

MyoRobot 3.0

Stretch-correction & auto-focus LWD optics for tracking structure-function relationships in single muscle fibers

Despite the recent advancements regarding robotization and automation, investigating the biomechanics of muscle still represents a labor-intensive research sector. Our sophisticated engineering solution, the *MyoRobot*, has contributed to easing the efforts of pre-clinical muscle diagnostics and bio-material testing through an atomization of active and passive biomechanics recordings and an integrated optical system to visualize structure-function relationships (diameter and sarcomere length). Yet, live structure-function recordings, e.g. the sarcomere length distribution during active contraction or (in)homogeneity during passive hysteresis stretches, would require three essential properties not governed by the current setup to allow feasible operation for the experimenter. Therefore, we plan on implementing a high resolution long-working-distance (LWD) optical platform, featuring stretch-correction and auto-focus functionality. This requires an infinity corrected objective mounted on a bi-axial actuation platform that (i) can be operated digitally, and furthermore (ii) operate according to image processed feedback (autofocus and stretch-correction). Therefore, the student will install a bi-axial optical platform operated by two linear motors in cross-configuration (parts already available, CAD done, construction in progress). You will...

- Engineer a control program in LabVIEW to drive each axis independently (motion controllers are LabVIEW compatible; a firmware communication interface exists)
- Assemble and quantify the bi-axial LWD optical platform below the *MyoRobot* and validate its imaging quality (*magnification, resolution, etc.*) and operation (*accuracy, speed, repeatability*) on single muscle fibres (those will be done by experienced lab personnel, but your will also get a chance to try this independently if you will). [*Ray tracing simulations in Zemax can be completed optionally*]
- If time allows: Work on image processing to implement auto-focus and stretch-correction during active contraction and passive elongation. Both will require to utilize information obtained from the camera, transfer this into motion commands and feed it back to actuate the motors accordingly. Auto-focus, e.g., can be implemented by contrast optimization algorithms, while stretch-correction will require the field-of-view to always visualize the same segment of the fiber as it is being stretched. This can, e.g., be done via image correlation and determining the linear axis shift that must be compensated by motor actuation.

The applicant should be interested (or already have experience) in:

- Technology development in a medical-/health-related context
- Software development with LabVIEW (for motor and camera control)
- Image processing and pattern recognition techniques/algorithms
- Basic optics principles of microscopes

If you feel interested and/or challenged, please contact Dr. Michael Haug (michael.haug@fau.de) or Mena Michael (mena.michael@fau.de).

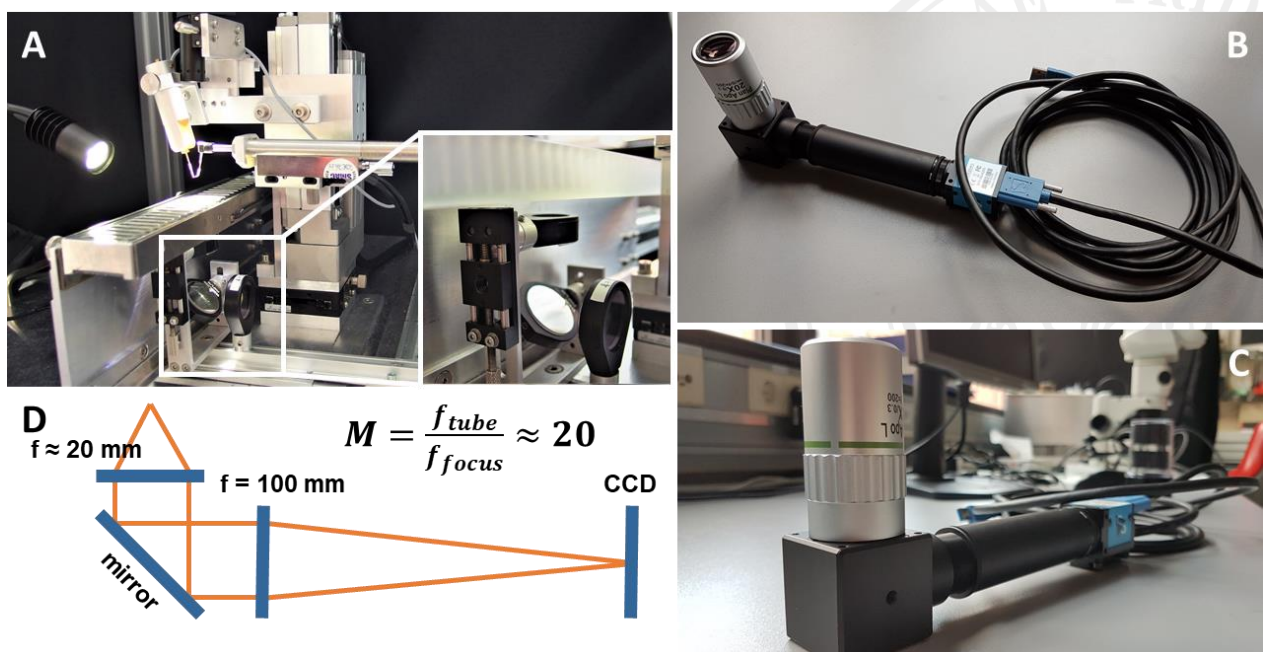


Figure 1. Optics system upgrade to implement auto-focus and stretch-correction functionality and LWD objective optics. A, photograph of the current MyoRobot v.2.0 biomechanics system with optics lens system (enlarged). B&C, components for implementing LWD optics using a commercial objective, deflection prism and a CMOS camera sensor. D, simplified sketch detailing the infinity optics ray guidance.

Literature and Links:

- Haug et al. "MyoRobot 2.0: An advanced biomechatronics platform for automated, environmentally controlled skeletal muscle single fiber biomechanics assessment employing inbuilt real-time optical imaging"; Biosensors and Bioelectronics; DOI: [10.1016/j.bios.2019.04.052](https://doi.org/10.1016/j.bios.2019.04.052)