IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Study on Facial Skin Types Classification Using Deep Learning

Sneha Gaikwad
Dept. Of Information Technology
B.K Birla College of Arts, Science and Commerce (Autonomous)
Kalyan, India

Vandana Maurya
Dept. Of Information Technology
B.K Birla College of Arts, Science and Commerce (Autonomous)
Kalyan, India

ABSTRACT

The need of facial skincare is growing and the market is huge. Skin kinds, skin problems and skin tones can all be used to classify facial skin. For customized skin care, an accurate skin type classification is essential. This paper investigates the classification of facial skin types using Convolutional Neural Networks (CNNs) and makes recommendations for how CNNs can be used to efficiently categorize skin types and provide a useful tool for individualized dermatology and skincare. This study opens the door for further developments in individualized dermatological care by adding deep learning technology into the skincare sector.

Keywords— Facial Skin Type; Convolutional Neural Network; Dermatology; Deep Learning

I. INTRODUCTION

A. Background

The classification of facial skin type is an essential aspect of personalized skincare and dermatological care because it serves as the base for tailoring skincare routines and treatments for an individual. Traditional methods include manual assessments such as visual inspections by dermatologists or self-evaluation through questionnaires. These methods result in errors and inconsistencies. Additionally, this leads to incorrect classifications which ultimately affects the effectiveness of skincare recommendations and treatments. A possible method for classifying skin type is deep learning especially Convolutional Neural Networks (CNNs), which have shown impressive results in image recognition and analysis. In the field of dermatology, the tools and techniques used have evolved. But still an automated and trust-worthy system is needed to effectively categorize the skin types. This study theoretically suggests the usage of Convolutional Neural Networks (CNNs) to identify skin types due to capability in producing accurate results. By utilizing this technology in the field of dermatology, the research seeks to bridge the gap between traditional approaches and AI-driven approaches.

B. Importance of Facial Skin Type Classification

For several reasons, the facial skin types need to be classified accurately:

Personalized Skin Care Products and Treatments: Recognizing a person's skin type makes it easier to suggest particular products and treatments, enhancing the results of skin-care routines.

Improved Treatment Procedures: To dermatologists, the thorough classification of skin types helps them to understand the actual condition and formulate a solution that meets the needs of the patient.

Reduction of Consumer Distrust on Skincare Products: Classification that is done wrong can have nasty implications such as skin irritation or worsening the skin condition, thus making consumers wary of skincare products. In combining such AI-oriented paradigms such as CNNs, the discipline can get rid of the drawbacks of subjective assessments and provide more efficient and reliable and extendable means for skin care and treatment of skin diseases.

C. Objectives

The purpose of this research is stated below:

Demonstrate the weaknesses of the traditional skin type classification systems.

Justify the uses of Convolutional Neural Networks (CNNs) as a way of effectively classifying different types of facial skin.

Define the theoretical model of artificial intelligence skin classifiers and present possible uses of such technologies in personalized and general dermatology.

Create a foundation for specific intervention that will allow for deployment of CNN tools coupled with dermatology equipment. Where addressing the above goals meets, this research intends to provide useful evidence for understanding the nexus between AI and dermatology that will provide opportunities for advancing skincare.

II. LITERATURE REVIEW

A. Overview of Skin Type Classification

Classification of facial skin types is essential in the provision of personalized care to clients and in the management of dermatological treatment procedures. Logic dictates that such evaluations are first performed by trained professionals (dermatologists) in clinics, or, patients complete self-evaluation questionnaires. However, on many occasions, these methods do not yield reliable results because they depend on human sight and it is customary to make errors in evaluations and assessments. In recent times, scholars have began employing AI in efforts to overcome these challenges. There is a probable possibility in AI being able to assist in enhancing the accuracy and increase the speed of delivery of personal care applications particularly in the area of beauty. For instance, [1]developed a skin type classification model using a Convolutional Neural Networks (CNN) deep learning algorithms. Various CNN architectures including MobileNet-V2, EfficientNetV2, InceptionV2 and ResNet-V1 were developed and evaluated in this work to classify human skin types (dry, normal, and oily) and produced desired results. Initially, the research faced certain challenges such as dataset imbalance and biases in data quality. However, these problems were addressed using techniques like data augmentation and resampling. The development of skin type classification systems has also expanded into practical applications.[2] designed a smartphone-based system for classifying facial skin quality using Convolutional Neural Networks (CNN) deep learning algorithm. This system recognized three classes - good facial skin quality, bad facial skin quality and face makeup.

B. Advances in Deep Learning for Dermatology

[3]provided a newer approach for analyzing cosmetic ingredients and built a novel recommendation system combined with skin analysis. They focused on designing a deep neural network to estimate skin concerns: pores, redness, acne, wrinkles, pigmentation and dark circles, rather than focusing on skin types. The challenge they encountered during this process was the issue of dataset imbalance and thus impacting the model's performance, particularly for skin concerns with fewer samples.

The study conducted by [4] introduced a innovative approach of using Pyramid Convolutional Layers (PCL) .The purpose of using Pyramid Convolutional Layers to regularize and capture multi-scale and contextual attributes , thus enhancing classification accuracy for identifying skin types.

In the study of [6] , two different types of deep learning architecture - CNN and LSTM were used to classify the skin types . They performed techniques such as hyper parameter optimization with different activation functions and optimization algorithms. These advancements emphasize the evolving sophistication of deep learning methods in overcoming challenges in the field of dermatology.

C. Role of CNNs in Image-Based Classification

Convolutional Neural Networks (CNNs) have been considered as a dominant deep learning technique for image-based classification tasks due to their ability to extract and analyse spatial features effectively. Many studies illustrated CNNs' potential in classifying facial skin types and other dermatological features. Another study [5] discussed the applications of Convolutional Neural Network for skin type classification , achieved an accuracy rate of about 85% but showed a slight biasness towards oily images. Their research reveal that deep learning especially CNN has great potential in skin type classification. And with an expanded dataset, these models can produce more accurate and precise results .In the study of [7] , explored the use of Convolutional Neural Networks (CNN) to classify facial skin types (normal, oily, dry, and combination skin) in women aged 20–30 based on small dataset . The research [8] integrated object detection and deep learning algorithms to develop a skin-type model based on unique dataset consisting of facial images of Malaysian skin for the study . Many existing studies depends on small datasets, that may not represent the huge variety of skin types found in entire population. The lack of large and labeled datasets for skin type classification remains a significant limitation.

III. RESEARCH METHODOLOGY

A. Deep Learning and CNNs

CNNs have become one of the most popular and efficient types of deep learning when it comes to image-related problems including skin type classification. In contrast to a lot of the traditional approaches where features had to be manually created, CNNs are able to learn how to classify skin types by themselves by utilizing a variety of different features such as tone, texture and other important facial features. This property of CNNs is able to provide automated and more accurate classifications than manually. Deep learning models consists of Convolutional Neural Network (CNN) and it is widely used for image classification tasks, including skin type classification. Rather than manual feature engineering they automatically extract relevant features from facial images. Figure 1 depicts the architecture of CNN.

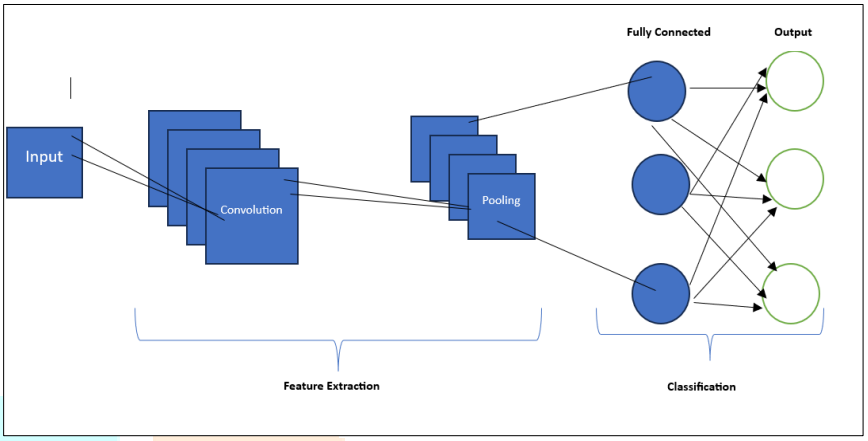

Figure 1: Architecture of CNN

B. Model Design

This article details a methodology for skin type classification based on the fine-tuned transfer learning of a pre-trained CNN model. In a standard implementation of this model for image tasks, the model already contains knowledge about recognizing and manipulating images, so it can be specifically tuned from recognizing images in general, to categorizing skin types such as oily skin, normal skin, dry skin and combination skin. The model will be trained on features that will be skin tone and texture, facial features as these will be very useful in predicting skin type intricately.

C. Dataset Requirements

To be able to train this model, there is a need to have a dataset consisting of images of facial skins from people who have been categorized according to their skin type i.e., oily, normal, dry or combination skin type. In order to make sure that the model indeed generalizes and does not overfit, a few augmentation techniques such as rotating, flipping, zooming in, and changing brightness will be employed. It is anticipated that these techniques will create enough diversity and help resolve problems like class imbalance thereby providing a boost to the performance and sturdiness of the model.

D. Evaluation Metrics

To assess the performance metric of the model and its effectiveness, several models that are standard in the field will be utilized such as accuracy, precision, and recall along with F1 score. It is expected that such granularity in performance assessment will provide a good insight regarding the aspects of the model and its performance on different classes. Besides, a confusion matrix will be used to illustrate how classifications were produced and performed as well as indicate what aspects of the model may be damaged or biased, for example when the model fails to distinguish between two similar skin types and mixes them up while classifying them.

E. Proposed method

This framework provides a general methodological approach to the application of CNNs to facial skin types classification. It describes data set requirements, model configuration, and evaluation criteria. This methodology can be viewed as a starting point for future practical work and as a guide to building more efficient, automated and personalized systems of dermatological care. It is expected that incorporation of deep learning technologies would enable to overcome the traditional limits of accuracy and scope of skin type classification. This, in turn, will apply AI models to skin type classification instead of standard approaches.

IV. POTENTIAL APPLICATIONS

A. Personalized Skincare Solutions

The potential of using deep learning approaches like Convolutional Neural Networks (CNN) in the classification of facial skin types provides an opening which if adequately exploited can foster personalized skin care solutions. Such understanding of an individual's skin or combination skin enables the recommendation of a more specific and targeted approach to skin care. Such personalization of skin care can be taken further, for instance, by acquiring a real time analysis of the consumer's skin type using mobile applications, or other online platforms. This would enable consumers to have better control over the type of products they apply, enhancing the entire skin care process and most likely reducing the cases of skin problems resulting from wrong product use.

B. Dermatological Diagnosis Assistance

In the area of Dermatology, deep learning models assist the healthcare workers in diagnosing the medical condition on skin. Such models can also identify dermatological conditions such as acne, rosacea, and pigmentation issues from images of the face. The systems might help in providing primary diagnosis which will allow the dermatologists handle the more difficult cases. The combination of these Al-tools into practice could enable to improve the accuracy of diagnosis thresholds, decrease human error, and ensure prompt treatment decisions. Moreover, such systems could be applied in places far from where trained dermatologists are available hence adding value to telemedicine services.

V. CHALLENGES AND LIMITATIONS

The creation of reputable and effective skin type classifiers meets various challenges. One major hurdle relates to data availability and diversity. Availability of a very large and diverse dataset of skin types, tones, and demographics (varying age groups and ethnicities) will allow these deep learning models to generalize optimally. However, this data is quite difficult to collect due to the issues of privacy and ethical values. Moreover, categorization of this data might require a lifetime. Many existing datasets are limited and small, thus biased toward certain groups or populations, which in turn leads to low performance. Ethical concerns and bias in AI can be well conceived. Trained on imbalanced datasets, models tend to become biased, and this may create anomalous or even discriminative results. Such as, models that will mostly train on lighter skin will fail while performing on darker skin types, thus depriving them of personalized skincare insights. Privacy concerns, again, act as hurdles when it comes to photographs of faces and personal data. Efforts must be shifted towards minimizing these ethical concerns regarding data by ensuring privacy, informed consent, and transparency in data usage. This leads to yet another area that also imposes technical limitations on this work. Training deep learning models, specifically CNNs, normally requires very large computational resources such as powerful GPUs and data with huge memory, which not every researcher or practitioner has. Deep learning models are highly sensitive to hyperparameters, so hyperparameter tuning is the common procedure that has to be blinded to get an optimal performance finish, whereby increases in time consumption and resources. Models are prone to overfitting if the size of the dataset is small or unbalanced, and this causes a serious reduction in the generalizing ability on which progress in AI depends.

VI. CONCLUSION

This research explored the theoretical use of convolutional neural networks (CNNs) for facial skin type classification in the field of dermatology. The research seeks to bridge the gap between traditional approaches and AI-driven approaches. This study offers a conceptual structure that covers the required procedures, approaches, and difficulties for future implementation. The information provided serve as a foundation for further research, encouraging the collection of robust datasets, develop optimized model and validation of the proposed techniques in real-world scenarios. Thus, CNNs have the potential to transform skin type classification with further developments in this area.

VII. FUTURE WORK

The future research can be directed in finding solutions to the existing challenges with a particular focus on small sample size and diversity which will increase the chances of making the models suitable for all possible skin types. Besides, adopting new model designs which would be efficient in processing datasets with class imbalance and improving model prediction performance would be essential as well. Diversifying the Al in dermatology technologies by coupling it with augmented reality and mobile apps would increase usability as well as enable patients and health service providers to scan skin conditions in real-time. Moreover, it is important to emphasize ethical issues, particularly concerning privacy and data safety. As Al models are rapidly getting embedded into healthcare and personal care systems, it would be important to always guarantee that the face images and other personal data would not be put into improper use. Furthermore, in order to be able to withstand the sceptics demonstration of distrust towards Al, the models have to be well explained and understood by the users as well as dermatologists. If these challenges are resolved and the applicability of CNNs broadened, they can transform the field of dermatology, which will make skin care more accurate, targeted and affordable for various population groups.

REFERENCES

[1] S. Saiwaeo, S. Arwatchananukul, L. Mungmai, W. Preedalikit, and N. Aunsri, "Human skin type classification using image processing and deep learning approaches," *Heliyon*, vol. 9, no. 11, p. e21176, Nov. 2023, doi: 10.1016/j.heliyon.2023.e21176.

[2] C.-L. Chin, M.-C. Chin, T.-Y. Tsai, and W.-E. Chen, "Facial skin image classification system using Convolutional Neural Networks deep learning algorithm," in *2018 9th International Conference on Awareness Science and Technology (iCAST)*, Fukuoka: IEEE, Sep. 2018, pp. 51–55. doi: 10.1109/ICAwST.2018.8517246.

[3] J. Lee, H. Yoon, S. Kim, C. Lee, J. Lee, and S. Yoo, "Deep learning-based skin care product recommendation: A focus on cosmetic ingredient analysis and facial skin conditions," *Journal of Cosmetic Dermatology*, vol. 23, no. 6, pp. 2066–2077, 2024, doi: 10.1111/jocd.16218.

[4] K. Saraphon, S. Chaising, N. N. Aung, and W. Srimaharaj, "Regularized Pyramid Convolutional Layers for Human Skin Type Assessment," in *2024 Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Electronics, Computer and Telecommunications Engineering (ECTI DAMT & NCON)*, Chiang-mai, Thailand: IEEE, Jan. 2024, pp. 80–84. doi: 10.1109/ECTIDAMTNCON60518.2024.10480082.

[5] A. Kothari, D. Shah, T. Soni, and S. Dhage, "Cosmetic Skin Type Classification Using CNN With Product Recommendation," in *2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT)*, Kharagpur, India: IEEE, Jul. 2021, pp. 1–6. doi: 10.1109/ICCCNT51525.2021.9580174.

[6] F. B. Kara, R. Kara, and S. Sakaci ÇeliK, "Skin Type Detection with Deep Learning: A Comparative Analysis," *Düzce Üniversitesi Bilim ve Teknoloji Dergisi*, vol. 11, no. 2, pp. 729–742, Apr. 2023, doi: 10.29130/dubited.930096.

[7] A. Anton, N. F. Nissa, A. Janiati, N. Cahya, and P. Astuti, "Application of Deep Learning Using Convolutional Neural Network (CNN) Method For Women's Skin Classification," *SJI*, vol. 8, no. 1, pp. 144–153, May 2021, doi: 10.15294/sji.v8i1.26888.

[8] Y. H. Gan, S. Y. Ooi, Y. H. Pang, Y. H. Tay, and Q. F. Yeo, "Facial Skin Analysis in Malaysians using YOLOv5: A Deep Learning Perspective," *JIWE*, vol. 3, no. 2, pp. 1–18, Jun. 2024, doi: 10.33093/jiwe.2023.3.2.1.