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

LATIM

Internship offer 2024

INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

CREATIS

Deep characterization of prostate cancer in multi-parametric imaging

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], multi-parametric 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].

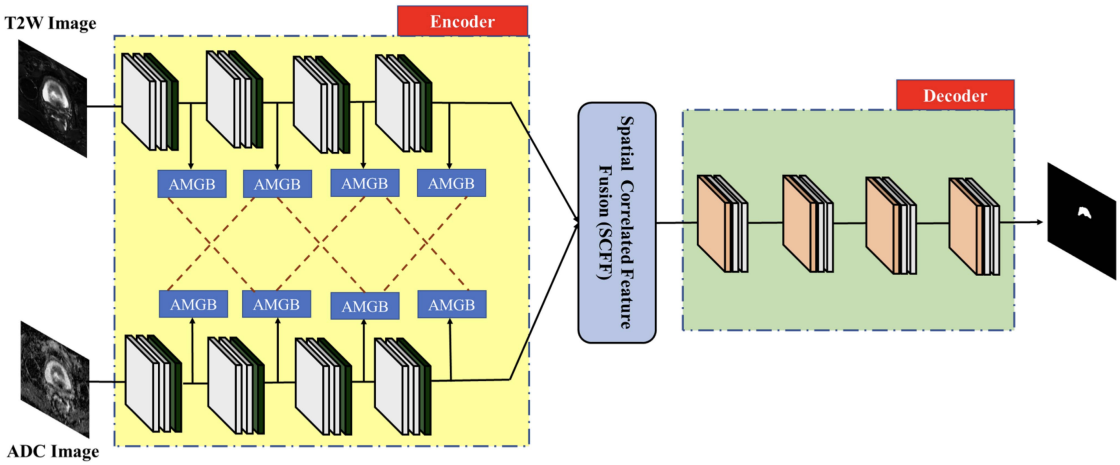

FIGURE 1 – Cross-modal prostate cancer segmentation [5].

Internship topic

In this context, we are interested in the development of multi-task networks that can simultaneously detect/segment lesions and characterize their clinical stage. The main methodological objective of the internship will be to take advantage of redundancies and complementarities between channels by considering four mp-MRI sequences (T2, ADC, B2000, perfusion), thereby extending bimodal fusion approaches previously proposed for PCa imaging that used only T2 and ADC [5]. A priority will be given to the development of innovative DL architectures that can leverage the various modalities through cross-modality learning [6].

Cross-modality learning is usually performed with architectures containing many layers specific to each modality, which does not allow to fully exploit potentially valuable inter-modal information.

Efforts will be devoted to the design of more compact models [8] by widely re-using network parameters (e.g., sharing convolution kernels between modalities). Through cross-modality learning, the contributions will aim at obtaining more accurate and synthetic models, with associated uncertainty quantification. Multi-modal medical Transformers models for segmentation and detection will be primarily considered, in line with prior research [8] conducted at LaTIM.

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 : P.-H. Conze (IMT Atlantique, LaTIM[2]) and V. Jaouen (IMT Atlantique, LaTIM)
- Applications by email to `pierre-henri.conze@imt-atlantique.fr` and `vincent.jaouen@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] G. Zhang et al., *Cross-modal prostate cancer segmentation via self-attention distillation.* IEEE Journal of Biomedical and Health Informatics, 2021.

[6] V. Valindria et al., *Multi-modal learning from unpaired images : application to multi-organ segmentation in CT and MRI.* Winter Conference on Applications of Computer Vision, 2018.

[8] A. Boutillon et al., *Generalizable multi-task, multi-domain deep segmentation of sparse pediatric imaging datasets via multi-scale contrastive regularization and multi-joint anatomical priors.* Medical Image Analysis, 2022.

[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`