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Skin Disease Classification Using CNN

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Abstract: Skin diseases represent a significant global healthcare challenge, with certain malignant lesions such as melanoma requiring early diagnosis to improve patient survival rates. Traditional dermatological diagnosis primarily depends on visual examination by specialists, which may be subjective, time-consuming, and limited by the availability of experienced dermatologists. This paper presents a deep learning–based multi-class skin disease classification system using Convolutional Neural Networks (CNNs) for automated analysis of dermoscopic skin images. The proposed framework classifies skin lesions into nine distinct disease categories using a publicly available dermoscopic image dataset. Image preprocessing techniques including resizing, normalization, and augmentation are applied to improve model generalization and classification performance. To enhance interpretability, Explainable Artificial Intelligence (XAI) techniques based on Gradient-weighted Class Activation Mapping (Grad-CAM) are incorporated to visualize important lesion regions influencing prediction outcomes. The trained CNN model is integrated into a Streamlit-based web application that enables real-time image upload and disease prediction along with confidence visualization. Experimental evaluation demonstrates that the proposed system achieves reliable multi-class classification performance with a validation accuracy of approximately 87%. The proposed framework serves as an intelligent decision-support tool for educational and preliminary diagnostic assistance and highlights the potential of explainable deep learning techniques in medical image analysis.This paper discusses the system architecture, methodology, implementation, and performance evaluation of the proposed solution.

Keywords: Skin Disease Classification, Deep Learning, Convolutional Neural Network, Explainable AI, Grad-CAM, Dermoscopic Image Analysis, Streamlit

I.INTRODUCTION

Skin diseases are among the most common health problems affecting people worldwide. Certain skin diseases, especially melanoma and other malignant skin lesions, can become dangerous if not detected at an early stage. Traditional diagnosis methods mainly rely on visual examination by dermatologists, which can be time-consuming and dependent on specialist expertise. In many areas, limited access to experienced dermatologists may lead to delayed diagnosis and treatment.

This paper presents a Multi-Class Skin Disease Classification System using Deep Learning techniques. The proposed system uses a CNN model trained on dermoscopic skin lesion images to classify nine different skin disease categories. Image preprocessing techniques such as resizing, normalization, and augmentation are applied to improve classification accuracy and model performance.

Recent advancements in Artificial Intelligence (AI) and deep learning have improved medical image analysis systems significantly. Convolutional Neural Networks (CNNs) are widely used for image classification tasks because they can automatically learn important visual features such as texture, color patterns, and lesion structures directly from images. These capabilities make CNNs suitable for automated skin disease classification.

To improve usability and accessibility, the trained model is integrated into a Streamlit-based web application that allows users to upload skin images and receive real-time prediction results along with confidence scores. The proposed system achieves effective multi-class classification performance with approximately 87% validation accuracy and serves as a supportive tool for preliminary skin disease analysis and educational purposes.

1.1 Project Description

The project focuses on developing an automated skin disease classification system using Convolutional Neural Networks (CNNs). The system analyzes dermoscopic skin images and predicts the most probable disease category from nine supported skin lesion classes. The CNN model learns visual features such as lesion texture, colour distribution, and structural patterns directly from the training dataset.

The proposed framework uses image preprocessing operations including resizing and normalization to improve prediction performance. The trained model is deployed using the Streamlit framework to provide a simple and interactive

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web-based interface. Users can upload skin lesion images and receive prediction results along with confidence percentages in real time.

The system is designed as an intelligent decision-support tool for educational and research purposes. Although it is not intended to replace professional medical diagnosis, it demonstrates the practical application of deep learning techniques in automated dermatological image analysis.

1.2 Motivation

Skin diseases and skin cancer cases are increasing rapidly across the world, creating a growing need for early and accurate diagnosis. Traditional diagnosis methods mainly depend on dermatologist expertise and manual examination, which may not always be accessible in rural or underdeveloped areas. Delayed detection of serious skin diseases such as melanoma can increase health risks and reduce treatment effectiveness.

Recent advancements in Artificial Intelligence and deep learning provide opportunities to develop automated medical image analysis systems that assist in preliminary disease detection. Convolutional Neural Networks (CNNs) have shown promising performance in image classification tasks due to their ability to automatically extract meaningful visual features from images.

The motivation behind this project is to develop an intelligent and user-friendly skin disease classification system capable of providing quick and reliable predictions using dermoscopic images. The system aims to support early-stage screening and improve accessibility to preliminary dermatological analysis through a web-based platform. By integrating deep learning with real-time prediction capabilities, the proposed framework demonstrates the practical potential of AI-assisted healthcare applications.

II. RELATED WORK

Paper [1] discusses traditional skin disease classification methods based on image processing and machine learning techniques. Although these approaches achieved moderate accuracy, they required manual feature extraction and were highly sensitive to variations in image quality and lighting conditions.

Paper [2] explores Convolutional Neural Network (CNN)-based skin lesion classification systems for melanoma detection. The study demonstrates improved classification accuracy compared to conventional machine learning methods; however, the system focuses mainly on binary classification tasks.

Paper [3] introduces deep learning approaches using large dermoscopic image datasets for automated skin cancer detection. The results show that CNN-based models can learn complex visual patterns directly from images and provide better generalization performance.

Paper [4] applies transfer learning techniques using pre-trained deep learning models such as ResNet and Inception for skin lesion analysis. These approaches improve feature extraction capability and classification performance but often require high computational resources.

Paper [5] reviews Explainable Artificial Intelligence (XAI) techniques in medical image analysis. The study highlights that visualization methods such as Gradient-weighted Class Activation Mapping (Grad-CAM) improve transparency by identifying image regions influencing prediction decisions, thereby increasing user trust and interpretability in AI-based healthcare systems.

III. METHODOLOGY

A. System Environment

The proposed skin disease classification system is developed using Python-based deep learning and web application frameworks. The system utilizes TensorFlow and Keras libraries for designing and training the Convolutional Neural Network (CNN) model. Streamlit is used to develop a real-time web-based interface for image upload and prediction visualization. The overall environment supports image preprocessing, model inference, and prediction display in an integrated framework suitable for automated dermatological image analysis.

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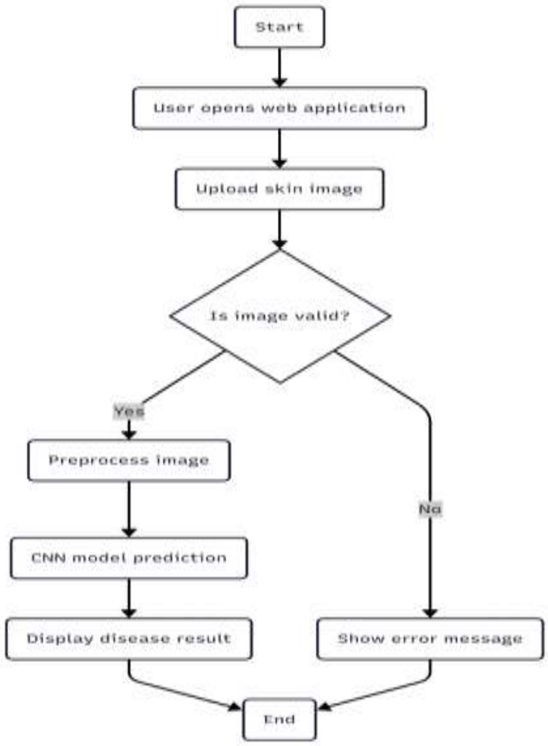

Fig 1: Flowchart of methodology

B. System Architecture

User-Side Interaction:
Users interact with the system through a Streamlit-based web interface. The interface allows users to upload dermoscopic skin images in JPG or PNG format for classification.

Image Preprocessing:
The uploaded image is resized to 180 × 180 dimensions and normalized before being passed to the CNN model. Basic image validation is also performed to ensure that the uploaded image contains a visible skin lesion region.

CNN-Based Classification:
The pre-processed image is provided as input to the trained Convolutional Neural Network model. The CNN extracts important visual features such as texture patterns, lesion boundaries, and colour variations to classify the image into one of the predefined skin disease categories.

C. CNN-Based Classification Mechanism

The proposed framework utilizes a Convolutional Neural Network (CNN) architecture for multi-class skin disease classification. The CNN model consists of multiple convolutional layers, activation functions, pooling layers, dropout layers, and dense layers. The convolutional layers extract meaningful visual features from dermoscopic images, while pooling layers reduce feature dimensionality and computational complexity. The final dense layer uses a softmax activation function to generate probability scores across nine supported skin disease classes.

D. Implementation Flow

1. Initialize the Streamlit web application and trained CNN model.
2. Upload dermoscopic skin lesion image through the user interface.
3. Validate and preprocess the uploaded image.
4. Resize and normalize the image for CNN input.
5. Perform CNN-based prediction on the processed image.
6. Generate probability scores for all disease classes.
7. Display predicted disease class and confidence score.
8. Visualize prediction probabilities and Grad-CAM heatmap results.

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E. Hardware and Software Requirements

- **Hardware:** Intel Core i5 Processor or higher, Minimum 8 GB RAM, Standard desktop or laptop system, GPU support (optional for faster training).
- **Software:** Python 3.8 or above, TensorFlow and Keras, Streamlit Framework, NumPy, Pillow, Matplotlib, and Scikit-learn, Visual Studio Code and Anaconda Environment.

IV. SIMULATION AND EVALUATION FRAMEWORK

This section describes the implementation and evaluation process of the proposed skin disease classification system. The framework combines deep learning techniques with a web-based prediction interface to enable automated and real-time skin disease analysis using dermoscopic images.

A. System Architecture and Workflow

The proposed system consists of four major components: image upload interface, preprocessing module, CNN-based classification model, and prediction visualization module. Users upload dermoscopic skin images through the Streamlit interface, after which the image is resized and normalized before being passed to the trained CNN model. The model predicts the disease class and generates confidence scores for all supported categories.

B. Simulation Setup

The system is trained and evaluated using a publicly available dermoscopic skin image dataset containing approximately 2357 images across nine different disease classes. Image augmentation techniques such as rotation, zoom, and horizontal flipping are applied to improve model generalization and reduce overfitting.

C. Classification and Prediction Process

The uploaded image is preprocessed and provided as input to the CNN model. The model extracts important visual features and classifies the image into one of the predefined disease categories. The final prediction result along with confidence percentage and probability distribution is displayed through the web interface.

D. Results and Observations

Classification Performance:

- The proposed CNN model achieved approximately 87% validation accuracy.
- The system successfully classified multiple skin disease categories with reliable prediction performance.

Real-Time Prediction:

- The Streamlit-based web application provided smooth and real-time prediction results.
- Confidence scores and probability graphs improved prediction visualization and user understanding.

Explainable AI Visualization:

- Grad-CAM heatmaps highlighted important lesion regions responsible for prediction outcomes.
- The visualization improved transparency and interpretability of the deep learning model.

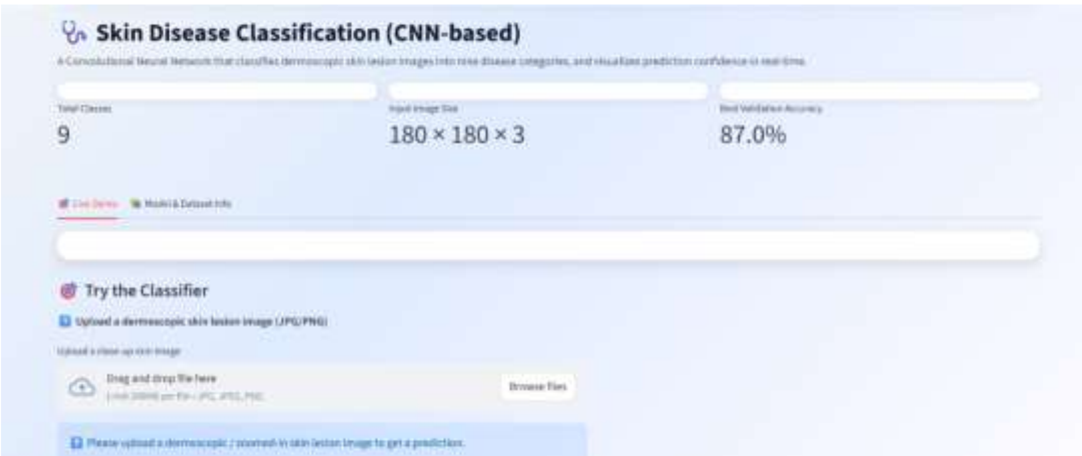

Fig 2: User Interface of the Proposed System

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Home page of the skin disease classification application, providing an image upload option and basic information about the trained CNN model.

Fig 3: Uploaded Skin Lesion Image

The uploaded dermoscopic image is used as input for skin disease prediction.

Fig. 4: Skin Disease Prediction Result

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This figure displays the output generated by the CNN-based skin disease classification system. The model predicts the input image as dermatofibroma along with the associated confidence score. It also visualizes the probability distribution across all supported disease classes using a bar chart, helping users understand the model's prediction certainty and class-wise comparison.

V. RESULTS AND DISCUSSION

The proposed Multi-Class Skin Disease Classification System was successfully implemented and evaluated using dermoscopic skin lesion images. The CNN-based model demonstrated effective performance in classifying nine different skin disease categories with approximately 87% validation accuracy.

The system successfully identified important visual patterns such as lesion texture, color distribution, and structural irregularities from the input images. Image preprocessing and augmentation techniques improved model generalization and reduced overfitting during training.

The Streamlit-based web application provided real-time prediction results with confidence scores and probability visualization for all supported disease classes. The integrated Grad-CAM visualization improved interpretability by highlighting lesion regions influencing prediction outcomes.

Overall, the experimental results indicate that the proposed framework provides reliable multi-class skin disease classification and demonstrates the practical application of deep learning and explainable AI techniques in medical image analysis.

VI. CONCLUSION

This paper presented a Multi-Class Skin Disease Classification System using Convolutional Neural Networks and Explainable AI techniques. The proposed framework successfully classified dermoscopic skin lesion images into nine different disease categories using deep learning–based image analysis. The system integrated image preprocessing, CNN-based classification, Grad-CAM visualization, and a Streamlit-based web application to provide real-time prediction and confidence visualization. Experimental evaluation demonstrated effective classification performance with approximately 87% validation accuracy.

The proposed system serves as an intelligent decision-support tool for educational and preliminary screening purposes. Although it is not intended to replace professional medical diagnosis, the project demonstrates the effectiveness of deep learning techniques in automated dermatological image analysis.

VII.FUTURE WORK

The proposed system can be enhanced further by training the model on larger and more diverse skin lesion datasets to improve classification accuracy. Advanced deep learning architectures such as transfer learning and hybrid CNN models can also be integrated to improve prediction performance.

Future improvements may include mobile application support, cloud deployment, real-time camera-based image capture, and integration with telemedicine platforms. Additional Explainable AI techniques and automated lesion detection mechanisms can further improve transparency and usability of the system.

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