CAN GEODESIC INFORMATION HELP CONVOLUTIONAL NEURAL NETWORKS? APPLICATION TO THE SEGMENTATION OF FONTANA MASSON HISTOLOGICAL IMAGES OF PIGMENTED RECONSTRUCTED EPIDERMIS

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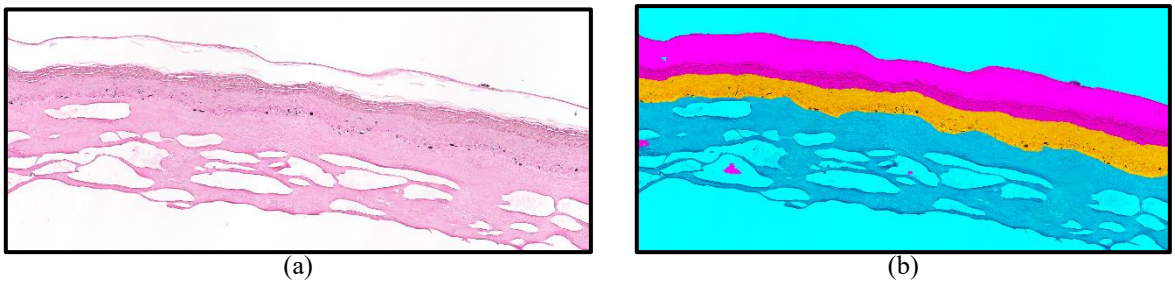
During the past years, the way of working in the histological field has changed due to the emergence of Whole Slide Imaging (WSI) solutions that are now available and useful for pathologists but also for dermatologists and cosmetologists. These automated scanners improve digital histology by allowing several hundred slides a day to being acquired through imaging process, and stored, used for second opinions or for automated analysis.

This well-established technology provides large sets of image data that need to be automatically processed whatever the amount of generated data. Image analysis methods based on *Deep Learning* have proved to be extremely useful in this field [1]. For image segmentation tasks, *Deep Learning* approaches use mainly convolutional neural networks [2]. However, these networks can only process local information. In the current study, non-local information was essential to correctly segment images.

The images that were collected include pigmented reconstructed epidermis samples used to evaluate and identify the de-pigmenting or pro-pigmenting efficiency of cosmetic ingredients. They have been colored using a Fontana Masson staining, a silver stain that is used to highlight melanin and to also reveal skin layer morphology. Their sizes are diverse and can reach up to 20 million pixels. The ground truth has been obtained by an automatic method developed by the ADCIS company, whose results were manually edited and modified by L'Oréal experts, when needed.

On those images, the goal of the segmentation is to identify two regions corresponding to two specific skin layers: the *stratum corneum* (SC) and the living epidermis (see Figure 1).



(a) (b)

Figure 1: *(a) Original image.*
(b) Original image with the automatic layer detection: stratum corneum (magenta), living epidermis (orange) and other regions (cyan).

The boundary between the SC and the background is usually rather difficult to determine, mainly because it can be composed of different layers separated by gaps due to the desquamation process that happens in the SC. Such layers are only considered as part of the SC if they constitute an unbroken boundary between the background and the sample. This feature is highly non local, and as such a convolutional neural network cannot enforce it.

To circumvent this, we use two different non-local approaches based on geodesic operators that are quite popular in mathematical morphology. The first solution is based on the addition of an extra input channel to the convolutional network containing the connected component of the background touching the top of the image. The second solution is based on the reconstruction by erosion from the top and the bottom of the image to propagate information about the connectivity to the whole image.

Both methods are giving satisfactory results, but each has some benefits and drawbacks, that will be discussed during the presentation.

REFERENCES

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