

1. Position identification

Title of post : Post-doctoral position

Type of contract : Finite duration Contract (CDD)

Category (A,B or C) : A

Contract/project period : 24 months **Expected date of employment :** Nov. 1, 2024

Proportion of work : 100%

Workplace : ICube laboratory, Rodin team, IHU Strasbourg

Desired level of education : PhD thesis

Experience required : PhD in robotics or related field

Contact(s) for information on the position (identity, position, e-mail address, telephone) : Florent Nageotte, Associate Professor, nageotte@unistra.fr, 03 90 41 35 38

Date of publication : July 3, 2024

Closing date for the receipt of applications : September 15, 2024

2. Research project or operation

The research project is part of the "Next Generation Surgical & Interventional Procedures" initiative led and funded by Inserm. It gathers the ICube laboratory in Strasbourg, the PRISM Inserm U1192 laboratory and the Inria Defrost team from the CRISAL laboratory in Lille.

Surgical need:

Cancer stands as the second leading cause of global mortality, as per World Health Organization (WHO) estimates. In tumor treatment, surgery remains the primary approach. A pivotal aspect of cancer surgery revolves around the precision involved in tumor resection, which profoundly impacts treatment outcomes. Despite the array of cutting-edge technologies available in prominent medical facilities, achieving complete tumor resection remains a challenge. This challenge is primarily due to the absence of real-time, precise information regarding the tumor's local and regional extent. Furthermore, tumors may be situated in locations that are challenging for conventional rigid medical instruments to access. This adds complexity to the task of determining tumor margins and performing resections in minimally invasive procedures.

Project:

To address the aforementioned challenge, our goal is to develop innovative, minimally invasive tools based on in vivo measurement devices for real-time analysis of tissues and in situ definition of tumor margins. The PRISM laboratory located in Lille, France, develops the SpiderMass technology based on mass spectrometry, that allows to realize analysis on in vivo tissues and in situ. Nevertheless, the measurements are essentially punctual and the probe needs to be moved precisely with respect to tissues in order to scan their entire surface and thus create full maps of tissue characteristics.

For this purpose, we propose to rely on robotic solutions that can allow to automatize scanning and to ensure completeness of the task. For reaching targets that are not directly accessible via simple laparoscopic access, we will use robotic solutions based on flexible robots that have the potential to be used in many different medical applications. The [RDH](#) / Rodin team in the [ICube](#) laboratory (University of Strasbourg, CNRS, INSERM) develops robotic solutions based on flexible endoscopes that have been brought to pre-clinical trials. The [Defrost team](#) from Christian Duriez and Gang Zheng at CRISAL (Univ Lille, Ecole Centrale, CNRS and Inria) develops soft robotic solutions for medical applications.

The scanning task will be defined by the medical user by relying on endoscopic images. Automatic scanning of tissues with SpiderMass requires the accurate 3D positioning of the focalizing point of the device with respect to tissues. The endoscopic camera available for the medical user will be used as the primary source of information for guidance of the robotic tool.

3. Activities

➤ **Description of the research activities :**

The post-doctoral researcher will be in charge of developing software solutions and to integrate them with hardware for realizing accurate scanning of tissues with flexible endoscopic systems using the feedback provided by an endoscopic camera.

For this purpose several aspects will have to be tackled.

- Development of kinematic and dynamic models of flexible robotic instruments to be incorporated in control laws and allowing to perform open-loop motions
 - Development and / or use of tissue tracking algorithm to follow the motion of the targets in the endoscopic images during the displacement of the endoscope and the motion of the tissues.
 - Development and implementation of vision-based closed-loop control laws in order to bring the instrument at the desired position and to follow planned trajectories with respect to tissues.
 - Visualization of mass spectrometry maps and their fusion with visible endoscopic images
- Discrepancies between the planned task and the realized one will have to be taken into account in order to provide geometrically correct maps.

➤ **Related activities :**

- Writing of research reports and scientific articles for conferences or journals.
- Regular reporting of the work advancement to the project team.
- Participation to the research team general activities (meetings, workshops, seminars).

If interested and if time allows in addition to the research activities, teaching in the master programs of Telecom Physique Strasbourg that are linked to medical robotics could be considered.

1/2

4. Skills

➤ **Qualifications/knowledge :**

We are looking for a candidate holding a PhD in robotics or in a related field (computer vision, automatic control). A research experience in the robotics field is mandatory. The knowledge of flexible or continuum robots and of the medical robotics field are interesting assets.

Liking of experimental work and interest for medical applications are expected.

➤ **Operational skills/expertise :**

- Proficiency in C / C++ programming.
- Advanced skills in scientific reporting (oral reporting, scientific papers, research reports, oral presentations).
- Knowledge or experience with SOFA and / or with ROS would be appreciated (but are not mandatory).
- B2 level in English is expected. French speaking is not mandatory.

➤ **Personal qualities :**

- The candidate should be a driving force for proposing research tracks and solutions. He / she should be independent in technical developments.
- He / she should interact smoothly with researchers, engineers and students involved in the project.
- He / she should have scientific curiosity and be rigorous in technical developments.

5. Environment and context of work

➤ **Presentation of the laboratory/unity :**

The research work will be carried out in the Rodin team of the ICube laboratory (University of Strasbourg, CNRS, INSERM). Rodin is a recently created unit funded by Inserm in Strasbourg. It relies on the previously strong research activities of the RDH team (Robotics, Datascience for Healthcare) in relation to medical applications.

RDH has 20 years of experience in medical robotics, especially in the context of robotic flexible endoscopy. Robotic developments will be mainly realized on the STRAS robot, developed by the RDH team and located at the IHU robotic platform.

The IHU robotic platform is located at the central hospital of Strasbourg near downtown Strasbourg. Strasbourg is a vibrant mid-size town, a host of European institutions, allowing affordable accommodation.

The project is co-led by the PRISM laboratory in Lille and the Defrost team at INRIA Lille.

PRISM Inserm U1192 is an interdisciplinary team that is dedicated to translational research through technological and therapeutic innovations. In particular, PRISM has a long-lasting and internationally recognized expertise in MS-based tissue analysis by MS Imaging.

Defrost team (CRISTAL Lab, Univ. Lille, Centrale, Inria, CNRS) focused on soft robotics, is specializes in modeling, simulation, and control. Defrost team develops advanced computational models and control strategies for robots made from soft materials, enhancing their adaptability and functionality in delicate environments.

➤ **Hierarchical relationship :**

The work will be supervised by Florent Nageotte, associate professor in the RDH / Rodin team in Strasbourg, specialist in robotic flexible endoscopes control; and by Isabelle Fournier, Professor at PRISM, specialist of Mass Spectrometry Imaging; and Christian Duriez, Research Director at INRIA and Gang Zheng research scientist at INRIA, specialists in simulation and control of deformable robots.

➤ **Special conditions of practice :**

The research work will be carried out in Partnership with Isabelle Fournier in the PRISM laboratory and with the Defrost team (C. Duriez, G. Zheng) both located in Lille, France (5 minutes only from each other). It is envisioned that a part of the work will be realized in Lille either during short stays or a longer residence. This will allow accessing specific equipment (for example the SpiderMass system) beneficial for the research.

To apply, please send your CV, cover letter and diploma to :

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