LITERATURE SURVEY

1 **Paper Title:** AI-based localization and classification of skin disease with erythema.

Authors: Ha Min Son, Wooho Jeon, Jinhyun Kim, Chan Yeong Heo, Hye Jin Yoon, Ji-Ung Park & Tai-Myoung Chung

Abstract: Although computer-aided diagnosis (CAD) is used to improve the quality of diagnosis in various medical fields such as mammography and colonography, it is not used in dermatology, where noninvasive screening tests are performed only with the naked eye, and avoidable inaccuracies may exist. This study shows that CAD may also be a viable option in dermatology by presenting a novel method to sequentially combine accurate segmentation and classification models. Given an image of the skin, we decompose the image to normalize and extract high-level features. Using a neural network-based segmentation model to create a segmented map of the image, we then cluster sections of abnormal skin and pass this information to a classification model. We classify each cluster into different common skin diseases using another neural network model. Our segmentation model achieves better performance compared to previous studies, and also achieves a near-perfect sensitivity score in unfavorable conditions. Our classification model is more accurate than a baseline model trained without segmentation, while also being able to classify multiple diseases within a single image. This improved performance may be sufficient to use CAD in the field of dermatology.

Disadvantages:

Algorithms are generally designed to select a single likely diagnosis, thus providing suboptimal results for patients with multiple, concurrent disorders.

2 Paper Title: AI-based detection of erythema migrans and disambiguation against other skin lesions.

Authors: Philippe M.Burlina, Neil J.Joshi, Phil A.Mathew, WilliamPaul, Alison W.Rebman, John N.Aucott.

Abstract: This study examines the use of AI methods and deep learning (DL) for pre-screening skin lesions and detecting the characteristic erythema migrans rash of acute Lyme disease. Accurate identification of erythema migrans allows for early diagnosis and treatment, which avoids the potential for later neurologic, rheumatologic, and cardiac complications of Lyme disease. We develop and test several deep learning models for detecting erythema migrans versus several other clinically relevant skin conditions, including cellulitis, tinea corporis, herpes zoster, erythema multiforme, lesions due to tick bites and insect bites, as well as non-pathogenic normal skin. We consider a set of clinically-relevant binary and multiclass classification problems of increasing complexity. We train the DL models on a combination of publicly available images and test on public images as well as images obtained in the clinical setting. We report performance metrics that measure agreement with a gold standard, as well as a receiver operating characteristic curve and associated area under the curve. On public images, we find that the DL system has an accuracy ranging from 71.58% (and 95% error margin equal to 3.77%) for an 8-class problem of EM versus 7 other classes including other skin pathologies, insect bites and normal skin, to 94.23% (3.66%) for a binary problem of EM vs. non-pathological skin. On clinical images of affected individuals, the DL system has a sensitivity of 88.55% (2.39%). These results suggest that a DL system can help in pre-screening and referring individuals to physicians for earlier diagnosis and treatment, in the presence of clinically relevant confusers, thereby reducing further complications and morbidity.

Disadvantages:

Deep Learning requires very large amount of data in order to perform better than other techniques.

3 **Paper Title:** The mathematics of erythema: Development of machine learning models for artificial intelligence assisted measurement and severity scoring of radiation induced dermatitis.

Authors: Rahul Ranjan, Richard Partl, Ricarda Erhart, Nithin Kurup, Harald Schnidar

Abstract: Although significant advancements in computer-aided diagnostics using artificial intelligence (AI) have been made, to date, no viable method for radiation-induced skin reaction (RISR) analysis and classification is available. The objective of this single-center study was to develop machine learning and deep learning approaches using deep convolutional neural networks (CNNs) for automatic classification of RISRs according to the Common Terminology Criteria for Adverse Events (CTCAE) grading system. Scarletred® Vision, a novel and state-of-the-art digital skin imaging method capable of remote monitoring and objective assessment of acute RISRs was used to convert 2D digital skin images using the CIELAB color space and conduct SEV* measurements. A set of different machine learning and deep convolutional neural network-based algorithms has been explored for the automatic classification of RISRs. A total of 2263 distinct images from 209 patients were analyzed for training and testing the machine learning and CNN algorithms. For a 2-class problem of healthy skin (grade 0) versus erythema (grade ≥ 1), all machine learning models produced an accuracy of above 70%, and the sensitivity and specificity of erythema recognition were 67–72% and 72–83%, respectively. The CNN produced a test accuracy of 74%, sensitivity of 66%, and specificity of 83% for predicting healthy and erythema cases. For the severity grade prediction of a 3-class problem (grade 0 versus 1 versus 2), the overall test accuracy was 60–67%, and the sensitivities were 56–82%, 35–59%, and 65–72%, respectively. For estimating the severity grade of each class, the CNN obtained an accuracy of 73%, 66%, and 82%, respectively. Ensemble learning combines several individual predictions to obtain a better generalization performance. Furthermore, we exploited ensemble learning by deploying a CNN model as a meta-learner. The ensemble CNN based on bagging and majority voting shows an accuracy, sensitivity and specificity of 87%, 90%, and 82% for a 2-class problem, respectively. For a 3-class problem, the ensemble CNN shows an overall accuracy of 66%, while for each grade (0, 1, and 2) accuracies were 76%, 69%, and 87%, sensitivities were 70%, 57%, and 71%, and specificities were 78%, 75%, and 95%, respectively. This study is the first to focus on erythema in radiation-dermatitis and produces benchmark results using machine learning models. The outcome of this study validates that the proposed system can act as a pre-screening and decision support tool for oncologists or patients to provide fast, reliable, and efficient assessment of erythema grading.

Disadvantages: CNN fails to encode the position and orientation of objects. They have a hard time classifying images with different positions.

4 **Paper Title:** Studies on different CNN algorithms for face skin disease classification based on clinical images

Authors: Zhe Wu, Shuang Zhao, Yonghong Peng, Xiaoyu He, Xinyu Zhao, Kai Huang, Xian Wu, Wei Fan , Fangfang Li, Mingliang Chen, Jie Li, Weihong Huang, Xiang Chen, Yi Li.

Abstract: Skin problems not only injure physical health but also induce psychological problems, especially for patients whose faces have been damaged or even disfigured. Using smart devices, most people are able to obtain convenient clinical images of their face skin condition. On the other hand, convolutional neural networks (CNNs) have achieved near or even better performance than human beings in the imaging field. Therefore, this paper studied different CNN algorithms for face skin disease classification based on clinical images. First, from Xiangya-Derm, which is, to the best of our knowledge, China's largest clinical image dataset of skin diseases, we established a dataset that contains 2656 face images belonging to 6 common skin diseases (seborrheic keratosis (SK), actinic keratosis (AK), rosacea (ROS), lupus erythematosus (LE), basal cell carcinoma (BCC), and squamous cell carcinoma (SCC)). We performed studies using 5 mainstream network algorithms to classify these diseases in the dataset and compared the results. Then, we performed studies using an independent dataset of the same disease types, but from other body parts, to perform transfer learning on our models. Comparing the performances, the models that used transfer learning achieved a higher average precision and recall for almost all structures. In the test dataset, which included 388 facial images, the best model achieved 92.9%, 89.2%, and 84.3% recall for LE, BCC, and SK, respectively, and the mean recall and precision reached 77.0% and 70.8%.

Disadvantages: The number of SK images is significantly more than the number of AK images which causes misclassification.

5 **Paper Title:** Skin Diseases Classification Using Hybrid AI Based Localization Approach

Authors: N. Rajkumar, R. Sugumar, K. V. Daya Sagar, R. Shobarani, K. Parthiban Krishnamoorthy, A. K. Saini, H. Palivelaand, A. Yeshitla

Abstract: One of the most prevalent diseases that can be initially identified by visual inspection and further identified with the use of dermoscopic examination and other testing is skin cancer. Since eye observation provides the earliest opportunity for artificial intelligence to intercept various skin images, some skin lesion classification algorithms based on deep learning and annotated skin photos display improved outcomes. The researcher used a variety of strategies and methods to identify and stop diseases earlier. All of them yield positive results for identifying and categorizing diseases, but proper disease categorization is still lacking. Computer-aided diagnosis is one of the most crucial methods for more accurate disease detection, although it is rarely used in dermatology. For Feature Extraction, we introduced Spectral Centroid Magnitude (SCM). The given dataset is classified using an enhanced convolutional neural network; the first stage of preprocessing uses a median filter, and the final stage compares the accuracy results to the current method.

Disadvantages: Analyzing big data is one of the biggest challenges of CAD.

6 Paper Title: Human–computer collaboration for skin cancer recognition.

Authors: Philipp Tschandl, Christoph Rinner, Zoe Apalla, Giuseppe Argenziano, Noel Codella, Allan Halpern, Monika Janda, Aimilios Lallas, Caterina Longo, Josep Malvehy, John Paoli, Susana Puig, Cliff Rosendahl, H. Peter Soyer, Iris Zalaudek & Harald Kittler

Abstract: The rapid increase in telemedicine coupled with recent advances in diagnostic artificial intelligence (AI) create the imperative to consider the opportunities and risks of inserting AI-based support into new paradigms of care. Here we build on recent achievements in the accuracy of image-based AI for skin cancer diagnosis to address the effects of varied representations of AI-based support across different levels of clinical expertise and multiple clinical workflows. We find that good quality AI-based support of clinical decision-making improves diagnostic accuracy over that of either AI or physicians alone, and that the least experienced clinicians gain the most from AI-based support. We further find that AI-based multiclass probabilities outperformed content-based image retrieval (CBIR) representations of AI in the mobile technology environment, and AI-based support had utility in simulations of second opinions and of telemedicine triage. In addition to demonstrating the potential benefits associated with good quality AI in the hands of non-expert clinicians, we find that faulty AI can mislead the entire spectrum of clinicians, including experts. Lastly, we show that insights derived from AI class-activation maps can inform improvements in human diagnosis. Together, our approach and findings offer a framework for future studies across the spectrum of image-based diagnostics to improve human–computer collaboration in clinical practice.

Disadvantages:

Low level features are not able to describe and interpret semantically the context of the images such as colour, gradient orientation with the content of the image seen.

7 Paper Title: Computer-aided diagnosis of skin diseases using deep neural networks

Authors: Muhammad Naseer Bajwa,Kaoru Muta,MuhammadImran Malik,Shoaib Ahmed Siddiqui,Stephan Alexander Braun , Bernhard Homey ,Andreas DengelandSheraz Ahmed.

Abstract: Propensity of skin diseases to manifest in a variety of forms, lack and maldistribution of qualified dermatologists, and exigency of timely and accurate diagnosis call for automated Computer-Aided Diagnosis (CAD). This study aims at extending previous works on CAD for dermatology by exploring the potential of Deep Learning to classify hundreds of skin diseases, improving classification performance, and utilizing disease taxonomy. We trained state-of-the-art Deep Neural Networks on two of the largest publicly available skin image datasets, namely DermNet and ISIC Archive, and also leveraged disease taxonomy, where available, to improve classification performance of these models. On DermNet we establish new state-of-the-art with 80% accuracy and 98% Area Under the Curve (AUC) for classification of 23 diseases. We also set precedence for classifying all 622 unique sub-classes in this dataset and achieved 67% accuracy and 98% AUC. On ISIC Archive we classified all 7 diseases with 93% average accuracy and 99% AUC. This study shows that Deep Learning has great potential to classify a vast array of skin diseases with near-human accuracy and far better reproducibility. It can have a promising role in practical real-time skin disease diagnosis by assisting physicians in large-scale screening usingclinical or dermoscopic images.

Disadvantages:

Non-visual metadata is not normally available with most of the medical image datasets, if such additional information is available DNNs are capable of utilizating it and improving their classification performance.

8 **Paper Title:** Artificial intelligence-based image classification methods for diagnosis of skin cancer.

Authors: Manu Goyal , Thomas Knackstedt , Shaofeng Yan , SaeedHassanpour

Abstract: Recently, there has been great interest in developing Artificial Intelligence (AI) enabled computer-aided diagnostics solutions for the diagnosis of skin cancer. With the increasing incidence of skin cancers, low awareness among a growing population, and a lack of adequate clinical expertise and services, there is an immediate need for AI systems to assist clinicians in this domain. A large number of skin lesion datasets are available publicly, and researchers have developed AI solutions, particularly deep learning algorithms, to distinguish malignant skin lesions from benign lesions in different image modalities such as dermoscopic, clinical, and histopathology images. Despite the various claims of AI systems achieving higher accuracy than dermatologists in the classification of different skin lesions, these AI systems are still in the very early stages of clinical application in terms of being ready to aid clinicians in the diagnosis of skin cancers. In this review, we discuss advancements in the digital image-based AI solutions for the diagnosis of skin cancer, along with some challenges and future opportunities to improve these AI systems to support dermatologists and enhance their ability to diagnose skin cancer.

Disadvantages:

The performance of a deep learning algorithm usually suffers from unbalanced datasets, despite using tuning tricks like a penalty for false negatives found in minor skin lesion classes during training using custom loss function.

9 Paper Title: Deep Learning Based Decision Support for Medicine--A Case Study on Skin Cancer Diagnosis.

Authors: Adriano Lucieri, Andreas Dengel, Sheraz Ahmed

Abstract: Early detection of skin cancers like melanoma is crucial to ensure high chances of survival for patients. Clinical application of Deep Learning (DL)-based Decision Support Systems (DSS) for skin cancer screening has the potential to improve the quality of patient care. The majority of work in the medical AI community focuses on a diagnosis setting that is mainly relevant for autonomous operation. Practical decision support should, however, go beyond plain diagnosis and provide explanations. This paper provides an overview of works towards explainable, DL-based decision support in medical applications with the example of skin cancer diagnosis from clinical, dermoscopic and histopathologic images. Analysis reveals that comparably little attention is payed to the explanation of histopathologic skin images and that current work is dominated by visual relevance maps as well as dermoscopic feature identification. We conclude that future work should focus on meeting the stakeholder's cognitive concepts, providing exhaustive explanations that combine global and local approaches and leverage diverse modalities. Moreover, the possibility to intervene and guide models in case of misbehaviour is identified as a major step towards successful deployment of AI as DL-based DSS and beyond.

Disadvantages:

The model training using CNN leads to issues like overfitting, exploding gradient, class imbalance etc and these can ultimately diminish the performance of the model.

10 Paper Title: Intelligent dermatologist tool for classifying multiple skin cancer subtypes by incorporating manifold radiomics features categories.

Authors: Omneya Attallahand Maha Sharkas

Abstract: *The rates of skin cancer (SC) are rising every year and becoming a critical health issue worldwide. SC's early and accurate diagnosis is the key procedure to reduce these rates and improve survivability. However, the manual diagnosis is exhausting, complicated, expensive, prone to diagnostic error, and highly dependent on the dermatologist's experience and abilities. Thus, there is a vital need to create automated dermatologist tools that are capable of accurately classifying SC subclasses. Recently, artificial intelligence (AI) techniques including machine learning (ML) and deep learning (DL) have verified the success of computer-assisted dermatologist tools in the automatic diagnosis and detection of SC diseases. Previous AI-based dermatologist tools are based on features which are either high-level features based on DL methods or low-level features based on handcrafted operations. Most of them were constructed for binary classification of SC. This study proposes an intelligent dermatologist tool to accurately diagnose multiple skin lesions automatically. This tool incorporates manifold radiomics features categories involving high-level features such as ResNet-50, DenseNet-201, and DarkNet-53 and low-level features including discrete wavelet transform (DWT) and local binary pattern (LBP). The results of the proposed intelligent tool prove that merging manifold features of different categories has a high influence on the classification accuracy. Moreover, these results are superior to those obtained by other related AI-based dermatologist tools. Therefore, the proposed intelligent tool can be used by dermatologists to help them in the accurate diagnosis of the SC subcategory. It can also overcome manual diagnosis limitations, reduce the rates of infection, and enhance survival rates.*

Disadvantages:

This model requires massive number of data to yield accurate results.