Master's internship – 2027

Electromagnetic tracking and guidance of steerable needles

Supervision:

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Context:

Percutaneous thermal ablation destroys tumors from the inside using a needle inserted through the skin. The ARC needle, a hollow articulated needle with controllable stiffness developed by ICube and EPFL, can follow curved trajectories to reach tumors behind sensitive structures, and our team has developed methods to plan such trajectories automatically. However, following a curved trajectory without direct view is very difficult. The MagNav project adapts ManaDBS, an electromagnetic tracking system developed at ICube with FHNW (Switzerland) using AMR magnetic sensors and quasi-static fields robust to metallic perturbations. A previous Master's intern developed a flexible strip of sensors that can be inserted into the ARC needle to reconstruct its position, orientation and curvature. This internship will build on her work.

Work description:

The intern will address two challenges. The first one is registration: a calibration procedure will be designed to estimate the transformation between the field generator and the imaging device, using reference objects carrying both image markers and magnetic sensors. Rigid registration methods (point-based, ICP, or learning-based) will then be implemented, and their accuracy assessed on abdominal phantoms by comparing the needle shape measured by tracking with CT images. The second challenge is guidance: the intern will develop a real-time interface to help the clinician follow a planned curved trajectory, first in three steps (entry point, needle orientation, depth at which to trigger the bending), then, if successful, with dynamic detection and correction of deviations. The system will be evaluated on phantoms with feedback from IHU Strasbourg clinicians.

References:

1. C. Vergne, et al. *Low-field electromagnetic tracking using 3-D magnetometer for assisted surgery*, IEEE Transactions on Magnetics, 59(2), 1-5, 2022.
2. A. Morin, et al. *Towards non-linear needle trajectories: performance analysis of the ARC passive-steerable needle in a phantom gel model*, In proceedings of CARS 2025, IJCARS, vol. 20, suppl. 1, p. S37-S38, Springer, 2025.
3. A. Morin, et al. *Planning non-linear trajectories for no-touch thermal ablation using passive steerable needle with controlled stiffness and PSAM*, 19th AE-CAI workshop of MICCAI 2025, to appear in IET Healthcare Technology Letters, Wiley.

Team and environment:

The internship is part of MagNav, an internal ICube project gathering the EM3, IMAGeS and RDH teams of ICube and the IHU Strasbourg. The intern will be hosted at the ICube Institute, Illkirch Campus of Strasbourg, France, with access to the tracking system, ARC needles, phantoms and the IHU experimental and imaging facilities. Development will be done in python and/or C++.

Internship duration: 5-6 months, starting January, February or March 2027.

Profile: MSc with a major in computer science, medical imaging, biomedical engineering or related fields. Proficiency in python or C++ required; knowledge in image processing and registration appreciated. Good English required.

For further information and application, please contact the supervisors.