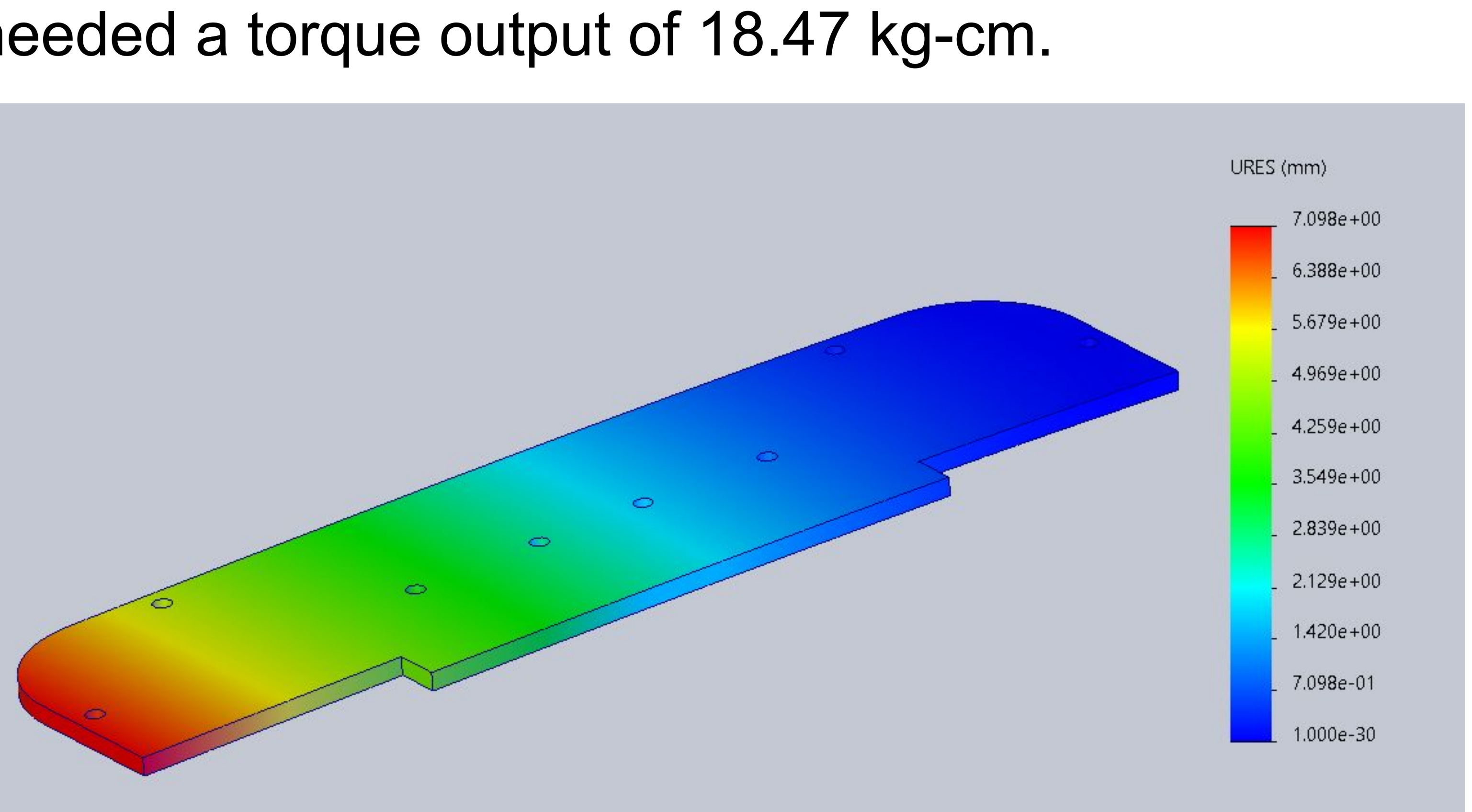
At the onset of our project, a research team expressed a need for an inexpensive underwater manipulator. Currently, underwater manipulators on market are very complex, specified, and expensive leaving a lack of access for university researchers, independent engineers, and hobbyists. Our stakeholders identified the following needs:

1. Completely waterproof and resistant to pressure
2. Less than 3 lbs and Less than 2 feet in length
3. Able to mount onto a BlueROV
4. Has at least 3 Degrees of Freedom
5. Costs less than $500 to develop
6. Ability to pick up oyster-sized objects at the bottom of a tank

Design Calculations & Analysis

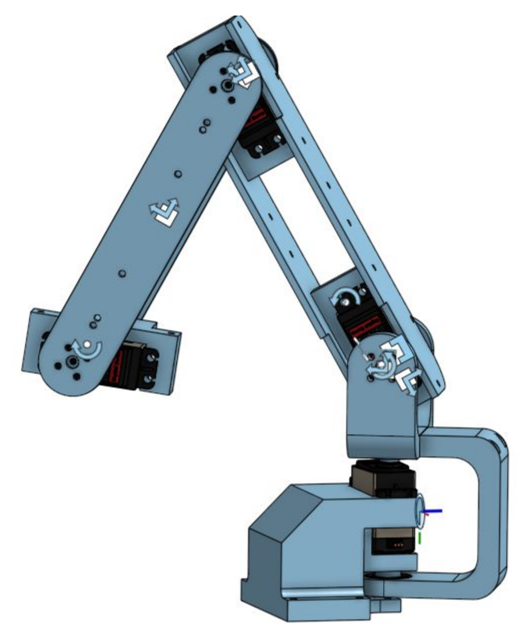
	Limb Length (cm)	Limb Mass (kg)	Joint Mass (kg)	Joint Torque (kg-cm)
Gripper	10	0.12	0.082	1.6
Wrist	2	0.01	0.082	2.368
Elbow	15	0.03	0.082	9.583
houlder	15	0.03	0.082	18.47
Base	0	0.2	0.082	0

he torque calculations, based on rough weight stimations, revealed that the most critical joint eeded a torque output of 18.47 kg-cm.



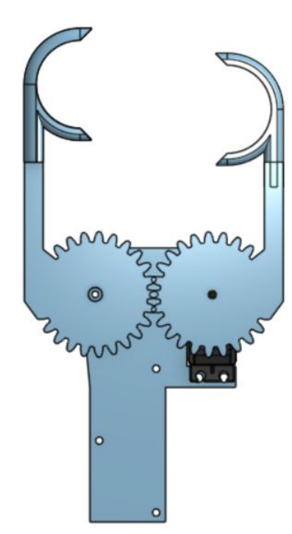
From FEA, the loading conditions on the most critical joint were simulated and resulted in a displacement of 7 m. Additionally, stress failure does not occur either.

Final Design



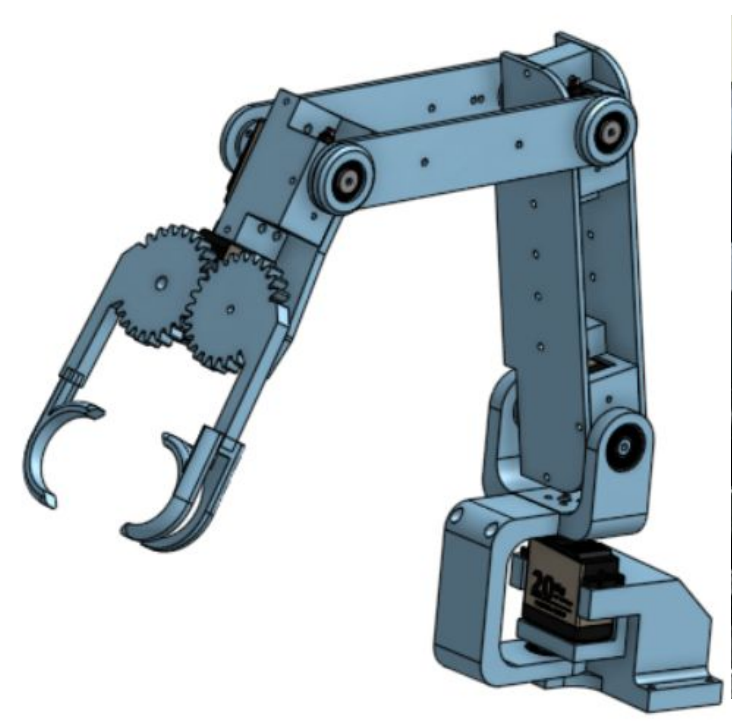
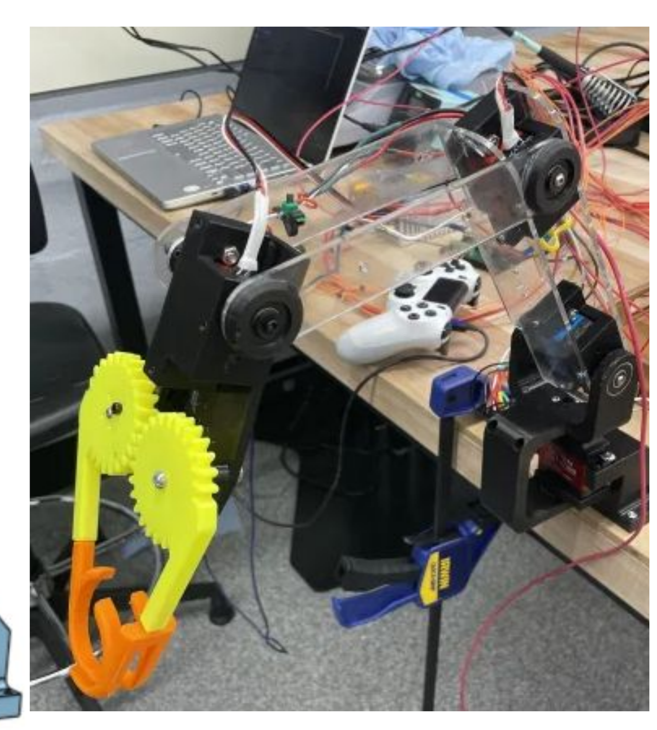

Our arm is constructed with acrylic appendages and servo motors.

- Acrylic is completely waterproof and excellent in rapid prototyping
- Servo Motors have been individually waterproofed with epoxy resin and mineral oil
- The Servo Motor housings are custom 3D prints made from PLA




Our end effector is made of PLA and actuated with a single servo motor.

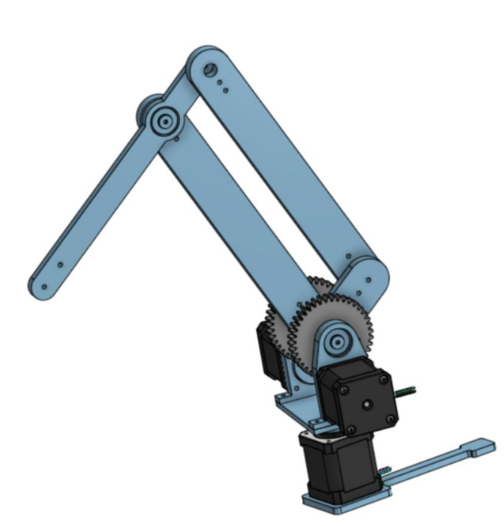
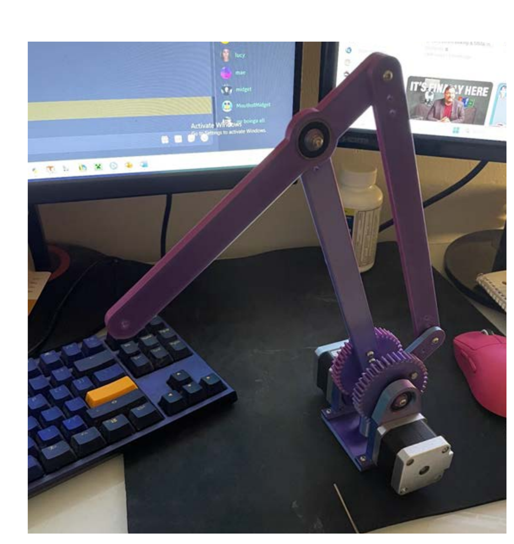
- 3D printing allowed several iterations before deciding on this configuration
- With the use of gears, both limbs can move simultaneously with the motor

The final assembly successfully works with a controller.

- Each joint has variable rotation made possible by a gaming controller
- The “X” button on this controller activates the end effector of the arm

Prototype & Test Results

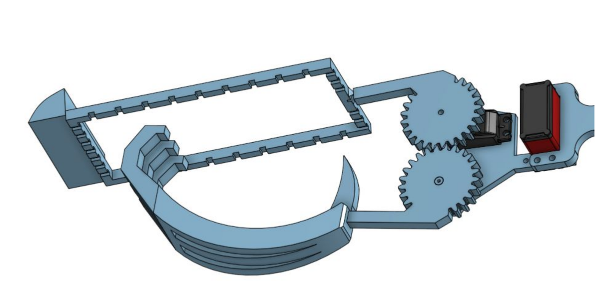
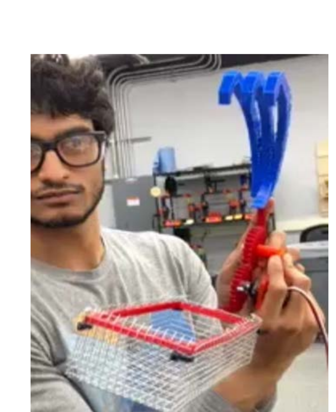



This prototype of the arm was made with only 3 stepper motors.

- Stepper motors could not be individually waterproofed
- The arm could move with 3 degrees of freedom and had a reach of under 2 feet


Ultimately we had to change designs due to a failure in a waterproof test.

- Sealed the electronics with neoprene
- Neoprene is not flexible enough to allow smooth movement and hard to fully seal
- Stepper motors failed after being submerged for 24 hours

An initial prototype of the end effector.

- A claw and net design meant to “sweep” oysters into the net
- Too large and too heavy for our arm
- Still able to actuate with single servo