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AI-Based Skin Disease Detection and Classification Using Deep Learning

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Abstract - Skin diseases are common health problems that affect people across different age groups and geographical regions. Early and accurate identification is important because delayed diagnosis or inappropriate treatment may lead to complications. This paper presents an AI-based Skin Disease Detection and Classification System that analyzes digital skin images and provides preliminary information about possible skin conditions. The proposed system uses image preprocessing operations such as resizing, pixel normalization, noise handling, and image standardization to improve input consistency. EfficientNetB0 is used as the primary deep learning model with transfer learning to extract meaningful visual features and classify predefined skin disease categories. The predicted disease and confidence score are displayed through an Android-based application. The application is developed using Android Studio, Java, and XML, while the model is trained using Python, TensorFlow, and Keras and deployed using TensorFlow Lite. A product recommendation module maps the detected condition to a predefined recommendation database containing product category, ingredients, intended skin concern, usage information, and safety precautions. The proposed system is intended for preliminary screening and skin-disease awareness and is not a replacement for professional medical diagnosis.

Keywords: Convolutional Neural Networks (CNN), Deep Learning, Skin Disease Detection, EfficientNetB0, HAM10000, Transfer Learning, Image Preprocessing, TensorFlow Lite, Android Application

I. INTRODUCTION

Skin diseases are among the most common health problems affecting people across different age groups and geographical regions. Conditions such as acne, eczema, psoriasis, fungal infections, and other skin disorders can significantly affect physical comfort, appearance, and quality of life. Early and accurate identification is important because delayed diagnosis or inappropriate treatment may lead to complications.

Conventional skin disease diagnosis generally depends on visual examination and clinical experience. This can be challenging when different diseases exhibit similar visual symptoms. In addition, the availability of dermatologists and specialized healthcare facilities is limited in many rural and remote areas. Patients may need to travel long distances or wait for appointments to obtain professional consultation.

With the rapid development of Artificial Intelligence (AI), Machine Learning (ML), and Deep Learning, automated analysis of medical images has become an important area of research. The proposed Skin Disease Detection System uses deep learning techniques to analyze digital images of affected skin and classify them into predefined disease categories.

The system accepts a skin image captured using a smartphone or uploaded by the user. Before classification, the image undergoes preprocessing operations such as resizing, normalization, noise reduction, and standardization. These operations help the model learn visual characteristics such as color, texture, shape, edges, and lesion patterns.

EfficientNetB0 is used as the primary deep learning model. Transfer learning allows the pretrained network to provide useful general visual features while maintaining relatively low computational requirements. The extracted features are passed through classification layers to predict the most probable disease category and a confidence score.

The proposed model is intended to be integrated into an Android application. Users can select or capture a skin image and obtain a preliminary prediction together with basic disease information and general skin-care guidance. The main objective is to provide a fast, accessible, and user-friendly preliminary screening solution. The system supports awareness and early consultation and is not intended to replace dermatologists or professional medical diagnosis.

II. LITERATURE REVIEW

Previous studies have explored image processing, machine learning, convolutional neural networks (CNNs), transfer learning, and multimodal approaches for automated skin disease analysis. These studies demonstrate the potential of artificial intelligence for assisting in the classification of skin conditions while also highlighting challenges related to dataset diversity, image quality, computational requirements, privacy, and practical deployment.

[1] Verma and Pathak (2024) reviewed various approaches for skin disease image analysis, including image processing techniques, Convolutional Neural Networks (CNNs), Support Vector Machines (SVM), and K-Nearest Neighbors (KNN). The study highlighted challenges related to dataset diversity, image quality, and computational cost and emphasized the need for practical and scalable automated systems.

[2] Narendra et al. (2024) proposed a multimodal approach combining DenseNet169, ResNet50, Natural Language Processing (NLP), and Telegram for skin disease analysis. The study used DermNet data containing 13 disease classes and 11,747 images. The reported results included 77.07% accuracy, 96.72% Area Under the Curve (AUC), and 93.62% NLP accuracy. The study also identified challenges related to image quality, dataset diversity, NLP limitations, privacy, and the development of user-friendly systems for practical use.

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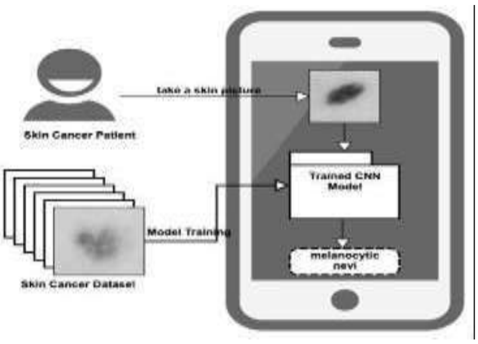
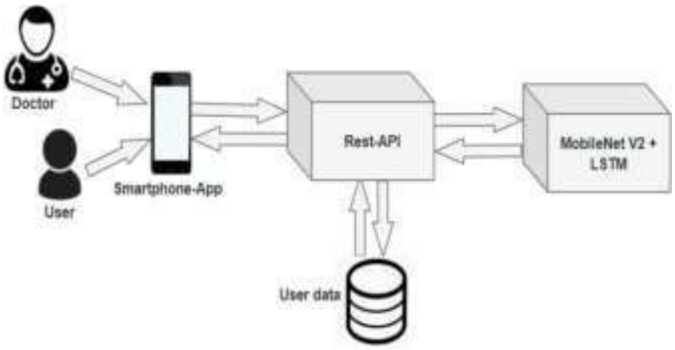
III. PROPOSED METHODOLOGY

The proposed system aims to develop an AI-based skin disease detection and recommendation application that analyzes skin images and provides preliminary information about the detected skin condition. The system integrates deep learning, image preprocessing, and a mobile application interface.



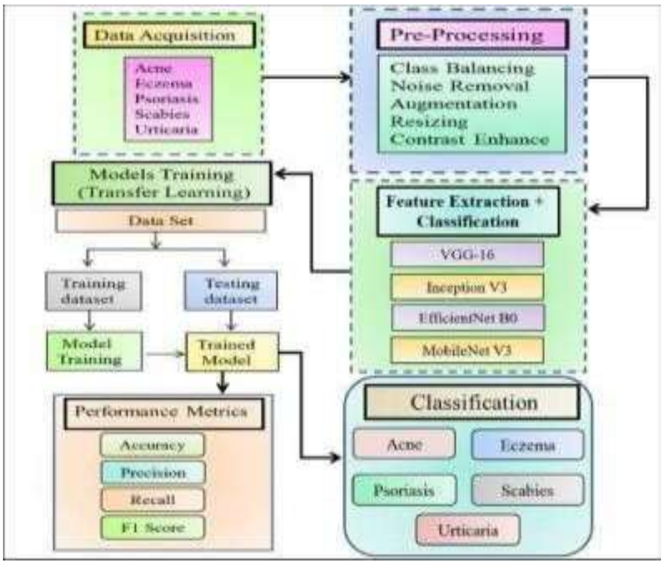
A. Overall System Architecture

The application is created using Android Studio, where Java is used to develop the main functions of the app and XML is used to design its screens and interface. The AI model is developed and trained using Python, TensorFlow, and Keras. Tools such as OpenCV, NumPy, and Pandas are used to process images and prepare the dataset for training. Once the model is trained, it is converted into TensorFlow Lite (TFLite) format. This makes it possible to add the AI model to the Android application and generate predictions directly on the mobile device.



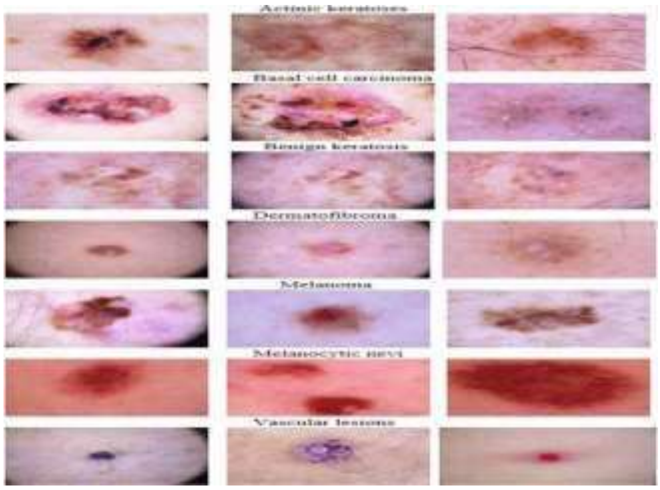
B. Proposed System Workflow

The process starts when the user opens the Android application and either selects an image or takes a photo of the affected skin area. The image is first processed by resizing it and adjusting its values to match the requirements of the AI model. The processed image is then given to EfficientNetB0, which identifies important features from the image and predicts the most likely skin disease from the available categories. The application then shows the predicted disease along with its confidence score. After identifying the disease, the app provides related information, including its symptoms, possible causes, precautions, and recommended skin-care products.



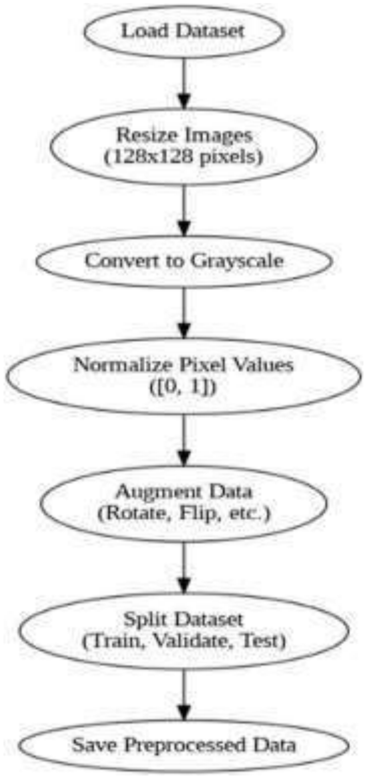
C. Dataset Collection

A suitable publicly available dermatological image dataset is used for training the proposed deep learning model. The reference study discusses benchmark datasets such as HAM10000 and ISIC and describes organization of images into folders according to disease classes. Dataset preparation includes removal of duplicate and corrupted images, classification according to disease categories, separation of training and testing images, balancing where required, and standardization of image dimensions.



D. Image Preprocessing

Image preprocessing is important because user-uploaded images may differ in dimensions, lighting conditions, and quality. Before providing an image to EfficientNetB0, the following operations are performed: (1) image resizing to the required input dimensions; (2) pixel normalization to an appropriate range; (3) noise handling to reduce unwanted information; and (4) image standardization to maintain a consistent input format.



E. Transfer Learning

Transfer learning is used to make the training process faster and improve the model's classification performance. Instead of training the EfficientNetB0 model from scratch, a model that has already been trained on a large dataset can be used as the starting point. The pretrained model has already learned basic visual features such as edges, shapes, textures, and patterns. These learned features can then be adapted to identify different skin diseases.

F. Model Training

During the training process, the prepared and augmented images are given to the EfficientNetB0 model. The model learns to connect the visual features in the images with their corresponding skin-disease labels. The training process includes several steps: the image is passed through the model, important features are extracted, the disease is classified, the prediction error is calculated, and the model's weights are updated to improve its predictions.

IV. SKIN DISEASE CLASSIFICATION AND ANDROID INTEGRATION

After training, the model receives an unseen skin image and generates probability values for all predefined disease categories. The class with the maximum probability is selected as the predicted disease. For example, the reference workflow illustrates probability values of Acne = 0.08, Eczema = 0.12, Psoriasis = 0.76, and Ringworm = 0.04; therefore, Psoriasis is selected as the predicted class in that example.

A. Tensor Flow Lite Conversion

After successful training and evaluation, the trained model is converted into TensorFlow Lite format. This enables the model to be integrated into the Android application and used for on-device prediction.

B. Android Application Development

The mobile application is developed using Android Studio. The user interface is designed using XML, Java handles user interaction and application functionality, and the trained EfficientNetB0 TensorFlow Lite model is integrated as the AI component.

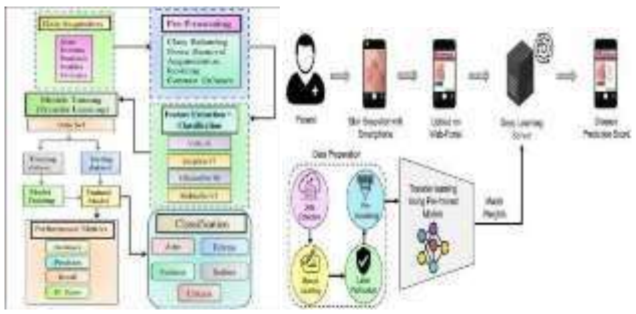
C. Image Upload and Analysis

The user can either choose a skin image from the phone's gallery or take a new photo using the camera. After clicking the Analyze Skin button, the image is prepared for analysis by resizing, normalizing, and converting it into the format required by the TensorFlow Lite model. The model then analyzes the image and calculates the probability of different skin diseases. The disease with the highest probability is identified as the result, and its name and confidence level are shown to the user.

V. PRODUCT RECOMMENDATION MODULE

One of the main features of the proposed system is the product recommendation module. Once the skin condition is identified, the application uses the predicted disease to find suitable recommendations from a predefined database. This database may include details such as the product name, category, key ingredients, skin concern it is designed for, how to use it, and necessary safety precautions. The purpose of this module is to provide users with general skin-care information and suitable product suggestions based on the predicted condition.

The recommendation process follows this sequence:
Predicted Condition → Recommendation Category → Suitable Product



VI. RESULTS AND DISCUSSIONS

The reference material explains the expected workflow and features of the proposed system, but it does not include actual experimental results for the EfficientNetB0 model. Therefore, no specific values for accuracy, precision, recall, F1-score, or validation performance are reported.

The proposed application is designed to perform the complete process, starting from image selection or capture and ending with skin-disease prediction. It displays the predicted disease along with its confidence score and provides related information and suitable recommendation categories. Since the system uses TensorFlow Lite, the model can run directly on a mobile device, reducing the need for continuous internet connectivity or server-based processing. This can make the application more accessible for users who need preliminary information about possible skin conditions, especially in areas where specialist availability is limited.

However, several factors may affect the system's performance in real-world use. These include the diversity and quality of the training dataset, image quality, computational limitations of mobile devices, user privacy, and ease of use. These factors should be carefully considered when testing and evaluating the proposed application.

VII. CONCLUSION

The proposed AI-Based Skin Disease Detection and Classification System provides an accessible approach for the preliminary identification of common skin diseases using Artificial Intelligence and Deep Learning. The system analyzes clinical or smartphone-captured skin images and applies preprocessing operations such as resizing, normalization, noise handling, and standardization to improve input consistency.

EfficientNetB0 with transfer learning is used to learn important visual features such as color, texture, edges, and lesion patterns and classify predefined skin conditions. The generation of a disease probability score provides users with preliminary information about the detected condition. Integration with an Android application and TensorFlow Lite makes the system suitable for mobile-based use.

The system has potential to improve early awareness and preliminary screening, particularly in areas where access to dermatologists is limited. However, predictions should be considered preliminary and must not replace professional medical examination or diagnosis. Future improvements can focus on larger and more diverse datasets, improved model performance, real-world clinical validation, privacy protection, and further mobile or web deployment.

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