



Abstract: Guided Filter Regularization for Improved Disentanglement of Shape and Appearance in Diffeomorphic Autoencoders

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The disentanglement of shape and appearance is a prominent computer vision task, that has become relevant in the medical imaging domain in recent years. Medical images are often acquired in different hospitals, by different devices and using different parameters, resulting in varying intensity profiles. However, when performing population-based analysis over various datasets, e.g. from different hospitals, it is important to be able to distinguish between changes in the anatomical shapes and device-dependent intensity changes. Diffeomorphic and deforming autoencoders are commonly applied for appearance and shape disentanglement. Both models are based on the deformable template paradigm, however, they show some weaknesses for the representation of medical images. On the one hand, diffeomorphic autoencoders generate a global template for the whole dataset, however, they only consider spatial deformations. On the other hand, deforming autoencoders also regard changes in the appearance, yet, no uniform template is generated for the whole training dataset and the appearance is modeled using only a very few parameters. In the presented work [1], we propose a method that represents images based on a global template, where next to the spatial displacement, the appearance is modeled as the pixel-wise intensity difference to the unified template. To ensure that the generated appearance offsets adhere to the shape defined by the template, a guided filter smoothing of the appearance map is integrated into an end-to-end training process. In the experiments performed on brain MRIs, this regularization approach shows significant improvement of the disentanglement of shape and appearance. Furthermore, the generated templates are crisper and improved registration accuracy can be achieved. Our experiments also underline that the proposed approach can be utilized in the field of automatic population analysis.

References

1. Uzunova H, Handels H, Ehrhardt J. Guided filter regularization for improved disentanglement of shape and appearance in diffeomorphic autoencoders. Proc Mach Learn Res. 2021;143:774–86.