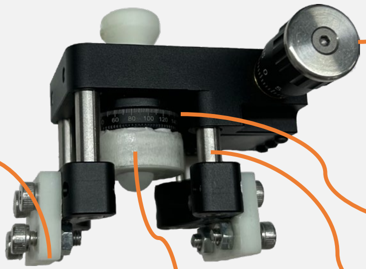
EasyCalib: Simple and Low-Cost In-Situ Calibration for Force Reconstruction with Vision-Based Tactile Sensors

Mingxuan. Li, Lunwei. Zhang, Yen. Hang. Zhou, Tiemin. Li, and Yao. Jiang, “EasyCalib: Simple and low-cost in-situ calibration for force reconstruction with vision-based tactile sensors”, https://arxiv.org/abs/2403.10256

1. Structure of EasyCalib



Fixed bracket

- 3D printed pieces using photopolymer
- Hole diameter: 5mm

Z-Axis Translation Installation Seat Objective Lens Mounting Bracket

- Resolution of 0.001mm, with a max-stroke of 2mm
- The SM1 thread (1.035 "-40), for 30mm cage system
- Installing lens:Ø1 inch or 25mm optical element

Compatible Manual Rotation Mount

- External SM1 threads, for 30mm cage system
- Mount Ø1/2" optics up to 0.26" (6.5 mm) thick
- Full 360° rotation, resolution of 2°

Others

- Bolts and nuts: M4 / M2
- Connection methods: Solvent cementing and threading

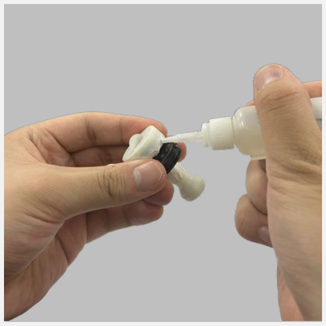
Rotating Handle

- 3D printed pieces using photopolymer
- With a groove for installing elastic indenter (PDMS)

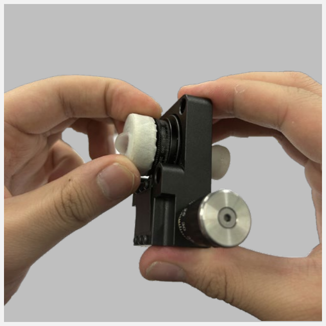
Cage Mounting Brackets and Rods

- Compatible with 30 mm Cage Systems
- Locked into place with top-Located setscrews

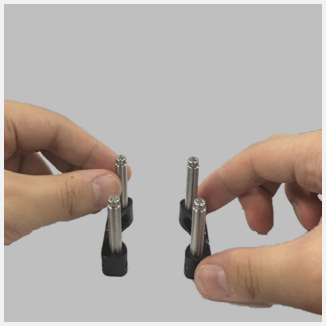
2. Composition of EasyCalib



(1) Gluing the rotating Mount, handle and elastic indenter together

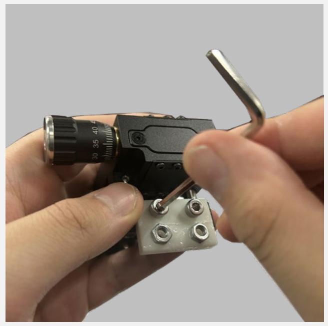


(2) Thread the rotation mount and translation mount together



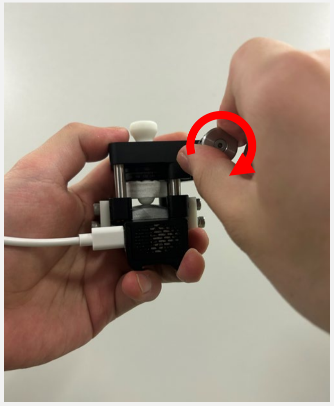
(3) Connecting cage mounting brackets and rods

(4) Connecting cage mounting rods and translation mounts

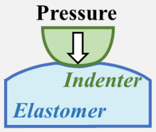


(4) Mounting fixed bracket and screws for fixing the sensor

3. Usage of EasyCalib



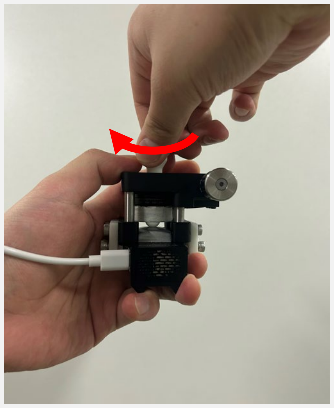
Calibration based on **Normal Contact Theory**



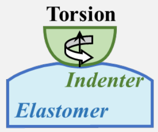
$$\gamma_2 = \boldsymbol{H_1} \cdot \gamma_1 + H_2 \cdot \gamma_1{}^{1.5},$$

$$\boldsymbol{H_1} = \frac{32}{9\pi} \cdot \frac{1 - \nu_2{}^2}{1 - \nu_1{}^2} \cdot \frac{E_1}{E_2}$$

① Adjust the micrometer, and record a series of total displacement $\gamma_1 + \gamma_2$ measured by the translation mount and the maximum indentation γ_1 measured by the sensor, and fit H_1 according to Eq. (23).



Calibration based on **Torsion Contact Theory**



$$\theta_2 = \boldsymbol{H_3} \cdot \theta_1,$$

$$\boldsymbol{H_3} = 2.014 \cdot \frac{1 + \gamma_2}{1 + \gamma_1} \cdot \frac{E_1}{E_2}$$

② Set $\gamma_2 = 1mm$, adjust the handle, and record a series of total rotational angle $\theta_1 + \theta_2$ measured by the rotation mount and the rotational angle θ_1 measured by the sensor. Then, fit H_3 according to Eq. (40).