PhD position: « Optimization of trajectories for the simultaneous placement of numerous surgical tools »

Location: ICUBE/IGG, Université de Strasbourg (https://icube.unistra.fr)

PhD advisor: Caroline Essert (http://dpt-info.u-strasbg.fr/~essert)

Starting: September 1st, 2017
Duration: 3 years
Salary: gross salary approx. 1680€ per month
Possibility of teaching for french-speaking candidates (extra 400€ per month)

Description:

In surgery, either open or minimally invasive surgery, planning an intervention is a decisive task. The chances of success of a surgical operation depend strongly on a good preoperative planning, and the choice of the most appropriate strategy.

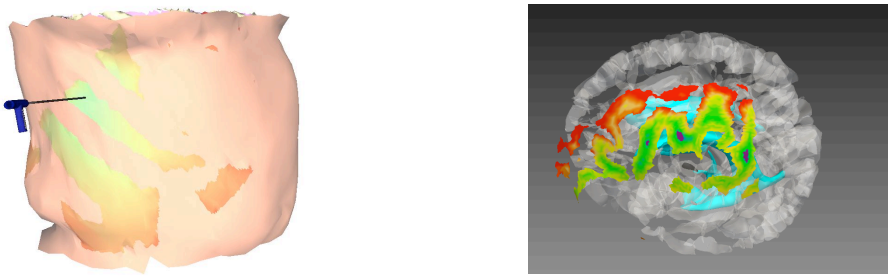
A few days before the intervention, CT or MRI images of the patient are acquired, then the physician elaborates his intervention plan from these sets of preoperative 2D slices. It is a difficult task, as the physician has to build a mental representation of a 3D model of the anatomy of the patient and the position of pathologies. In the case of an intervention involving the planning of a path for a needle or electrode, the surgeon has to estimate a secure tridimensional path that will ensure a maximal efficiency. When planning multiple trajectories, the task is even more complex as there are possible interactions between the surgical tools.

In this PhD study, we propose to help the surgeon by providing him a tool to assist him in planning the interventions, taking into account the deformability of the tissues. The objective is to propose an optimal strategy of intervention, specific to the patient and the type of operation, thanks to an automatic computation based on the expertise of the field, the preoperative data, and a precise simulation of the effects of the treatment during surgery.

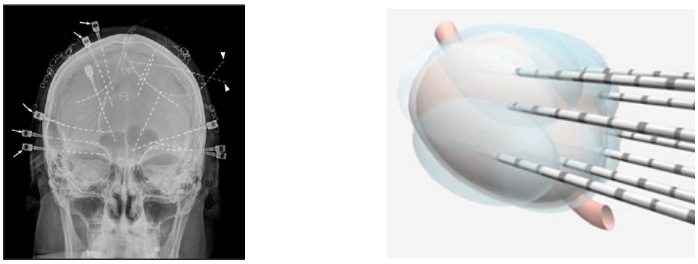
This work will rely on previous results of IGG group in LSIIT, in which a generic language is studied, that allows to describe operative frameworks able to be adapted to technical progresses of interventions. It will be done in collaboration with various academic and clinical partners. In this PhD, we will focus on extending IGG's planning methods so that they can handle a large quantity of variables to optimize, with fast computation times compatible with clinical routine. Another difficulty in this kind of planning is how to visualize and navigate through the numerous possible solutions in an interactive and intuitive way. A task of the research work will also be to search for innovative interaction techniques to browse the solution space, using for instance devices like a LeapMotion.

As for the application of this research, we will focus mainly on two types of interventions: the treatment of tumors by percutaneous cryotherapy (renal and desmoïd tumors), and the placement of SEEG recording electrodes in neurosurgery for the treatment of epilepsy. However, we will keep concerned by the genericity of the approach thanks to a formalization of the concepts, that led the works of IGG group in the fields of surgical planning so far.

This conceptual work will need an immersion of the candidate in the fields of medicine and surgery, geometric modeling by constraint solving and formalization, multi-criteria optimization, simulation, interaction, which constitutes a multi-disciplinary work.



Previous works of IGG group on trajectory planning of surgical tools placement



SEEG (left) and cryoablation (right)

The methods proposed during this PhD will be implemented in the planning software and will be compared to literature. Particular attention will be given to the presentation of the results in an intuitive and ergonomic way. A rigorous validation will be performed in collaboration with radiologists of the University Hospital of Strasbourg for the cryoablation application, and with neurosurgeons from the University Hospitals of Rennes, Strasbourg and Hôpital de la Pitié Salpêtrière of Paris for SEEG. The candidate will also interact with academic partners at LTSI Rennes, ICM Paris, and SPL Boston.

Qualifications: Master / Diploma with a technical and scientific background, in Computer Science / Engineering. Strong skills in C++ programming are required. Good communication skills as well as a good level of English are expected. Expertise in computer graphics or computer vision is also expected. Expertise in Numerical methods would be a plus.

To apply: send electronically a resume, a one-page letter of motivation, graduation documents and grades, the Master's thesis, and names/addresses of at least two references to:

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