Master thesis

Multi-Modal Image Registration by Domain-Invariant Feature Learning

Project Description

Diagnostic tasks, image-guided surgery and radiotherapy as well as motion analysis all rely heavily on accurate intra-patient image registration. Furthermore, inter-patient registration enables atlas-based segmentation or landmark localisation and shape analysis. While conventional deformable registration methods are based on computationally intensive iterative optimization, convolutional neural networks can estimate full-size deformation fields in one fast forward pass through the network [1]. However, multi-modal image registration is still one of the most challenging registration tasks, due to the inherent structural differences of the modalities and the missing dense ground truth (see Figure 1). The challenge is in learning modality-invariant features and using the right representative metrics for evaluating the registration performance for unlabeled and unaligned scans.

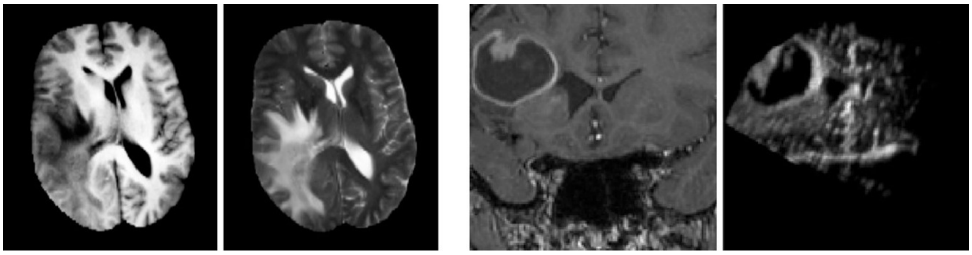

Figure 1: Left: T1-T2 MR Brain Dataset obtained from the MICCAI 2012 BRATS Challenge, Right: pre-operative T1-weighted MR and intra-operative (pre-resection) freehand ultrasound images [2]

The main goal in this project is to address the existing issues by proposing CNN based architectures based on modality-independent feature representation, while keeping the speed and quality comparable with the traditional iterative optimization approaches.

Requirements

Image analysis and deep learning, Python programming skills

Contact

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References

[1] Koen Eppenhof, Maxime Lafarge, Mitko Veta, and Josien Pluim. Progressively trained convolutional neural networks for deformable image registration. *IEEE Transactions on Medical Imaging*, 11 2019.

[2] Veronika A. Zimmer, Miguel Ángel González Ballester, and Gemma Piella. Multimodal image registration using laplacian commutators. *Information Fusion*, 49:130 – 145, 2019.