



Abstract: Focused Unsupervised Image Registration for Structure-specific Population Analysis

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Population-based analysis of medical images plays an essential role in identification and development of imaging biomarkers. Most commonly the focus lies on a single structure or image region in order to identify variations to discriminate between patient groups. In many applications, existing automatic segmentation tools or trained neural networks are used to identify relevant image structures. However, if new structures are to be analyzed, these approaches have the disadvantage that extensive manually segmented image data are required for development and training. Thus, in our paper [1], we focus on atlas-based segmentation methods for the analysis of image populations. Since, most frequently, high segmentation accuracy is only required in specific image regions while the accuracy in the remaining image area is of less importance, we propose an efficient ROI-based approach for unsupervised learning of deformable atlas-to-image registration to facilitate structure-specific analysis. The proposed approach features a multi-stage registration pipeline using a transformer-based architecture to perform atlas-to-image transfer at high resolution in the specified region of interest and at low resolution in the remaining image space. This reduces computational cost in terms of memory consumption, computation time and energy consumption without significant accuracy loss in the region of interest. The proposed method was evaluated for predicting cognitive impairment from morphological changes of the hippocampal region in brain MRI images. We compare our approach with models trained on full-resolution and half-resolution images, as well as with a U-net based registration network and iterative optimization-based registration methods. The experiments show that next to the efficient processing of 3D data, our method delivers accurate registration results comparable to state-of-the-art segmentation tools. Furthermore, the proposed method better captures morphological changes in a desired region of interest enabling better distinguishing between different cohorts.

References

1. Ehrhardt J, Uzunova H, Kaftan P, Krüger J, Opfer R, Handels H. Focused unsupervised image registration for structure-specific population analysis. Proc Med Imaging.