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Automated Identification of Hand Dermatitis Using U-Net-Based Segmentation Model

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Abstract. Hand dermatitis is a prevalent inflammatory skin condition that affects 10-15% of the general populace, often posing diagnostic challenges due to its varied causes and presentations, especially in the early diagnostic stages. This work utilizes a U-Net architecture for automated hand dermatitis detection and segmentation. Our dataset comprises 700 images of diseased hands and an equal number of non-diseased hands, carefully curated from various sources. Data augmentation techniques enhanced dataset diversity for diseased hands, especially to combat scarce data issues. The U-Net model was trained for 20 epochs by leveraging both binary cross-entropy and Dice loss together, achieving a training accuracy of 99.59% and a validation accuracy of 99.12%. The model demonstrated a Dice coefficient of 0.85 and an Intersection over Union (IoU) of 0.78, indicating strong segmentation performance. These results highlight the model's potential in aiding early diagnosis and distinguishing between diseased and non-diseased hands. Despite data limitations, the model's promising results suggest avenues for future improvements, including more extensive and more diverse datasets and exploring other skin conditions for differential diagnosis.

Keywords: Hand dermatitis, U-Net, Semantic segmentation, Image augmentation, Binary classification, Medical image analysis, Deep Neural Networks

1 Introduction

Hand dermatitis, or hand eczema, is a commonly occurring inflammatory skin disease impacting up to 10-15% of the normal population [1]. It accounts for nearly 20-35% of all dermatitis cases. [2] It mainly impacts both the dorsal and palmar sides of the hands and can be either acute or chronic. It is more commonly occurring in females than males, with young female adults being the largest group affected in that demographic. [3] It has a variety of causes, and often a combination of causes, mainly genetic and/or unknown factors (called constitutional hand dermatitis), and immune reactions or allergies (allergic contact dermatitis), and injury (contact irritant dermatitis). Common symptoms observed include irritation and itching, redness, burning sensations, and, in advanced cases (acute and chronic), swelling, blistering, fissures, and even lichenification. [4] Diagnosing hand dermatitis involves examinations, classification via history, patch tests, and even biopsies in extreme cases, with many options for differential diagnosis. However, mainly and especially in early-stage diagnosis, it is a visual and progressive review process, making it time-consuming and cumbersome. [5] Automated identification using deep learning-based neural networks has shown significant disease identification and medical image analysis results. U-net-based applications have been popular because they can segment images, making minute distinctions easier precisely. While revolutionary, they also require copious amounts of data to train but are known to provide good results if successfully trained and tested. This paper explores the application of U-net in identifying hand dermatitis, focusing on identifying diseased hands as part of the early diagnosis stages.