IMT Atlantique
Bretagne-Pays de la Loire
École Mines-Télécom

LATIM

Internship offer 2024

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

CREATIS

Self super-resolution for prostate cancer segmentation and detection

Context

With over one million new diagnoses and 350,000 deaths worldwide each year, Prostate Cancer (PCa) is the second most common cancer in men. Recommended before biopsies [1], multiparametric Magnetic Resonance Imaging (mp-MRI), which consists in acquiring multiple dedicated diffusion and anatomical MRI sequences, is playing an increasing role in early diagnosis. However, visual analysis of prostatic mp-MRI data requires considerable expertise due to the heterogeneity of pathological patterns, and suffers from poor inter-reader agreement, sub-optimal interpretation and over-diagnosis [2]. Furthermore, it does not allow to determine the cancer aggressiveness, as characterized by the Gleason Score (GS). In a context where active surveillance is recommended when a low-aggressivity cancer has been identified, it is crucial to accurately characterize cancer progression using non-invasive methods. For all these reasons, research into Deep Learning (DL) based diagnosis models to help radiologists analyze mp-MRI has been prolific in recent years [3]. To improve the performance of these models and move towards the clinical transfer of such tools, we propose to focus on multi-modal information fusion for detecting/segmenting prostate lesions and characterizing their aggressiveness, major challenges as differentiation between low- and medium/high-grade PCa is an important clinical determinant [4].

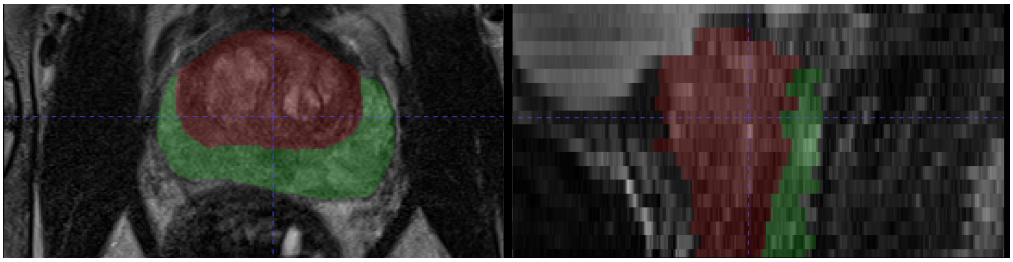

FIGURE 1 – Prostate MR images can be highly anisotropic with high in-plane resolution (left) and low through-plane resolution (right).

Internship topic

Many challenges in mp-MRI need to be addressed towards the mentioned objectives. One major bottleneck is the intrinsic quality of the images, which are generally acquired and reconstructed into 2D slices with large slice thickness, leading to very anisotropic 3D image volumes with low resolution (LR) and high resolution planes (HR). For instance, the HR plane can achieve resolution of <0.5 mm while slice thickness can reach >3mm (Fig. 1). A typical DL segmentation/detection pipeline would involve resampling the images into isotropic voxels resulting in stronger, artificial correlations between slices along the through-plane direction, which is not desired. A related issue in segmentation is the aleatoric uncertainty of the data induced by the lack of accurately delineated ground truths, as labels are typically obtained from these coarse anisotropic volumes. It is thus likely that more elaborate image enhancement techniques such as super-resolution (SR) models in the image and label space [5] could achieve improved accuracy in detection, segmentation and disease staging.

A major trend in DL is Self Supervised Learning (SSL), whereby unlabeled data is leveraged to improve model performance. Recently, a number of works have demonstrated the relevance of the

SSL paradigm for SR in medical image volumes [6, 7], alleviating the need for curated HR/LR pairs. In these methods, the model takes advantage of the HR plane to improve the resolution of the LR plane. In light of these approaches, the internship will focus on improving SSL-based SR architectures in mp-MRI and validate the impact of such approaches on segmentation and detection.

The core objective of the internship will be to validate and improve the SSL-based SR models which were previously developed at the LaTIM lab in mp-MRI for prostate cancer. The downstream segmentation and detection tasks will be carried out using state-of-the-art segmentation models such as U-Net and multi-modal medical Transformers, in line with previous research works [8].

Candidate profile

We are looking for a M2 student motivated by image analysis with a particular interest in DL applications. A background in biomedical or medical imaging and an experience with 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 team from INSA Lyon / CREATIS laboratory located in Lyon, France. A good ability to communicate in English as well as a fluent English for reading and writing scientific articles are also required.

Internship information

- 6-month internship starting from February to April 2024
- Location : IMT Atlantique[1], Technopôle Brest-Iroise, Brest, France
- Advisors : V. Jaouen (IMT Atlantique, LaTIM[2]) and P.-H. Conze (IMT Atlantique, LaTIM)
- Applications by email to `vincent.jaouen@imt-atlantique.fr` and `pierre-henri.conze@imt-atlantique.fr` including :
  - full curriculum vitæ
  - cover letter stating your motivation and fit for this project
  - latest grade transcripts
  - (optional) recommendation letters or contacts from former teachers/advisors

Bibliography

[1] N. Mottet et al., *Guidelines on prostate cancer—2020 update. part 1 : screening, diagnosis, and local treatment with curative intent.* European Urology, 2021.

[2] A. Westphalen et al., *Variability of the positive predictive value of PI-RADS for prostate MRI across 26 centers : experience of the society of abdominal radiology prostate cancer disease.* Radiology, 2020.

[3] Z. Khan et al., *Recent Automatic Segmentation Algorithms of MRI Prostate Regions : A Review.* IEEE Access, 2021.

[4] R. Cao et al., *Joint prostate cancer detection and Gleason score prediction in mp-MRI via FocalNet.* IEEE Transactions on Medical Imaging, 2019.

[5] Y. Li et al., *A review of the deep learning methods for medical images super-resolution problems.* Innovation and Research in BioMedical engineering, 2021.

[6] C. Zhao et al., *SMORE : a self-supervised anti-aliasing and super-resolution algorithm for MRI using deep learning* . IEEE Transactions on Medical Imaging, 2020.

[7] S. Remedios et al., *Joint image and label self-super-resolution.* MICCAI SASHIMI workshop, 2021.

[8] G. Andrade-Miranda et al., *Multi-modal medical Transformers : A meta-analysis for medical image segmentation in oncology.* Computerized Medical Imaging and Graphics, 2023.

1. `https://www.imt-atlantique.fr/`
2. Laboratoire de Traitement de l'Information Médicale, `http://latim.univ-brest.fr`