« Preoperative planning and intraoperative guidance for controlled articulated ARC needles»

Location: ICUBE Institute, IMAGeS group, University of Strasbourg (https://icube.unistra.fr)
PhD advisors: Pr. Caroline Essert, Dr. Lennart Rubbert, Dr. Juan Verde
Start: Sept 1st, 2023
Duration: 3 years
Application deadline: **April 30th, 2023**
Funding: 24.000 € annual salary (~19.000 € net annually, health insurance included)
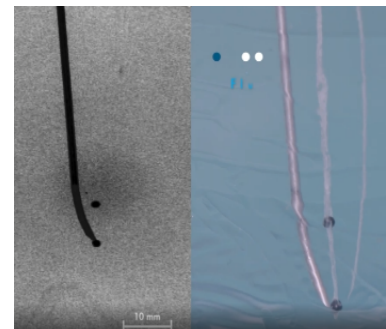Possibility to get teaching assistantship (~ 400 €/month)

Context:
The project focuses on AI-assisted needle interventions using the new articulated «ARC needle», to develop methods dedicated to flexible needles and non-linear trajectories. It aims to facilitate their use by surgeons, promote their deployment and adoption in hospitals, and ultimately pave the way for robotic-assisted insertion to improve efficacy and performance. It will cover both automated preoperative planning of one or more articulated needle trajectories, and intraoperative trajectory correction.

Mission:
The objective of this PhD project is to propose computational methods to plan curvilinear trajectories, achievable by the articulated ARC needle, from a specific entry point to a specific target point, and which would satisfy a set of predefined constraints such as organ avoidance.
Furthermore, as various procedures require multiple insertions of a needle (e.g., biopsy), or multiple needles to be inserted (e.g., ablation), the project will focus on planning the trajectories of several interacting needles with a focus on avoiding at best complete removal and redeployment of the needle by an optimally placed first insertion. Also, inserted needles should consider their interrelation, as they are used to deliver a different fraction of the whole treatment (e.g., multi-probe ablation), and the insertion of one can interfere the trajectory of others (e.g., treatment overlapping, mechanical constraints)
On the other hand, during needle insertion, to follow the previously planned trajectory, a tracking and guidance approach will be implemented. At the end of the project, we plan to obtain a software prototype allowing us to assist the operator before and during the intervention, and to evaluate the efficiency of the automatic planning and assistance with different configurations and use cases.

The thesis work will be done in collaboration with several academic and hospital partners, and in particular the Institute of Image-Guided Surgery (IHU Strasbourg: ihu-strasbourg.eu).

Related bibliography

- de Jong, T. L. et al. Needle placement errors: do we need steerable needles in interventional radiology? MDER Volume 11, 259–265 (2018).
- van de Berg, N. J., van Gerwen, D. J., Dankelman, J. & van den Dobbelsteen, J. J. Design Choices in Needle Steering—A Review. IEEE/ASME Trans. Mechatron. 20, 2172–2183 (2015).
- Pfeil, A., Cazzato, R.L. *et al.* Robotically Assisted CBCT-Guided Needle Insertions: Preliminary Results in a Phantom Model. Cardiovasc Intervent Radiol 42, 283–288 (2019).
- Engh, J. A., Minhas, D. S., Kondziolka, D. & Riviere, C. N. Percutaneous Intracerebral Navigation by Duty-Cycled Spinning of Flexible Bevel-Tipped Needles. Neurosurgery 67, 1117–1123 (2010).
- Scorza, D. et al. Surgical planning assistance in keyhole and percutaneous surgery: A systematic review. Medical Image Analysis 67, 101820 (2021).
- Babaiasl, M., Yang, F. & Swensen, J.P. Robotic needle steering: state-of-the-art and research challenges. Intel Serv Robotics 15, 679–711 (2022).

Expected candidate profile:
- Master's degree, preferably in Computer Science, or Biomedical engineering.
- Strong programming skills in python or C++ are mandatory.
- Good communication skills, both oral and writing, and proficiency in English are requested.
- Knowledge in optimization, artificial intelligence, computer graphics, and numerical methods are a plus.

To apply: Send a CV, cover letter, master internship report, master transcripts with ranking, and the names and contact information of at least 2 people who can recommend you to the following email addresses: essert@unistra.fr, lennart.rubbert@insa-strasbourg.fr, juan.verde@ihu-strasbourg.eu

NB: Incomplete applications without information about the student's ranking in his/her master's program will not be considered.