Background

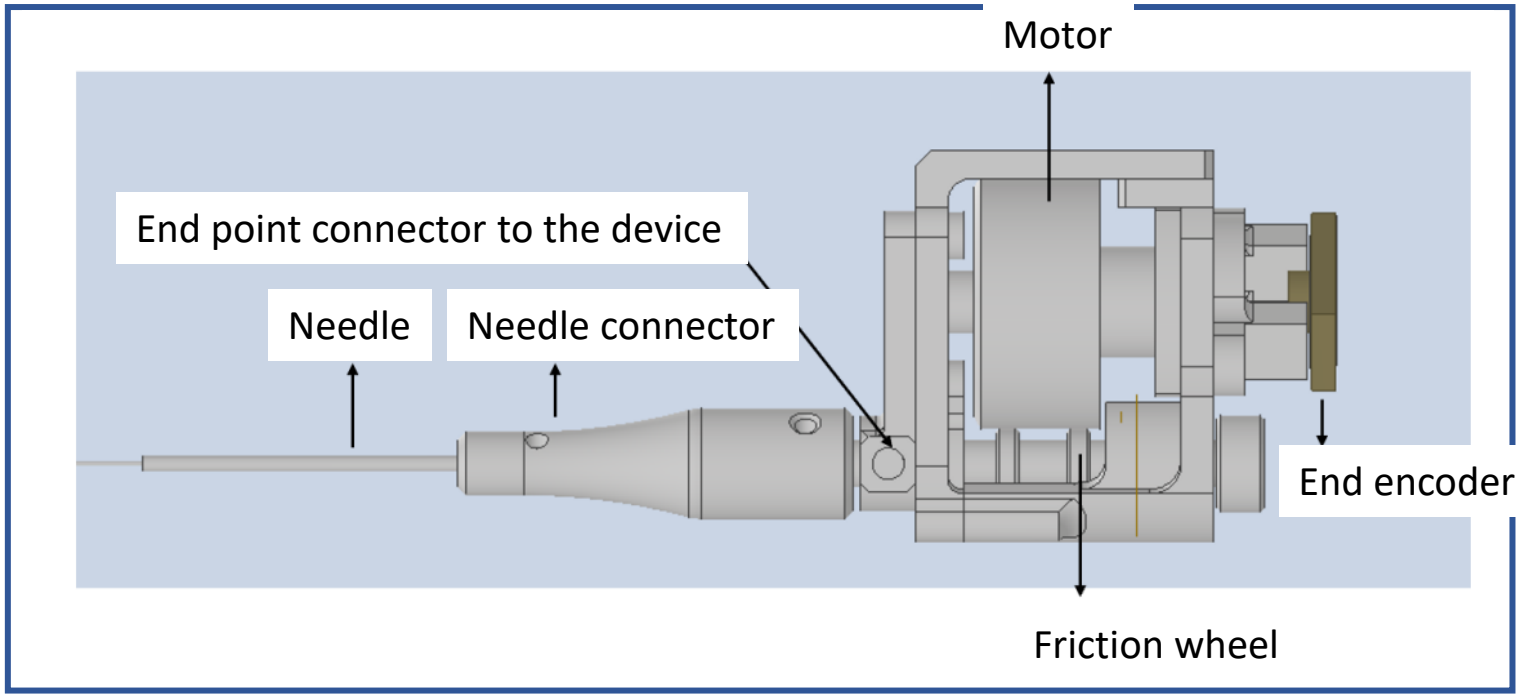
The goal is to design a torque feedback equipment for virtual acupuncture training. The hardware will be installed on a phantom haptic device, adding additional torque feedback and rotational freedom for user.

After the user inserts the endpoint (needle) into the tissue in the virtual environment. The program will calculate the feedback torque according to the depth of insertion, the rotation speed and the characteristics of the virtual tissue, and feed it back to the user to produce an operating experience close to the real environment.

phantom haptic device
Produces 3dof force feedback

Hardware

- Reduce overall weight
- Improve back-drive-ability, that is, it has small transmission damping, moment of inertia and backlash
- Additional clutch mechanism
  - Design 1



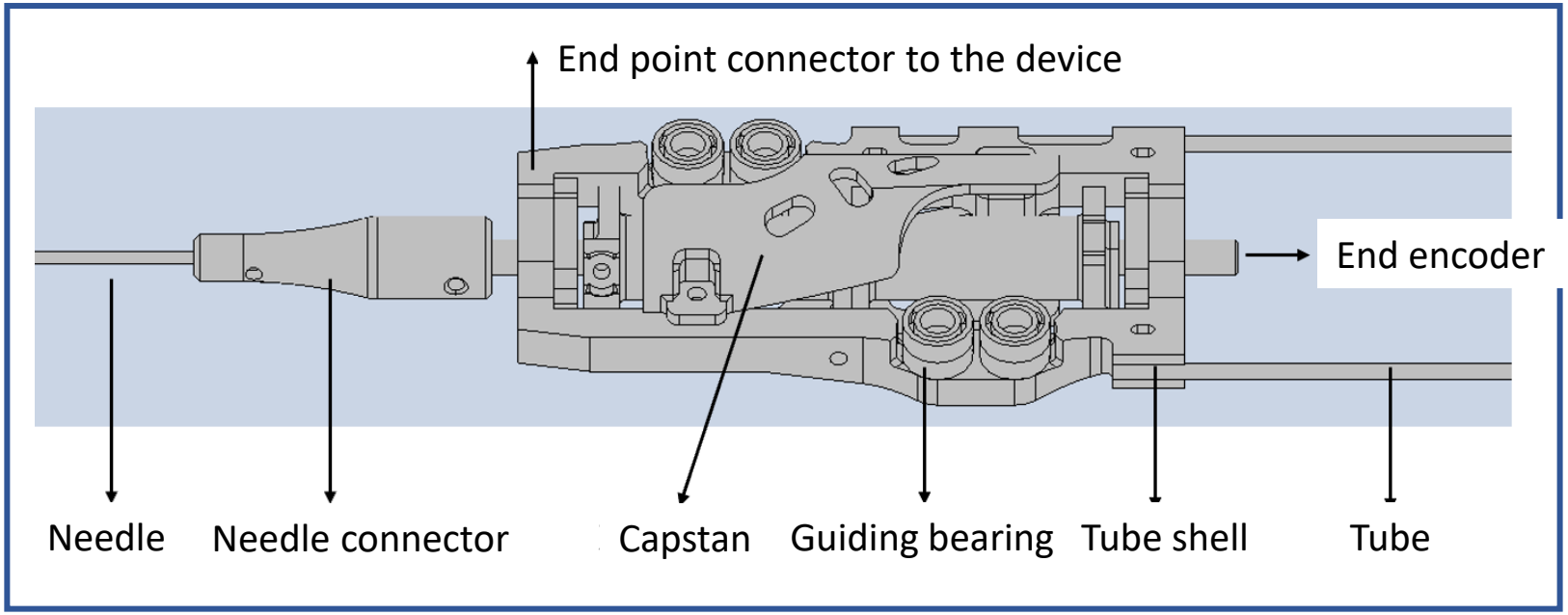
Con - The limitation of motor's weight would limit motor's maximum output torque

Hardware

The design hopes to reduce the overall weight of the tip device. If the motor is directly installed at the tip, the weight of the motor will affect the user's free movements.

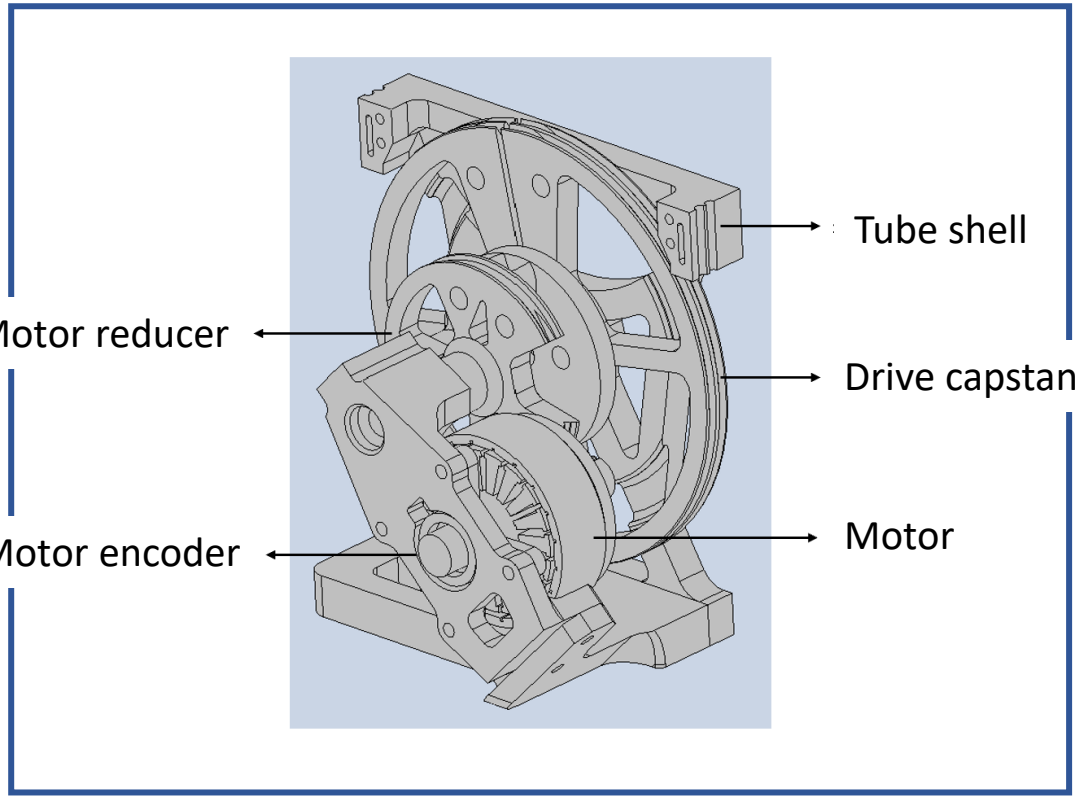
Consider separating the drive motor from the tip, mounting the motor on the device's base, and providing the torque feedback through a flexible transmission mechanic, which can effectively reduce the weight of the tip.

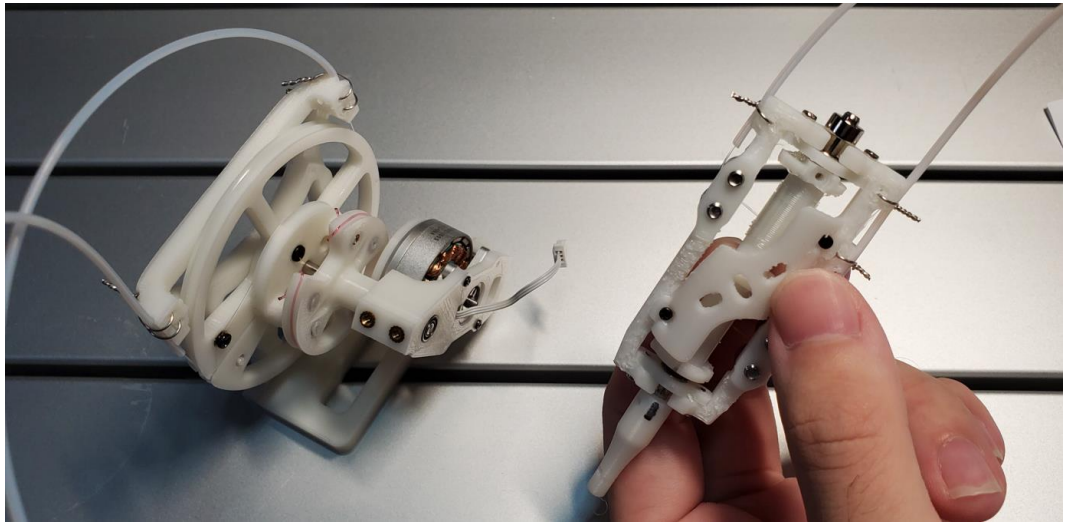
A capstan/wire transmission mechanic is used. Tensile force can be transmitted via the wire inside the tube. And the tube is flexible enough to avoid user/device's free movement in the workspace.



Hardware

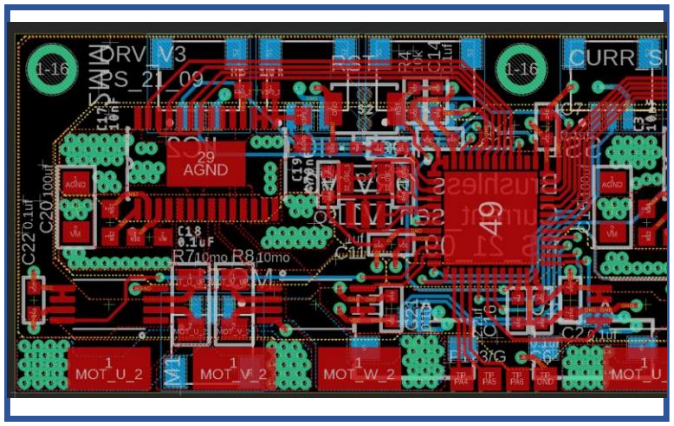
Base





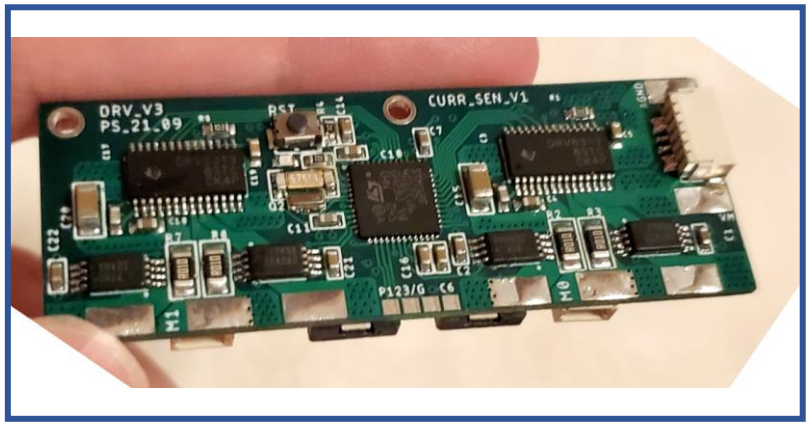
Eletronic

- Motor driver



- F401ccu6
- DRV8313
- 12bit encoder

- Can bus

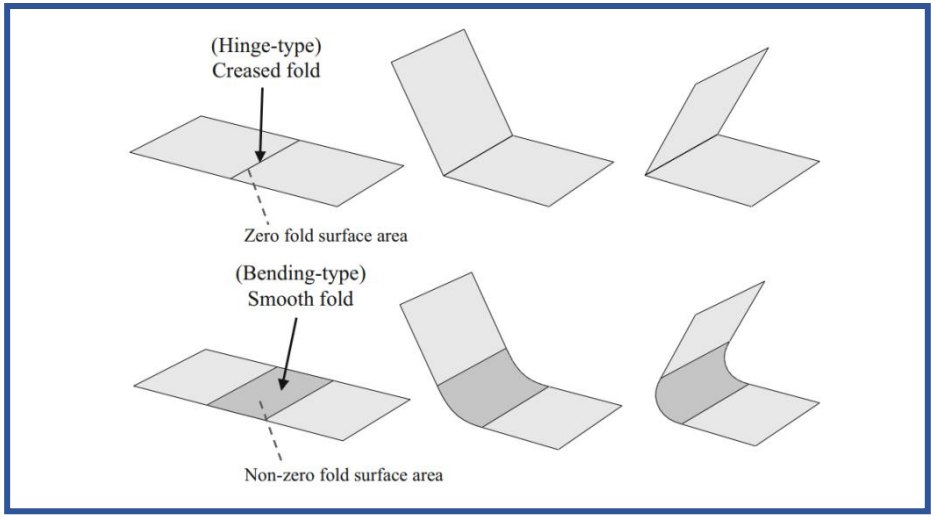


- Clutch mechanism

To achieve low friction free rotation of the needle. The needle need to be disconnected from the capstan transmission mechanic when no there's no feedback torque. An origami-inspired clutch mechanic is designed.

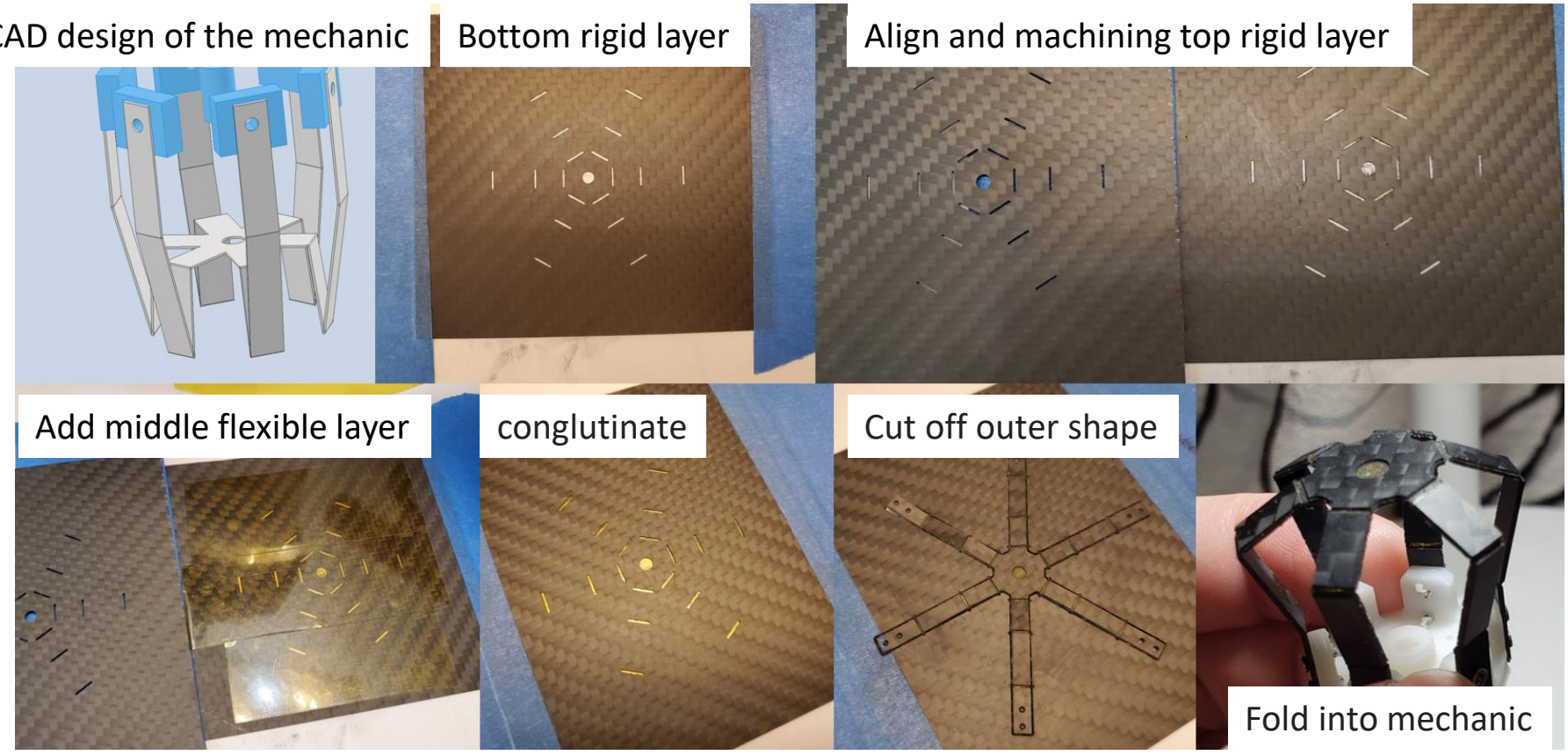
Free rotation

Brake



Hardware

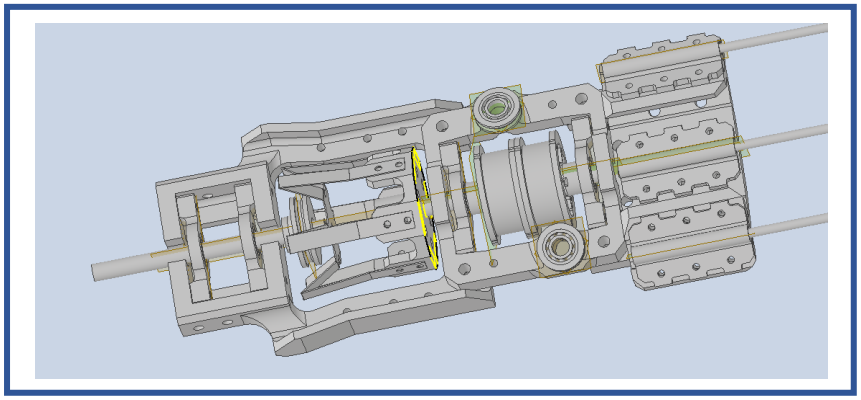
- Origami-inspired clutch mechanism
  Machining process

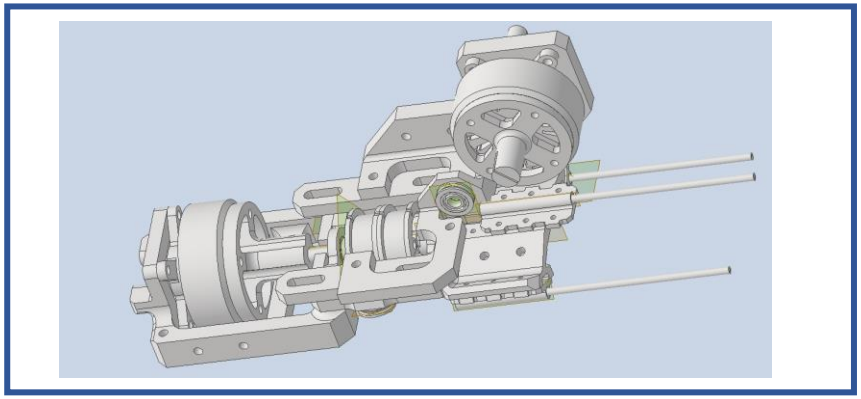


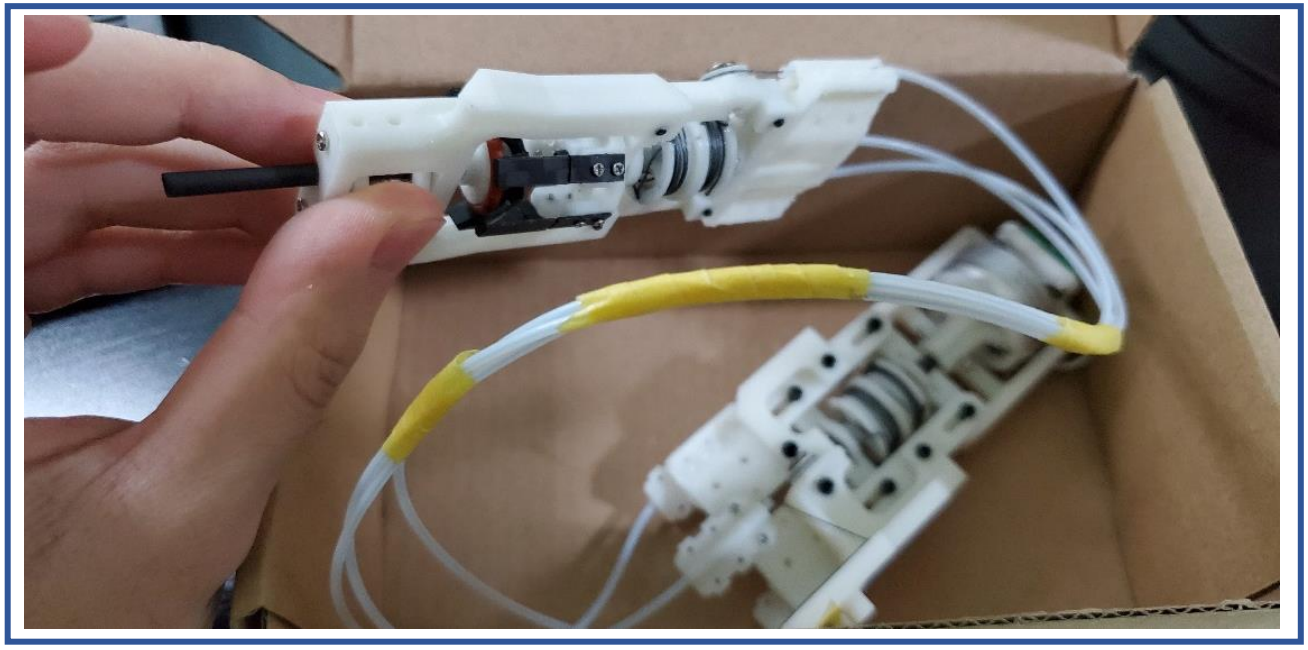
- The structure weights only 2.1g

Hardware

- CAD design with clutch mechanic’s actuator



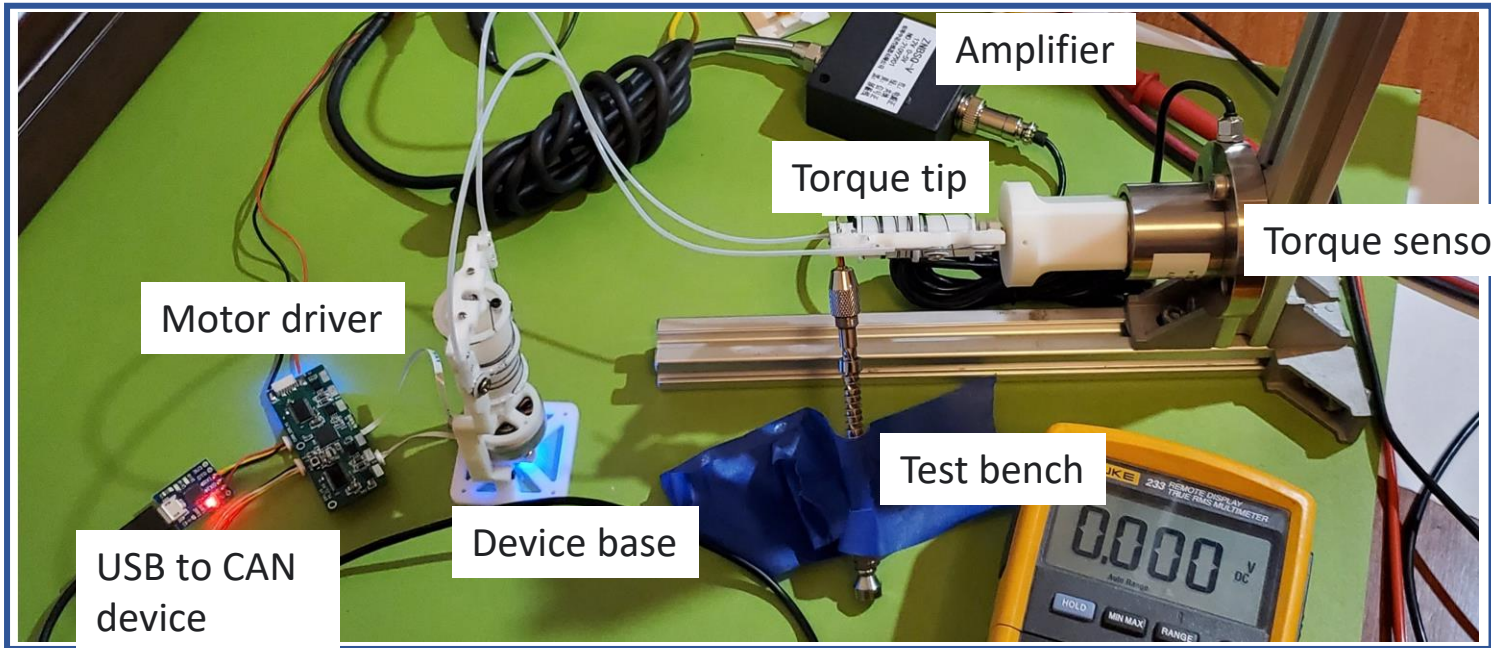




Test of output torque

- Test bench

5N*M Torque sensor used



- Test ouotput

0.02N*M Step output -left pic

0.02N*M Sine output -right pic