AI Powered skin lesion classification

Fathima Sana, Ayshath Shirin, Asiyath Fairooza, Naja Iqbal, and Avvanhi*

Department of Computer Science and Engineering, P. A. College of Engineering, Karnataka, Mangaluru, India

E-mail: avvanhi.cse@pace.edu.in

Abstract

Skin cancer has emerged as a pressing global health issue, with rising cases of melanoma and non-melanoma variants each year. Excessive exposure to ultraviolet radiation is widely recognized as a key contributing factor. Early detection remains critical, as diagnosing skin cancer in its initial stages significantly improves survival rates. However, manual diagnosis by dermatologists can sometimes be inconsistent, underscoring the need for more reliable automated solutions.

This study introduces an advanced deep learning-based system for accurate skin cancer classification, demonstrating improved performance over conventional diagnostic methods. The approach employs a pretrained MobileNet model, fine-tuned using transfer learning to enhance its diagnostic capabilities.

The system achieved an overall classification accuracy of 83.1% across multiple skin lesion categories, with top-2 and top-3 accuracies reaching 91.36% and 95.34%, respectively. Additionally, weighted averages for precision, recall, and F1-score were 89%, 83%, and 83%, highlighting its reliability. This AI-powered tool has the potential to assist dermatologists in making more informed clinical decisions.

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1 Introduction

Skin cancer has become a global health concern, primarily a result of growing exposure todamaging ultraviolet (UV) radiation.Environmental research indicates that ongoing ozone layer loss would dramatically exacerbate this issue,potentially adding hundreds of thousands of cases every year.There are current estimates of millions of new cases of skin cancer every year, with UV radiation causingthe overwhelming majority of these cases.The biological process is that UV rays destroy DNA in skin cells, which can cause growth of abnormal cellsand can lead to cancerous growths.Yet, diagnosis poses important challenges.Though dermoscopy (an advanced skin imaging method) gives better vision than the unaided eye,diagnostic quality varies widely depending on the practitioner.Experienced dermatologists have approximately 80% accuracy, whereas less skilled clinicians may be rightabout only six of ten cases.This variation suggests that there is a pressing need for more consistent methods of diagnosis.Artificial intelligence has particularly promising potential for use in medical imaging.Sophisticated neural networks can classify skin lesions with precision on par with expert doctors.

New methods tend to utilize transfer learning, where pre-trained models from general image databases areadjusted for medical purposes.This method has been found particularly useful since labeled medical images for training purposes arenotoriously scarce.The present study offers a novel AI system for classifying skin cancer, developed based on a more advanced MobileNet framework.The approach achieves robust performance across various forms of skin cancer and achieves specialist-levelaccuracy.Aside from classification, the research also entails thorough clinical patterns analysis in skin cancer presentation.To have the greatest real-world effect, the technology has been deployed as a web-based diagnostic tool, possiblyrendering expert-level skin cancer evaluation more universally available.This technology is a giant leap towards curbing the world burden of skin cancer through technological innovation,with the twin advantage of enhanced precision and increased

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accessibility in early detection campaigns.

2 Methodology

2.1 Dataset

The study employed the publicly available HAM10000 dataset comprising 10,015 dermoscopic images across seven clinically relevant categories. The dataset features histopathological confirmation for over 50% of cases, ensuring diagnostic reliability. Images were originally captured at 600×450 pixel resolution and represent a comprehensive spectrum of pigmented skin lesions.

2.2 Data Preprocessing

Standard preprocessing techniques were applied to optimize the images for deep learning analysis. All images were resized to 224×224 pixels to match network input requirements. Missing demographic data (57 age entries) were handled through mean imputation. The dataset was strategically partitioned into training (9,077 images) and validation (938 images) sets, with strict measures to prevent data leakage between partitions.

2.3 Data Augmentation

To address class imbalance, comprehensive augmentation strategies were implemented. Transformation techniques including random rotations ($\pm 30^{\circ}$), zoom variations (20% range), and horizontal/vertical flipping were systematically applied to minority classes. This process generated an enhanced training set of 38,569 images, effectively balancing class distribution while preserving diagnostic features.

2.4 Model Architecture

The study implemented a modified MobileNet architecture optimized for medical image

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analysis. The network leverages depthwise separable convolutions and includes 25 specialized layers. Transfer learning was employed by initializing with weights pretrained on ImageNet, followed by fine-tuning on the medical dataset. The model incorporates multiple normalization and regularization layers to enhance generalization capability.

2.5 Performance Evaluation

A robust evaluation framework was established using multiple metrics: classification accuracy, precision, recall, and F1-score. Weighted averages were calculated to account for class imbalances. The model was trained using categorical crossentropy loss with Adam optimization over 50 epochs. Validation was conducted on a completely independent subset to ensure unbiased performance assessment.

3 Results and Discussions

3.1 Data-set analysis

Analysis of the HAM10000 dataset revealed key clinical patterns regarding lesion distribution across different age groups and anatomical locations. The data showed that certain skin conditions rarely appear before age 20, while others like melanoma can occur at any stage of life. The back, extremities and torso emerged as the most commonly affected areas.

3.2 Model Validation

The MobileNet model achieved strong performance metrics when tested on 938 validation images, demonstrating particular strength in identifying melanocytic nevi. Evaluation results included weighted averages of 89% precision and 83% for both recall and F1-score, indicating robust diagnostic capability across multiple lesion categories.

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3.3 Confusion Matrix

Detailed examination of the confusion matrix revealed the model's varying performance across different lesion types. While showing excellent accuracy for melanocytic nevi (696 correct out of 751), the system faced challenges in distinguishing benign keratosis from similar-looking lesions, highlighting areas for potential improvement.

3.4 Loss and accuracy curves

The training process exhibited stable convergence patterns, with loss curves showing consistent downward trends and accuracy curves demonstrating steady improvement. The minimal gap between training and validation metrics indicated good model generalization without significant overfitting to the training data.

4 Conclusion

Skin cancer remains a spreading health issue globally, emphasizing the need for accurate and effective diagnostic tools.Our study illustrates how artificial intelligence can efficiently help diagnose different forms of skin cancer based on image analysis, with accuracy rates close to those of dermatology experts.

The AI system we created has encouraging diagnostic performance, accurately diagnosing skin conditions in 83% of cases.If its top three and two predictions are taken into consideration, accuracy becomes 91% and 95% accordingly.These predictions suggest the ability of the systems potential to become a useful second opinion for the doctors.Another advantage of our system is present in its feasible design.The technology runs very smoothly without employing costly hardware so it can become widely available for application.Different from past systems with less considered conditions, our system assesses seven different skins conditions with greater accuracy.

In the future, we see the potential to enhance the systems ability by adding more clinical

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factors like patient history, genetic markers, and more advanced imaging data.

This may result in more personalized and accurate diagnostic assistance.Weve already applied this technology to an online platform, making it accessible for initial evaluation by both healthcare professionals and patients.As this technology advances, it has great potential for enhancing early detection rates andtreatment outcomes in skin cancer care.

The incorporation of such AI systems into clinical practice is an important step in the direction of integratingtechnological advancement with clinical knowledge to advance patient heal.

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