AI-Based Image Classification for Early Detection of Skin Cancer

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Abstract- Skin cancer is one of the most prevalent types of cancer globally, with melanoma being the most fatal form if not detected early. Accurate and early diagnosis significantly improves patient outcomes and survival rates. Traditional diagnostic methods rely heavily on clinical examination and dermoscopic image analysis by dermatologists, which can be subjective and time-consuming. This research explores the development of an Artificial Intelligence (AI)-based system utilizing Convolutional Neural Networks (CNNs) to classify dermoscopic images of skin lesions into benign and malignant categories. The study aims to improve diagnostic accuracy, reduce human error, and provide an interpretable model through explainable AI techniques such as Grad-CAM visualization.

Keywords- Artificial Intelligence, Skin Cancer, Deep Learning, Convolutional Neural Networks, Explainable AI, Dermoscopy, Medical Imaging.

1. INTRODUCTION

Skin cancer has become a significant global health concern, with millions of new cases diagnosed annually. Melanoma, the deadliest type of skin cancer, accounts for a small percentage of cases but causes the majority of skin cancer deaths. Early detection and accurate diagnosis are essential for effective treatment and improved survival rates. Artificial Intelligence, particularly deep learning, has shown immense potential in medical image analysis. Convolutional Neural Networks (CNNs) can learn complex visual features from dermoscopic images, aiding in precise skin lesion classification.

2. RESEARCH GAP

Despite promising progress in AI-driven skin cancer detection, several challenges persist. Many existing models are trained on limited datasets, leading to poor generalization when applied to images from different sources. Furthermore, most models operate as 'black boxes', offering limited interpretability for clinical validation. This research addresses these issues by proposing a CNN-based model that balances high accuracy with explainability, thus enhancing clinical trust and real-world applicability.

3. OBJECTIVES

The primary objectives of this study are:
1. To develop and train a Convolutional Neural Network (CNN) for classifying dermoscopic images into benign and malignant skin lesions.
2. To evaluate the performance of different architectures such as VGG16, ResNet50, and EfficientNet.
3. To employ Grad-CAM visualization for highlighting critical image regions influencing the model's decisions.
4. To compare the proposed model's accuracy, sensitivity, and specificity against dermatologist-level performance.

4. METHODOLOGY

1. **Dataset:** The research will use publicly available datasets such as ISIC (International Skin Imaging Collaboration) and HAM10000, which contain labeled dermoscopic images of various skin lesions.
2. **Data Preprocessing:** Image resizing, normalization, and augmentation will be performed to enhance model generalization.
3. **Model Development:** CNN architectures including ResNet50 and EfficientNet will be trained using transfer learning.
4. **Evaluation Metrics:** Model performance will be measured using accuracy, sensitivity, specificity, precision, recall, and ROC-AUC.

5. **Explainability:** Grad-CAM visualization will be used to generate heatmaps that show the regions influencing model predictions.
6. **Tools Used:** Python, TensorFlow, Keras, OpenCV, and Scikit-learn.

5. EXPECTED RESULTS

The expected outcome is a high-accuracy CNN model capable of detecting skin cancer with performance comparable to or exceeding that of expert dermatologists. The integration of Grad-CAM visualization will enhance interpretability by providing clear visual explanations for model predictions. Such a system could serve as a clinical decision support tool, aiding dermatologists in screening and diagnosis.

6. DISCUSSION AND FUTURE SCOPE

This research could revolutionize early detection of skin cancer by enabling faster and more consistent diagnosis. Future work may include integrating multimodal data (clinical, genetic, and imaging), improving explainability, and deploying the model in telemedicine platforms. Further clinical trials and validation will be necessary before real-world implementation.

7. CONCLUSION

The proposed AI-based approach for skin cancer detection demonstrates the transformative potential of deep learning in medical diagnostics. By combining accuracy with explainability, the study aims to create a reliable diagnostic aid that bridges the gap between artificial intelligence and clinical practice.

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