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Abstract

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Recent Advances in Deep Neural Networks with Morphological Operators to Improve Semantic Segmentation of Histological Images

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The present study aims at automatically quantifying the melanin pigment on histological images from cross-sections of reconstructed human skin after Fontana Masson staining, in order to evaluate pro- or de-pigmenting potential of cosmetic ingredients. Whole Slide Imaging (WSI) allows acquiring a large number of large field-of-view images with millions of pixels, such that image processing becomes essential. Given that melanin is to be quantified within each skin compartment, the first processing step consists in the segmentation of the different skin layers: stratum corneum, living epidermis and living dermis (3 interfaces to be detected). However, due to the variability of experimental conditions, images aspect and color characteristics can change between studies or samples. The challenge of this study was to perform a robust segmentation even if the tissue and/or the acquisition conditions are different.

Deep neural networks (DNNs) for semantic segmentation of color-stained histological images constitute an active topic of research. The use of fully convolutional networks allows applying models to images of varying sizes which is convenient in histopathology image analysis. In this context, segmentation is considered as an image-to-image transform. This transform can be learnt by training DNNs architectures such as U-net [1]. However, these methods require a sufficient number of images to cover the variability encountered in image acquisition. To overcome this issue, many authors have explored preprocessing techniques, multi-resolution decomposition and/or data-augmentation techniques to facilitate the training of DNNs.

Three main contributions are presented in this paper. At first, the implementation of a new random sampling protocol for on-the-fly training; Second, improvements to the standard U-net architecture and, Third the inclusion of

morphological layers in this U-net architecture to take into consideration prior information about the shape/size of objects to be detected in the image. These modifications are well suited to handle the large variability within the data. Using the proposed on-the-fly training protocol allows us to learn a model that performs much better than competing methods even on a heterogeneous image database.

References

[1] O. Ronneberger, P. Fischer, and T. Brox. "U-net: Convolutional networks for biomedical image segmentation." MICCAI, pp. 234–241, 2015.