

POST-DOC Position in Computer Vision (12 months)

Title 3D pose estimation with digital holography microscopy for micro-robotics metrology

Domain Computer vision applied to the characterization of micro and nano positioning robots

Laboratory [FEMTO-ST Institute](#): a seven departments and more than 700 people institute affiliated with [CNRS](#) and [UBFC](#), located in [Besançon](#), a green and student city.

Project Holo-Control: Extended machine vision control capabilities using digital holography & artificial neural networks. Funded by the French National Research Agency (contract: ANR-21-CE42-0009)

Project context: The micro-robotic team is leader in visual 3D position measurement at small scales with innovative patterns stuck to the objects of interest. This method is particularly well suited to follow the 3D trajectories of stages in the field of micro and nano-positioning to complete assembly tasks, robot calibration, micro-instrument control and other.

Post-Doc subject: The project aims to perform 3D computer vision with digital holography (DH) that is an interferometric technique highly sensitive to the axial z direction. Furthermore, in DH, image reconstruction is performed numerically and the focus distance is adjusted as a computation parameter. This property results in a significant extension of the allowed z-range that switches from the usual depth-of-field (about 5 μ m with a 10x microscope lens) to an in-focus range of about 100 μ m. This work will be pursued in the frame of a national research contract (ANR-21-CE42-0009) funding the project.

Post-Doc objective: The aim of the post-doc will be to demonstrate for the first time the new capabilities for 3D pose estimation in micro-robotics permitted by DH microscopy and resulting from the combination of the nanometer Z-sensitivity of interferometry with the extended Z-range allowed by DH together with the previous capabilities of the nanometer measure in the plane. This will lead to the first system able to measure to 3D pose of a target with nanometric resolution in translation and microradians resolution in rotation with a single image. Results are expected to be published in a top level scientific journal like Science Robotics.



Team's equipment and background:

- Instruments :
 - Digital Holography Microscope (<https://www.lynceotec.com/dhm-digital-holographic-microscopy/>),
 - Hexapod (<https://www.newport.com/p/HXP50-MECA>),
 - High precision actuators: <http://www.madcitylabs.com/nanomet1020.html>, <https://www.smaract.com/rotation-stages/product/sr-2013>, <https://www.physikinstrumente.com/en/products/nanopositioning-piezo-flexure-stages/multi-axis-piezo-flexure-stages/p-561-p-562-p-563-pimars-nanopositioning-stage-201550/>
- Specific homemade devices: pseudo-periodic micro-encoded patterns for absolute position measurement (<https://hal.archives-ouvertes.fr/hal-03423034/document>)
- Clean room access to fabricate them
- Software: Vernier Library: 3D pose estimation of pseudo-periodic patterns under bright-field microscope (<https://projects.femto-st.fr/vernier/en>)

Recent related publications:

- A.N. André, P. Sandoz, B. Mauzé, M. Jacquot, G.J. Laurent, Sensing one nanometer over ten centimeters: A micro-encoded target for visual in-plane position measurement, ASME/IEEE Trans. on Mechatronics 25 1193 - 1201, 10.1109/TMECH.2020.2965211 (2020).
- B. Mauzé, R. Dahmouche, G.J. Laurent, A.N. André, P. Rougeot, P. Sandoz, C. Clévy, Nanometer Precision with Parallel Continuum Robots, Robotics and Automation Letters 5 3806-3813 10.1109/LRA.2020.2982360 (2020).
- A.N. André, P. Sandoz, B. Mauzé, M. Jacquot, G.J. Laurent, Robust phase-based decoding for absolute (X,Y) positioning by vision, IEEE Transactions on Instrumentation and Measurement 70, 10.1109/TIM.2020.3009353 (2021).
- B. Tiwari, M. Blot, G.J. Laurent, J. Agnus, P. Sandoz, P. Lutz, C. Clévy, A High Range-to-Resolution Multiaxis Force and Torque Sensing Platform, IEEE/ASME Transactions on Mechatronics 26, 4, 1837-1845, 10.1109/TMECH.2021.3071444 (2021).
- A.N. André, P. Sandoz, M. Jacquot, G.J. Laurent, Pose Measurement at Small Scale by Spectral Analysis of Periodic Patterns, International Journal of Computer Vision (in Press, DOI: 10.1007/s11263-022-01607-7).

Post-Doc activities: 1/3 experimental work, 1/3 software development, 1/3 publication writing.

Expected skills: computer vision, software development, publication writing, robotics or microscopy or micro-nano device manipulation. Knowledge in interferometry or holography would be appreciated but is not mandatory.

Post-Doc dates: 09-10 2022 to 08-09 2023

Salary: Gross salary from 2600 to 3500€ depending on experience

Selection process: Applicants shall send as soon as possible and at the latest on June 20th a detailed CV with a cover letter, their best publications and any further relevant document within a single pdf file to:

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