Master 2 Internship: Calibration and Visual Servoing of a Micro-Robotic System for Automated Multi-View Measurement of Microfibers

Context:

Micro-robotics makes it possible to manipulate and test objects of a few micrometers, such as the plant fibers (flax, hemp, nettle…) used in bio-based composites. At FEMTO-ST, the AS2M department has developed a multi-axis robotic platform for single fiber transverse compression tests (SFTCT, Fig. 1): a 10–25 µm fiber is positioned by high-precision robotic axes under a microscope, then compressed between two platens. The intern will have access to this high-tech platform, also used as a pilot line of the European project RAIDO.

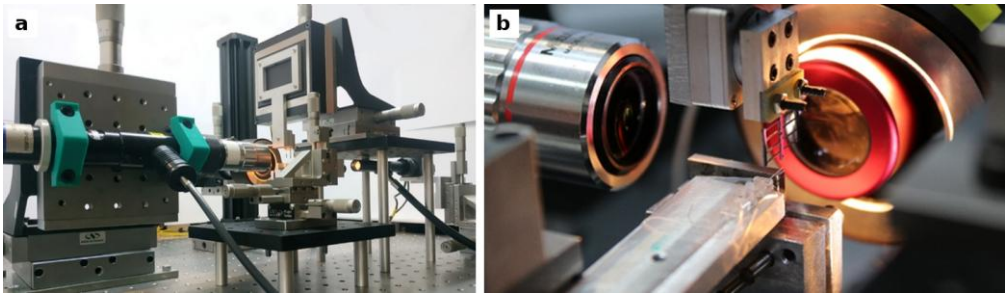


Figure 1: SFTCT micro-robotic platform at FEMTO-ST: (a) overview of the bench, (b) test area: microscope objective, lighting and fiber holder.

The fiber cross-section, which directly affects the identified mechanical properties, is currently measured by X-ray tomography on a separate instrument: the process is long, and sample transfers introduce uncertainties. A first proof of concept has shown that it can be measured on the bench itself by rotating the fiber in front of the camera. Automating this measurement is a robotics challenge: at high magnification the depth of field is only a few micrometers, and rotation-axis errors and fiber eccentricity move the fiber out of the field of view and out of focus at every rotation.

Internship objectives:

The main objective is to develop and experimentally validate a calibration and visual servoing strategy that keeps the fiber centered and in focus during rotation, enabling automated and repeatable multi-view imaging directly on the SFTCT platform. The selected candidate will be expected to:

1. Conduct a literature review on micro-robot calibration, visual servoing under microscope and multi-view measurement.
2. Calibrate the XYθ robotic system: identify the rotation axis in the camera frame, the image scale and the misalignments between the robotic axes and the optics; build a geometric model predicting rotation-induced image displacements; evaluate positioning accuracy and repeatability.
3. Implement visual servoing: combine model-based feedforward and image-based feedback to correct position and focus errors from 0° to 180°; evaluate accuracy, convergence and robustness, and minimize the acquisition time.
4. Extract the fiber contour: implement a conventional image-processing approach and explore deep learning-based segmentation.
5. Validate the complete system: residual image displacement, focus stability, acquisition time and measurement repeatability, compared with X-ray tomography.

Profile:

Master 2 or final-year engineering student in robotics, mechatronics or automatic control. Skills in robot kinematics and calibration, control (visual servoing is a plus), image processing (OpenCV) and programming (Python and/or MATLAB); taste for experimental work and teamwork.

Additional information:

- **Laboratory:** FEMTO-ST Institute – AS2M Department – RoMoCo Team, Besançon
- **Project:** MINIRO (Miniature Robotics), French PEPR Robotics program funded by France 2030- https://www.femto-st.fr/en/The-institute/news/national-research-program-miniature-robotics
- **Duration:** 5 to 6 months, starting February 2027 – **Stipend:** 550 € per month
- **Application:** CV, cover letter and transcripts of the last three years, in a single PDF
- **Supervisors:**
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