**PhD Position**

**Machine Learning & model-based registration for image-guided neurosurgery**

SECTOR: Higher Education Institution

LOCATION: France, Grenoble

RESEARCHER PROFILE:

- First stage researcher,

**INSTITUTION: Univ. Grenoble Alpes, University of Innovation**

One of the major research-intensive French universities, Univ. Grenoble Alpes enjoys an international reputation in many scientific fields, as confirmed by international rankings. It benefits from the implementation of major European instruments (ESRF, ILL, EMBL, IRAM, EMFL*). The dynamic ecosystem, grounded on a close interaction between research, education and companies, has earned Grenoble to be ranked as the 5th most innovative city in the world. Surrounded by mountains, the campus benefits from a natural environment and a high quality of life and work environment. With 7000 foreign students and the annual visit of more than 8000 researchers from all over the world, Univ. Grenoble Alps is an internationally engaged university.

A personalized Welcome Center for international students, PhDs and researchers facilitates your arrival and installation.

In 2016, Univ. Grenoble Alpes was labeled «Initiative of Excellence ». This label aims at the emergence of around ten French world class research universities. By joining Univ. Grenoble Alpes, you have the opportunity to conduct world-class research, and to contribute to the social and economic challenges of the 21st century ("sustainable planet and society", "health, well-being and technology", "understanding and supporting innovation: culture, technology, organizations" "Digital technology").

* ESRF (European Synchrotron Radiation Facility), ILL (Institut Laue-Langevin), IRAM (International Institute for Radio Astronomy), EMBL (European Molecular Biology Laboratory), EMFL (European Magnetic Field Laboratory)

**Key figures:**

- + 50,000 students including 7,000 international students
- 3,700 PhD students, 45% international
- 5,500 faculty members
- 180 different nationalities
- 1st city in France where it feels good to study and 5th city where it feels good to work
- ISSO: International Students & Scholars Office affiliated to EURAXESS
REFERENCES:

ISP-Idex project: MARIUS
SUBJECT TITLE: Machine Learning & model-based registration for image-guided neurosurgery
RESEARCH FIELD:
- Computer science
- Engineering > Electrical engineering
- Engineering > Biomedical engineering
- Technology > Medical technology

SCIENTIFIC DEPARTMENT (LABORATORY’S NAME):
- Univ. Grenoble Alpes, TIMC-IMAG lab
- Vanderbilt University, Dept. of Electrical Engineering and Computer Science, Nashville, TN, USA

DOCTORAL SCHOOL’S: MSTII - Mathematics, Information Sciences and Technologies, and Computer Science
SUPERVISOR’S NAME: Matthieu Chabanas

SUBJECT DESCRIPTION:

This project will involve research in the domain of medical image processing and biomechanical modeling for image guided brain surgery. In brain tumor surgery, it is essential that the surgeon can accurately identify malignant and healthy tissues to ensure the total resection of malignant tissue while reducing the morbidity on surrounding healthy tissues and eloquent cortex. Image-guided surgery technologies can aid the surgeon in this difficult task. Specifically, preoperative Magnetic Resonance (MR) images can be used to accurately delineate surgical targets preoperatively and optical trackers can be used intraoperatively to co-register the MR to the operating room and intra-operatively localize the position of surgical tools relative to the pre-operative plan. During surgery, however, significant movement and deformation of tissues occur due to gravity (called the “brain-shift” phenomenon), cerebrospinal fluid leakage, drugs and obviously the ongoing surgical actions such as manipulation, dissection or resection. Thus, the pre-operative MR cannot be used directly for intraoperative navigation since it no longer reflects the anatomical reality after resection. Intraoperative Ultrasound (IUS), a low-cost, portable and convenient system, can be used to image the progress of the resection and tissue deformation. However, these images are extremely noisy making difficult the accurate delineation of tissue contours and tumor margins, especially at the end of the procedure due to additional resection-induced artefacts. The goal of this thesis is to develop a system to perform real-time non-rigid MR-to-iUS registration, to fuse the high-quality images and planning to the operating room configuration, in order to guide the surgeon and assist with the decision process in real time during the surgery.
The project will involve the development and use of Machine Learning techniques, such as convolutional neural networks, for image segmentation and tissue classification. Such techniques have come into widespread use in the image processing community due to their high effectiveness even in difficult image analysis tasks. The project will also involve the development and use of biomechanical model-based registration techniques to fuse the preoperative MR with iUS images. The modeling methods are well suited for representing the physics of the deformations to the brain that occur during tumor resection; however they lack the high quality pre-to-intraoperative image matching method, which can be provided by medical image analysis techniques such as machine learning methods, necessary to guide the deformation of the brain model. The machine learning tools are capable of estimating correspondences between pre- and intraoperative images, but the intra-operative images are so noisy that regularization or constraint of the correspondences is necessary to obtain an accurate matching; and the physics model can be used to provide such regularization.

The PhD student will be co-supervised by:
- Dr. Matthieu Chabanas, Univ. Grenoble Alpes, TIMC-IMAG lab, Grenoble, France
- Dr. Jack Noble, Vanderbilt University, Dept. of Electrical Engineering and Computer Science, Nashville, TN, USA.

The PhD student will spend the first 18 months at Vanderbilt University and the final 18 months at Grenoble. The first portion of the project will be focused on developing iUS segmentation techniques, including the training of machine learning techniques using labeled iUS images and transfer learning, and registering the segmented iUS images to preoperative MR using standard geometric non-rigid warping functions as a first evaluation. The second portion of the project will be focused on developing biomechanical modeling techniques, including models that account for cutting and tissue removal during surgery. Finally, the two approaches will be combined into an integrated system, and performance of each component of the process will be systematically and comprehensively evaluated.
ELIGIBILITY CRITERIA
Applicants must hold a Master's degree (or be about to earn one) or have a university degree equivalent to a European Master's (5-year duration).

Applicants will have to send an application letter in English and attach:
- Their last diploma
- Their CV
- A short presentation of their scientific project (2 to 3 pages max)
- Letters of recommendation are welcome.

Address to send their application: Matthieu.Chabanas@univ-grenoble-alpes.fr, Jack.Noble@vanderbilt.edu

SELECTION PROCESS
Application deadline: **July 20, 2018** at 17:00 (CET)
Applications will be evaluated through a three-step process:

1. Eligibility check of applications in July 20, 2018
2. 1st round of selection: the applications will be evaluated by a Review Board on July 23, 2018. Results will be given on July 24, 2018
3. 2nd round of selection: shortlisted candidates will be invited for an interview session in Grenoble or by Teleconference on July 25-27, 2018. (if necessary)

TYPE of CONTRACT: temporary-3 years of doctoral contract
JOB STATUS: Full time
HOURS PER WEEK: 35
OFFER STARTING DATE: between October and December 2018 (depending on administrative procedures)
APPLICATION DEADLINE: July 20, 2017
Salary:
- 1,768.55 € (~1,415 € net) per month, during 18 months in France
- $2,500 net per month (+ health insurance), during 18 months in the United States
- **UGA IDEX-ISP – 18 months**
  2496€ brut chargé par mois, total 44 928€
- **Vanderbilt University, Nashville TN, USA – 18 months**
  $2,803 per month (net stipend + insurance + fees), total $50,460