3D Y-Net: Few-shot 3D Segmentation of Medical Images with Fourier Feature Networks

1. General Info

Project Title: 3D Y-Net: Few-shot 3D Segmentation of Medical Images with Fourier Feature Networks

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2. Project Abstract

In this project, we aim to perform the segmentation of 3D medical images with Fourier feature networks. In the first phase of the project, the Y-Net architecture [1] will be adapted to 3D volumes. The Fourier Convolutional layers will be adapted to 3D in the new architecture. The second phase will be done by training the 3D segmentation model in a few-shot setting [4]. The two phases can be done either in parallel by two groups of students or sequentially by all the students. The framework is preferred to be developed with MONAI [6].

3. Background and Motivation

Y-Net [1] is a new architecture for segmentation of 2D medical images which is able to extract both spatial and spectral domain features. The spectral features in Y-Net are extracted by Fourier Convolutional layers. This model outperforms SOTA in 2D images but is not tested with 3D volumes yet. The goal of this project is to first implement the network in 3D setting and evaluate its performance. Since the number of annotated volumes in medical datasets is limited, we intend to train the 3D segmentation model in few-shot setting using meta-learning [4] in the second phase of the project.

4. References

[1] Farshad, A., Yeganeh, Y., Gehlbach, P., & Navab, N. (2022). Y-Net: A Spatiospectral Dual-Encoder Network for Medical Image Segmentation. In International Conference on Medical Image Computing and Computer-Assisted Intervention (pp. 582-592). Springer, Cham.

[2] Roy, A. G., Siddiqui, S., Pölsterl, S., Navab, N., & Wachinger, C. (2020). Squeeze & excite guided few-shot segmentation of volumetric images. Medical image analysis, 59, 101587.

[3] Ouyang, C., Biffi, C., Chen, C., Kart, T., Qiu, H., & Rueckert, D. (2020, August). Self-supervision with superpixels: Training few-shot medical image segmentation without annotation. In European Conference on Computer Vision (pp. 762-780). Springer, Cham.

[4] Farshad, A., Makarevich, A., Belagiannis, V., & Navab, N. (2022). MetaMedSeg: Volumetric Meta-learning for Few-Shot Organ Segmentation. In MICCAI Workshop on Domain Adaptation and Representation Transfer (pp. 45-55). Springer, Cham.

[5] Tang, H., Liu, X., Sun, S., Yan, X., & Xie, X. (2021). Recurrent mask refinement for few-shot medical image segmentation. In Proceedings of the IEEE/CVF International Conference on Computer Vision (pp. 3918-3928).

[6] https://monai.io/

5. Technical Prerequisites

- Good background in machine learning and deep learning
- Experienced in PyTorch
- Experienced in Python
- Familiar with MONAI Framework (preferred)

6. Benefits:

- Weekly supervision and discussions
- Possible novelty of the research
- The results of this work are intended to be published in a conference or journal

7. Work packages and Time-plan:

* The dates are adopted from the previous year and are not finalized yet.

	Description	#Students	From	To
WP1	Familiarizing with the literature.	4	06.11	13.11
WP2	Familiarizing with the required frameworks. Come up with a detailed time-plan (gantt)	4	13.11	20.11
WP3	Implementing the 3D YNet Model	4	20.11	10.12
WP4	Evaluation of the implemented method	4	10.12	13.12
WP4	Comparison to related work + Preparing midterm presentation	4	13.12	20.12
M1	Intermediate Presentation II	4	20.12	
WP6	Implementing the few-shot setting	4	20.12	15.01
WP7	Evaluation and Comparison to SOTA	4	15.01	01.02
WP8	Final Presentation and Documentation	4	01.02	26.02
M2	Final Presentation	4	07.02	