

NANCY: Combining Adversarial Networks with Cycle-Consistency for Robust Multi-Modal Image Registration

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Abstract : Multimodal image registration is a profoundly complex task which is why deep learning has been used widely to address it in recent years. However, two main challenges remain: Firstly, the lack of ground truth data calls for an unsupervised learning approach, which leads to the second challenge of defining a feasible loss function that can compare two images of different modalities to judge their level of alignment. To avoid this issue altogether we implement a generative adversarial network consisting of two registration networks GAB, GBA and two discrimination networks DA, DB connected by spatial transformation layers. GAB learns to generate a deformation field which registers an image of the modality B to an image of the modality A. To do that, it uses the feedback of the discriminator DB which is learning to judge the quality of alignment of the registered image B. GBA and DA learn a mapping from modality A to modality B. Additionally, a cycle-consistency loss is implemented. For this, both registration networks are employed twice, therefore resulting in images \tilde{A} and \tilde{B} which were registered to \tilde{B} and \tilde{A} which were registered to the initial image pair A, B. Thus the resulting and initial images of the same modality can be easily compared. A dataset of liver CT and MRI was used to evaluate the quality of our approach and to compare it against learning and non-learning based registration algorithms. Our approach leads to dice scores of up to 0.80 \pm 0.01 and is therefore comparable to and slightly more successful than algorithms like SimpleElastix and VoxelMorph.

Keywords : cycle consistency, deformable multimodal image registration, deep learning, GAN

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