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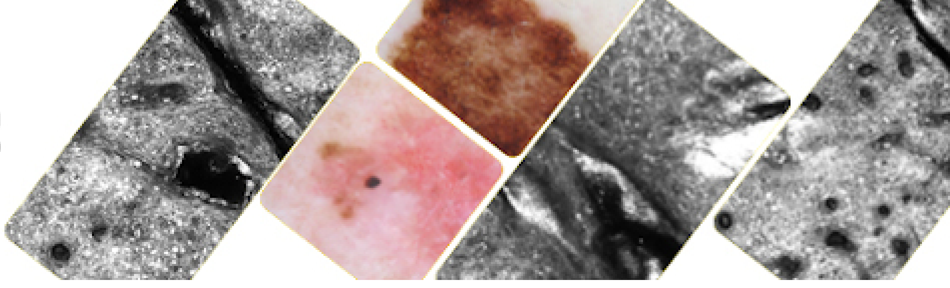

Deep learning-based skin layers segmentation for automatic quantitative metrics extraction

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Introduction

The morphology of skin layers and the quantitative metrics derived from them are underexplored in the diagnosis of skin diseases, mainly due to the complexity and time required for their extraction. Accurate detection of these layers are critical for enabling these analyses. In this study, we present a deep learning-based segmentation model to identify and segment the stratum corneum, epidermis, and dermis from line-field confocal optical coherence tomography (LC-OCT) images.

Materials & methods

The model, based on the U-Net convolutional neural network architecture, was trained and validated on a dataset of over 2,500 vertical LC-OCT images, encompassing various anatomical locations and including samples from both healthy individuals and patients with skin conditions such as inflammatory diseases and actinic keratosis. All images were annotated by LC-OCT clinical experts to ensure high-quality data.

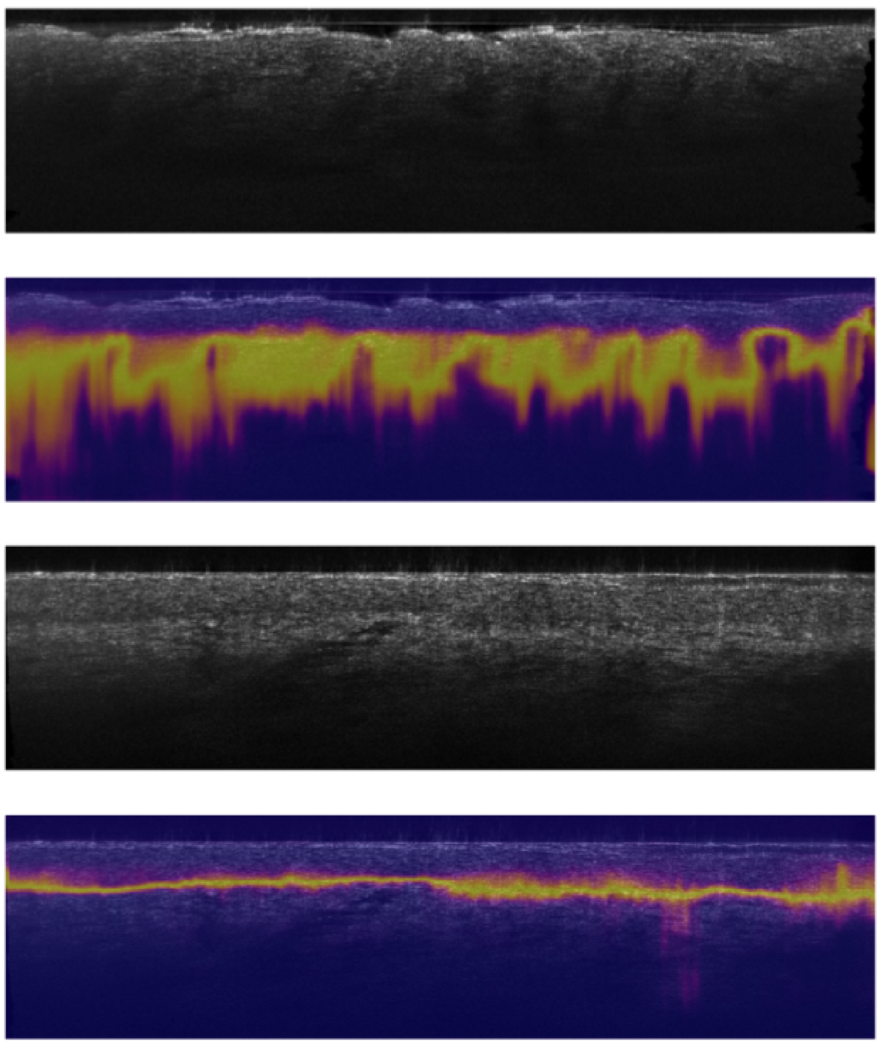

Figure 2: Top: LC-OCT image ; bottom: LC-OCT image with an overlay of the entropy of segmentation model on the epidermis class (violet indicates low entropy, yellow indicates high entropy)

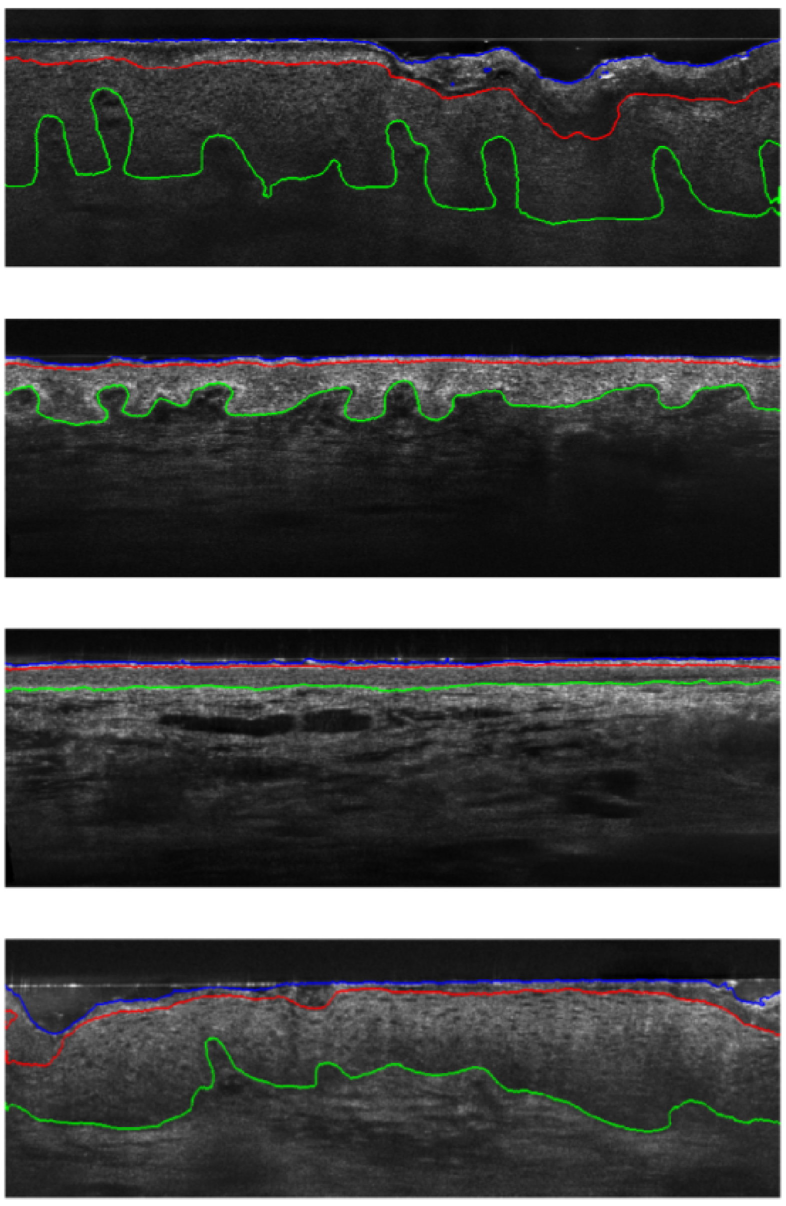

Figure 1: LC-OCT image with drawn AI-predicted contours (blue: surface, red: junction between stratum corneum and epidermis, green: dermoepidermal junction). From top to bottom: inflammatory disease, pigmented healthy skin, healthy skin, actinic keratosis.

Results

The model achieved a average Dice score of 0.95 across three skin layers and five cross-validation folds. This accuracy enables automatic, non-invasive extraction of key metrics like skin layer thickness, dermoepidermal junction (DEJ) undulation, and protrusion detection. These insights could improve skin disease classification and diagnosis. Furthermore, our study shows the potential to use model uncertainty as an indicator of atypical morphological features, such as disruptions in the DEJ, which are often associated with melanocytic lesions.

Conclusion

The integration of deep learning with LC-OCT imaging opens up new avenues for non-invasive, rapid, and precise skin disease diagnostics. Future research will focus on refining these models for other skin conditions and expanding their use to monitor disease progression and treatment response, ultimately improving patient outcomes.