Master internship
Towards a generic 3D vascular segmentation network

Context

The segmentation of vascular structures in medical images is a very difficult task as vessels are small, tortuous and low-contrasted structures. This is the first crucial step of many applications such as diagnosis or surgery planning of vascular diseases, blood flow simulation etc. Even though this task has been studied for more than twenty years [3, 4], the segmentation of blood vessels is still an open problem, especially regarding complex vascular network in 3D images (e.g. brain or liver vascular networks).

Recently, several supervised deep learning based methods were developed [6, 2, 5]. Nonetheless, the proposed models are poorly generalizable as they are trained on a specific image modality and organ. To apply these approaches on another organ or modality, they have to be re-trained, which requires a large annotated dataset. However, the annotation of blood vessels in 3D images is a very tedious and time-consuming task and consequently, most of the time, not available.

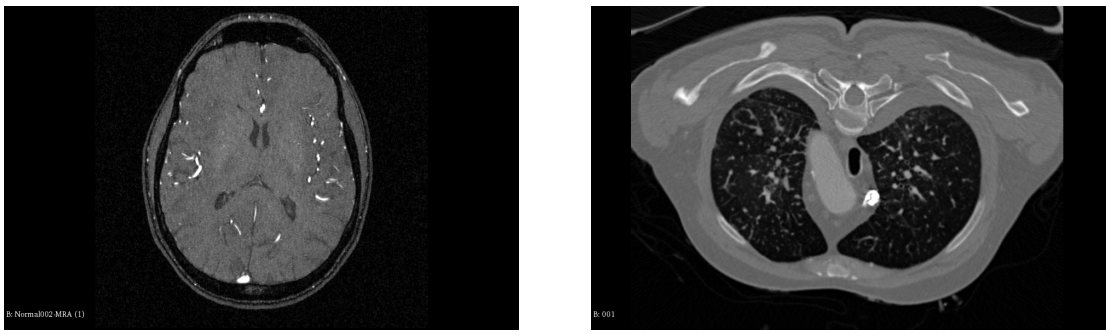

FIGURE 1 – Illustration of complex vascular networks from several organs and modalities : (a) brain vascular network in TOF-MRA, (b) pulmonary vascular network in CTPA.

Subject

Even though there is a large variability in the appearance of vascular networks in medical images (see Figure 1), several features are common : tubular structures organized in tree-like networks with decreasing diameters and contrast toward the vessels extremities. Thus, the goal of this internship is to develop a supervised deep learning based approach that focuses on the common vascular features in order to be more generalizable. Several ideas will be investigated, such as attention modules and training on multiple modalities and targeted organs from public datasets, such as in Boutillon et al.[1].

Profile

We are looking for a master student motivated by image processing with a particular interest in deep learning applications. A background in biomedical or medical imaging and an experience with

the Python programming language and Pytorch package are a plus. Good communication and team working skills are also required, as the intern will work in close collaboration with another intern from the IMT Atlantique / LaTIM laboratory.

Internship information

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

Références

[1] Arnaud Boutillon et al. "Multi-Task, Multi-Domain Deep Segmentation with Shared Representations and Contrastive Regularization for Sparse Pediatric Datasets". *MICCAI* (2021).

[2] Titinunt Kitrungrotsakul et al. "VesselNet : A deep convolutional neural network with multi pathways for robust hepatic vessel segmentation". *Computerized Medical Imaging and Graphics* 75 (2019), p. 74-83.

[3] David Lesage et al. "A review of 3D vessel lumen segmentation techniques : Models, features and extraction schemes". *Medical image analysis* 13.6 (2009), p. 819-845.

[4] Sara Moccia et al. "Blood vessel segmentation algorithms—review of methods, datasets and evaluation metrics". *Computer methods and programs in biomedicine* 158 (2018), p. 71-91.

[5] Lei Mou et al. "CS2-Net : Deep learning segmentation of curvilinear structures in medical imaging". *Medical Image Analysis* 67 (2021), p. 101874.

[6] Giles Tetteh et al. "Deepvesselnet : Vessel segmentation, centerline prediction, and bifurcation detection in 3-d angiographic volumes". *Frontiers in Neuroscience* 14 (2020), p. 1285.