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Editorial

Artificial Intelligence and its growing role in dermatology

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Introduction

Artificial intelligence (AI) was first coined at a famous Dartmouth college conference in 1956.[1] AI is progressively becoming involved in multiple disciplines and is also gaining popularity in the medical field. Role of AI in dermatology has a great scope since the diagnosis of dermatological diseases is highly dependent on clinical and morphological features and visual pattern recognition.

Artificial neural networks were developed a few decades ago and had applications in various fields while its role in dermatology remained limited. Hinton in 2006 proposed the concept of deep learning and its training methods that involved multiple processing layers to learn representation of data with various levels of abstraction.[1] After more than ten years of development, deep learning with conventional neural network (CNN) as the core has been widely applied in image processing in other fields such as radiology to differentiate between benign and malignant tumors.[1] AI has also been used in identification of ophthalmological diseases and recognition of breast carcinomas by 'deep mind' established in 2010.

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Currently imaging techniques such as dermoscopy, reflectant confocal microscopy and very high frequency ultrasound are being frequently used to help aid the dermatologists to reach a diagnosis.[1] These images are being used to develop deep learning. The application of AI requires massive skin image resources. The imaging data can be used to form a "multi dimensional skin image resource library" as a platform for user oriented image services based on the internet technology. AI requires extremely large datasets of images/slides for an accurate enough algorithm to be "learned". This huge volume of data does exist globally albeit in analog form with millions of slides held in storage around the world, and images of skin lesions stored electronically but the utilization of such resource is complicated by many technical hurdles.[2]

In 2017 Stanford university published a study on deep learning of skin tumors.[1] They trained a CNN using dataset of 129,450 clinical images consisting of 2032 different diseases. The CNN was used to perform pixel and disease labelling of fine grained objects. Machine recognition was performed for "Keratinocyte carcinomas versus Benign seborrheic keratosis" and "Malignant Melanomas versus benign Naevi". The results were compared with the diagnostic results of 21 board certified dermatologists. It was noted that AI was capable of classifying skin cancer with a level of competence comparable to dermatologists. Many other researches have used AI for diagnosis, treatment and grading of

psoriasis, atopic dermatitis and cutaneous malignancies.[1]

Uses of artificial intelligence in dermatology

A. Better identification of illnesses

Dermatological diagnosis is highly dependent on the visual image recognition of lesions.

Advanced dermatology software is developed by "derm engine "which automatically identifies labelled images that look similar to patient's case visually. This technology can help reduce the amount of time between a patient visiting clinic and receiving appropriate feedback. AIDERMA is the first comprehensive platform for artificial intelligence assisted diagnosis of patients in China which uses a mobile application and hand held dermoscopy.[1] The Chinese skin image database (CSID) was established in May 2017, skin image data is "flowed" through the internet, dermatological diagnosis and treatment are 'wisdom' through AI.[1] Keratinocyte carcinomas and melanomas, ulcer assessment (diabetic and pressure) have been assessed via AI. Seite *et al*. developed a smartphone AI tool that grades and classifies types of acne lesions (e.g., comedonal, inflammatory, post inflammatory hyperpigmentation, etc.).[3] Huang *et al*. developed a multi disease classifier that could analyze attributes (e.g., erythema, scaling, definite borders, etc.) and differentiate several papulosquamous diseases such as psoriasis, seborrheic dermatitis, lichen planus, Pityriasis versicolor, and chronic dermatitis.[3]

One application assessed muscle ultrasound images and differentiated between normal muscle, dermatomyosisits, polymyositis, and inclusion body myositis with accuracies between 76.2 and 86.6%.[3] Altogether, the theoretical utility of these applications for inflammatory diseases is significant, both further technological validation and clinical experimentation are needed.[3]

B. Differentiating malignant from benign lesions

AI is being successfully used in differentiating the malignant lesions from those that are benign. Skin Vision came up with a mobile application that uses machine vision to check for skin lesions to determine cancer through photoanalysis. When the user uses the app to take the photograph of the lesion an ML algorithm categorizes the lesion as low, medium or high risk, the latest version of skin vision app has a 95% sensitivity and 78% specificity for skin cancer detection.[4] Skin IO is another such app. Pigmented lesions such as melanomas and moles are also being assessed using such apps. Medical diagnosis relies on taking a careful medical history and perusal of the patient's records. It takes into account the patient's ethnicity, skin, hair and eye colour, occupation, illness, medicines, existing sun damage, the number of melanocytic naevi, and lifestyle habits (such as sun exposure, smoking, and alcohol intake). The behaviour and previous treatment of the lesion are also clues to the diagnosis.[5]

In the study published by ESMO, it was revealed that when calibrated to identify benign moles to the same extent as the 58 dermatologists, the CNN correctly identified 95% of melanomas from a sample of 100 images, whereas the dermatologists identified 86.6% of melanomas.[5,6]

C. Skin care treatment product suggestions by 'Artificially Intelligent user-friendly apps'

PROVEN Beauty is a California based startup which uses machine learning to offer consumers

customized cosmetic skin care products. The algorithm uses information from a large skin care database known as beauty Genome Project. Users fill up questionnaire and the app offers the appropriate customized skin care products.

Not only does AI in dermatology have potential in alerting people when they may need to see a doctor (usually through the use of a smart device), it can also be used to create an educational resource for medical students, as well as a confidence boost to physicians making a differential diagnosis.[6]

D. Predicting Skin Sensitization Substances

Research is also accumulating on using AI to minimize exposure to skin-sensitizing substances. A representative example by Zang *et al*. described an application capable of analyzing physiochemical properties of substances (e.g., melting point) and determining whether the substance could be a sensitizer or not.[3] This application yielded an accuracy of 81% when the substances were studied in a human cohort. Wilm *et al*. reviewed current advances in skin sensitization testing and highlighted several other examples, where AI has provided a method to reduce animal testing.[3] While this use of AI can have an impact on a population wide level, significant technological and clinical validation studies are necessary.

Challenges still to be overcome

Although Artificial intelligence has shown promising future but there are still a lot of challenges to overcome. The pictorial data collected for software is captured under optimal conditions which are not comparable to the end user photographs. Every user has a different mobile phone and camera and the optimal conditions such as adequate light, clarity and site are questionable variables.[6] With regards to issues surrounding lighting and picture size, some AI solutions are able to use the skin surrounding a lesion as a reference for the actual condition, meaning images taken by patients will not have to be of dermatoscope quality.[6] It is also troubling that the images used so far in training AI systems are exclusively that of light skinned people.[1] The algorithm is only as good as what has been taught to it. Another issue for AI may be the inability to distinguish between visually similar conditions with different causes, such as rashes caused by infection compared to rashes caused by a drug reaction. There is also potential for racial disparity in machine learning for skin cancer screenings. This was seen in the study published by ESMO, where there were far fewer images of patients that were not Caucasian, raising concerns that the mortality rate for African Americans developing melanoma will remain higher than in Caucasians even with the advent of AI in dermatology, despite Caucasians having a much higher risk of developing melanoma.[6] From a legal perspective, an issue that has yet to be fully addressed is the lack of explainability by neural networks. Currently, it is not possible to know what contributes to their decision-making process. This has led to criticisms and concerns that neural networks function as 'black boxes' with potential unanticipated and hard-to-explain failure modes. The European Union's General Data Protection Requirement specifies explainability as a requirement for algorithmic decision making, which is currently not achievable.[7] Diagnosis of skin diseases does not only require clinical images but also a comprehensive consideration of patient history, gender, age, race which make the diagnosis through AI more challenging. One of the bottle necks in the development of AI is still insufficient degree of information sharing between hospitals. A combination of medical and AI complex talents is scarce and close cooperation with multidisciplinary personnel in

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computer science, biomedical, and medical field is required to make AI applicable to all the variety of skin diseases.

Will the AI replace the dermatologists eventually is a big question mark as the human mind and assessment is still the gold standard, humans are far superior in recognizing mimetics and rarer, more unusual diseases where data available are inadequate or patterns too few to be learned but the patient friendly applications do make the end user less anxious and give them the direction to follow.[2] There is much need of research and development in this field especially in Pakistan and the developing countries. Data collection from Indo-Pak can be a major breakthrough in enhancing the proficiency of these apps. and can increase the utility of these apps for the non-fair skin toned population.

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