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The role of data augmentation on the performance of automated lesion classification in the presence of imaging artifacts: An evaluation of the 2019 ISIC Challenge PP Bedeschi, K Bose and V Rotemberg Memorial Sloan Kettering Cancer Center, New York, New York, United States

Convolutional Neural Networks (CNNs) have been shown to achieve dermatologist level accuracy for skin lesion diagnosis, but models have been limited by size and difficulties in training datasets. Data augmentation adds alterations (e.g., blur, flipping, etc.) to images to increase classifier robustness to real-world perturbations and artifacts. We identified the augmentation techniques used in 123 submissions to the International Skin Imaging Collaboration (ISIC) 2019 Grand Challenge and compared each classifier’s performance on images with and without artifacts. We developed a multiclass-multilabel CNN trained to detect artifacts seen in clinic: hair, blur, rulers, and pen markings, and achieved Area under the curve (AUC) of 79% and 74% for normal and artifact containing images respectively. Training on augmented dataset increased the accuracy in 72% and 66% of algorithms respectively, while ruler markings increased the accuracy in 70%. No specific augmentation technique was tied to improved or diminished performance. When using only 16/123 algorithms trained on normal and blur and had a 26% better performance than those that did not (p=0.0014). The top 5 algorithms had an average of 8.2 augmentation techniques (59% accuracy) compared to 1.4 in the bottom 5 (18% accuracy), supporting that data augmentation is vital for performance. Our work will shape the development of classifiers for melanoma diagnosis. We introduce a novel artifact classifier useful for quality assurance of dermoscopic images. We show that the diagnostic performance on images with artifacts is unaffected by augmentation techniques used, whereas blur is. Machine learning in dermatology may require data augmentation mirroring artifacts seen in clinic, such as artificial hair and pen marker generation. These results will improve the real-world applicability of automated dermatologic classifiers.

Clinical improvement in primary cicatricial alopecias following mast cell stabilizer treatment

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Primary cicatricial alopecia (PCA), often referred as scarring alopecia, is a group of disorders that result in permanent hair loss, and for which no FDA approved treatments exist. Common forms of PCA include Lichen Planopilaris (LPP), Frontal Fibrosing Alopecia (FFA) and Central Centriliguric Cicatricial Alopecia (CCCA), with LPP predominating in middle aged white women, FFA in the postmenopausal group, and CCCA in women of African descent. FFA is considered to be a variant of LPP, and CCCA shares several pathological features with advanced LPP; however, whether PCAs are separate diseases or share common pathological mechanisms remains an unresolved question. To determine if PCAs are molecularly distinct, we performed a high-content RNAseq from 26 LPP, 30 FFA, and 15 CCCA patients compared to 12 normal controls. This revealed a core set of dysregulated pathways shared among all PCA subtypes: 1) downregulated cholesterogenic genes (CYP51A1, NSDHL), 2) upregulated fibrosis and scarring genes (COL1A1, BMP10, CLDN5), and 3) a striking enrichment of mast cell genes (TPSAB1, MS4A2, CMA1). Notably, positive staining for mast cells (MC tryptase) was detected near the sebaceous glands of PCAs and not in controls. We also found that each subtype was associated with unique pathways, such as JAKSTAT signaling in CCCA, indicating potential molecular signatures within each subtype. To investigate the clinical significance of mast cells in PCAs, we treated 37 patients with the oral mast cell stabilizer drug, cromomlyn. Five patients reported improvement within 6 weeks and 3 continued to report transient improvement of symptoms after 3 months. While clinical improvement was transient, improvement of symptoms after 3 months. While clinical improvement was transient, improvement was not tied to finding any specific augmentation technique. We suggest that mast cell stabilizer treatment could be considered in PCA treatment strategies.

Automated atopic dermatitis severity assessment based on convolutional neural networks

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Convolutional neural networks (CNNs) is artificial intelligence (AI) neural network that can provide a binary or multiclass classification for the diagnosis of various skin disorders. However, there has been a challenge to predict the severity of skin disorders with CNNs. Here we invesigated the optimal preprocessing conditions and performance of trained CNN models to grade the severity of atopic dermatitis (AD). Five board-certified dermatologists independently graded the severity of 9192 cropped AD images (8189 from Seoul National University Hospital (SNUBH) and 1003 from Seoul National University Bundang Hospital (SNUBH)) based on the 4-scale Investigator Global Assessment (IGA). The dataset from SNUBH was divided into a training/validation set (6623 images) and a testing set (1566 images), while that from SNUBH was set as an external validation set. For training, the Inception-ResNet-V2 CNN architecture was employed using three distinct approaches; (1) combination of five gradings (integrated model) vs. training with each grading and combining the results (sum of individual models), (2) median values (one-hot encoding vs. distributions from five gradings (softmax), and (3) all training dataset vs. dataset with aggregation among three and more dermatologists (exclusion of noisy data). Ground truth was determined as the median value of five gradings. The CNN model using an integrated, one-hot encoding approach without noisy data outperformed other models both for a testing set (accuracy: 73%, macro-averaged AUC: 0.93, and macro-averaged F1-score: 0.71) and external validation set (accuracy: 72%, macro-averaged AUC: 0.93, and macro-averaged F1-score: 0.69). The CNN model can help to evaluate the severity of AD more objectively. Proper preprocessing can improve the performance of medical AI algorithms.

3D head visualization for mapping and tracking dermatological conditions

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Tracking or quantifying changes in hair and skin conditions over time is a task usually left up to the clinician: the affected areas (or images therein) are either compared to the photos taken during prior visits or a standard reference scale is used to compare the condition to a limited set of images or drawings to determine the severity level of the current state. While automated skin detection algorithms are gaining traction for binary diagnostic tasks or to segment areas of interest at a particular time-point, tracking changes automatically remains challenging due to the lack of easily accessible and affordable systems that can be used to quantitatively compare the changes in a standardized way. Focusing on tracking conditions that occur on the head, we present a new method to recover a clinically relevant model of a person’s head, defined as the complete 3D head surface in the absence of hair volume, starting only with a video taken from a single hand-held camera. Using techniques from computer vision, more specifically structure-from-motion and multi-view stereo, we determine first the shape of each person’s head and then the segment of the fitted 3D head for all video frames to recover texture mapping information, irrespective of the person’s pose. This alignment is then used to map and visualize hair or skin information, for example disease quantifications, onto the head model by finding changes in the condition over time. We demonstrate that our approach recovers a consistent geometry for varying head shapes, from videos taken by different people, with different smartphones, and in a variety of uncontrolled environments such as outdoors, living rooms, and hallways, and hence, can be applied to the clinical setting as well. Furthermore, once the head model of one person has been recovered, it can also be used in augmented reality compatible smartphones to guide image capture and map dermatological quantifications for integration in the clinic.