Master internship
3D graph-based brain vascular network modelling

Context

Ischemic stroke (the blockage of an artery that supplies blood to the brain) is a major cause of disability and death worldwide [2]. Recently, Endovascular Thrombectomy (EVT) has been proved very effective to treat ischemic stroke, which has led to its widespread adoption in clinical routine. EVT consists of the mechanical removal of the blood clot under image guidance. This interventional gesture is very difficult, and it is estimated that around 50% of EVT have a suboptimal outcome. The World Federation of Interventional and Therapeutic Neuroradiology recently recommended that simulation be integrated in this curriculum, with the *"ultimate goal of improving skills and reducing complications during patient management"* [4]. The PreSPIN ANR project (see Figure 1) aims at designing a simulator of the EVT intervention to help surgeons to train and plan for this difficult intervention. To do so, geometrically accurate models of the brain vascular network of patients suffering from ischemic stroke are required. In this context, the subject of this master internship is to develop a solution for modelling the brain vascular network based on vascular segmentations which were extracted from Magnetic Resonance Angiography (MRA) images.

Subject

From vascular segmentation, graph-based vascular models are built by extracting the blood vessel centerlines. In this graph, edges are the blood vessels and nodes represent the vessel bifurcations. The graph is then enriched by additional information such as vessel radius, mean intensity or anatomical labels. Recently, Paetzold et al. [3] compared three state-of-the-art graph extraction algorithms based on brain vascular segmentations. They showed that the Voreen vessel graph extraction method [1] provided the best results. The first goal of this internship is to build an accurate graph representation of the brain vascular network based on the work of Drees et al. [1]. Subsequently, post-processing strategies will have to be developed to take into account the specificities of cerebral vascular anatomy

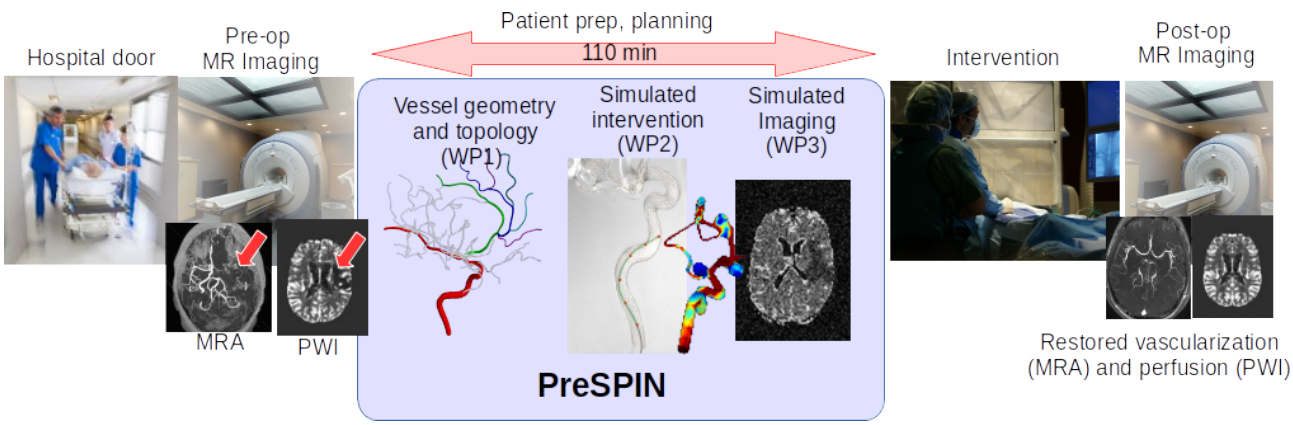

FIGURE 1 – PreSPIN project overview.

and allow the construction of a coherent final graph representation. The final goal of this internship is to provide a 3D volumic vascular model. From the previous graph representation, the idea is to build a set of 2D close curves that best fits the vessel border in each cross-section. An interpolation strategy will then be adopted to build the complete continuous 3D model.

Profile

We are looking for a master student motivated by image processing, with a particular interest in medical applications and graph-based approaches. A background in biomedical or medical imaging and an experience with the Python programming language are a plus.

Internship information

- 6-month internship starting from January to March 2022
- Location : CREATIS Lab at La Doua/INSA Lyon Campus.
- Advisors : Dr. Odyssée Merveille and Dr Carole Frindel
- Applications should be sent by mail to odyssee.merveille@creatis.insa-lyon.fr with a detailed CV, cover letter, the latest grade transcripts and optionally recommendation letters.

Références

[1] Dominik Drees et al. "Scalable robust graph and feature extraction for arbitrary vessel networks in large volumetric datasets". *BMC Bioinformatics* 22.1 (2021). ISSN : 1471-2105. DOI : 10.1186/s12859-021-04262-w. URL : http://dx.doi.org/10.1186/s12859-021-04262-w.

[2] D. Mozaffarian et al. "Heart disease and stroke statistics—2015 update : a report from the American Heart Association". *Circulation* 131 (2015), e29-e322.

[3] Johannes C. Paetzold et al. *Whole Brain Vessel Graphs : A Dataset and Benchmark for Graph Learning and Neuroscience (VesselGraph)*. 2021. arXiv : 2108.13233 [cs.LG].

[4] L. Picard et al. *Recommendation of the WFITN regarding simulation in neurointerventional training*. 2017.