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SkinMatch: AI-Enhanced Product Recommender

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Abstract*— Skin conditions affect millions worldwide, making personalized skincare recommendations essential for effective treatment and care. This work introduces SkinMatch, an AI-enhanced product recommender that leverages EfficientNet, a state-of-the-art Convolutional Neural Network (CNN), to classify skin conditions accurately. The system employs TensorFlow 2.x or PyTorch for deep learning, OpenCV for image processing, and a Flask-based web framework for seamless user interaction. By integrating computer vision with a robust recommendation system, SkinMatch analyzes user-uploaded facial images, detects skin conditions, and suggests suitable skincare products such as moisturizers, primers, and serums. SkinMatch aims to bridge the gap between AI-driven dermatological analysis and real-world skincare solutions, offering a scalable and user-friendly platform.

Keywords*—Skin condition classification, EfficientNet, CNN, AI-powered skincare, product recommendation, deep learning, Flask, OpenCV, TensorFlow, PyTorch.

I. Abbreviations and Acronyms

1) CNN-Convolution Neural Network
2) AI- Artificial Intelligence
3) API – Application Programming Interface

II. Introduction

In Skin health and personalized skincare have become increasingly important in modern healthcare and beauty industries. With the growing diversity of skin types, concerns, and available products, consumers often struggle to identify the most suitable skincare solutions. Traditional recommendation systems rely on manual input or generalized advice, which may not account for individual variations in skin texture, tone, and conditions. To address these challenges, artificial intelligence (AI) and computer vision offer a transformative approach by enabling automated, data-driven skincare recommendations.

In recent years, deep learning models, particularly Convolutional Neural Networks (CNNs), have demonstrated remarkable success in facial analysis and skin condition classification. However, many existing systems lack the precision to adapt to unique skin profiles or integrate real-time feedback for continuous improvement. To overcome these limitations, SkinMatch leverages EfficientNet, a state-of-the-art CNN architecture, to analyze facial images and extract critical skin metrics such as texture, pigmentation, and hydration levels. By combining computer vision with machine learning, the system provides highly personalized product recommendations tailored to individual needs.

SkinMatch is designed as a scalable and user-friendly application, featuring a Flask-based web framework for seamless interaction. The system employs OpenCV for real-time facial image processing and integrates advanced machine learning algorithms to refine recommendations based on user feedback. This project aims to bridge the gap between AI-driven dermatological analysis and practical skincare solutions, empowering users to make informed decisions while enhancing accessibility to personalized skincare.

The performance of SkinMatch is evaluated based on accuracy, adaptability, and user satisfaction metrics, demonstrating its potential to revolutionize the skincare recommendation landscape. By harnessing the power of EfficientNet and adaptive learning, this research contributes to the growing field of AI-enhanced dermatology and consumer-centric skincare innovation.

III. Literature Review

To address the difficulties associated with conventional diagnostic techniques, investigators have examined different machine learning and deep learning methodologies along with recommendation model. This literature review analyzes current studies on deep learning-driven skin disease classification and product recommenddation, concentrating on the development of model architectures, the use of datasets, and the efficacy of transformer-based approaches in comparison to traditional CNNs.

The paper, "Efficient Net-based Expert System for Personalized Facial Skincare Recommendations," authors J. Akshya, Vinit Mehra, M. Sundarrajan, Pattapu Teja Sri, and M. D. Choudhry present a hybrid model integrating K-Nearest Neighbors (KNN), Convolutional Neural Networks (CNN), Transfer Learning with EfficientNet B0, and content-based filtering to enhance facial skincare recommendations. The system considers user inputs such as skin tone, type, and acne severity, achieving a training accuracy of 87.10% and a validation accuracy of 80%. This approach demonstrates the potential of combining various machine learning techniques to provide personalized skincare solutions.

The article "A machine learning approach for skin disease detection and classification using image segmentation." This study focuses on developing a machine learning model to detect and classify various skin diseases through image segmentation techniques. The authors utilized datasets such as ISIC 2019 and HAM10000 to train and evaluate their model, aiming to improve the accuracy and efficiency of skin disease diagnosis. The research highlights the potential of machine learning in dermatology, emphasizing benefits like lightweight models suitable for real-time applications, which reduce computational expenses while ensuring accurate diagnosis of skin conditions.

The paper "Deep Learning based Model for Detection of Vitiligo Skin Disease using Pre-trained Inception V3," authored by Shagun Sharma, Kalpna Guleria, Sushil Kumar, and Sunita Tiwari. In this research, the authors employed the pre-trained Inception V3 model for feature extraction from skin images. They then utilized various classifiers—namely, naive Bayes, convolutional neural network (CNN), random forest, and decision tree—to differentiate between healthy skin and skin affected by vitiligo. The dataset comprised 1,202 images sourced from Kaggle, divided into 961 images for training and 241 images for testing. The combination of Inception V3 with a random forest classifier achieved the highest performance metrics, with an accuracy of 99.9%, recall of 0.999, precision of 0.999, area under the curve (AUC) of 1.00, and F1-score of 0.999. These results suggest that integrating Inception V3 with machine learning classifiers, particularly random forest, can effectively aid in the early detection of vitiligo, potentially facilitating timely medical intervention and improved patient outcomes.

The paper "Product Recommendation System," authored by Yeshiv Sahu, Pranshu Shukla, Avinash Kashyap, and Shubham Kumar. This study addresses the challenges retailers face in meeting diverse consumer demands by developing a product recommendation system that leverages data mining techniques. The authors employ content-based filtering, linear regression, and the K-Nearest Neighbor (KNN) algorithm to analyze customer data and predict products that align with individual preferences. The system was tested using data from a chain of perfumeries, demonstrating its ability to accurately identify consumer categories and provide tailored product suggestions. The system was tested using data from a chain of perfumeries, demonstrating its ability to accurately identify consumer categories and provide tailored product suggestions. The research highlights the effectiveness of integrating these data mining techniques to enhance online shopping experiences by offering personalized recommendations, thereby increasing customer satisfaction and potentially boosting sales.

The paper "Product Recommendation Using Emerging Technology," authored by Niveditha G, Palthuru Hiremata Aishwarya, Neha Math, and Dr. Sai Madhavi.This study introduces a product recommendation system designed to enhance customer satisfaction by suggesting products with high ratings and positive reviews. Leveraging machine learning techniques, the system analyzes customer reviews and ratings to recommend quality products to users. The implementation employs the Naive Bayes algorithm for sentiment analysis, processing textual data to classify reviews as positive or negative. This classification aids in predicting user preferences and delivering personalized product recommendations. The research highlights the benefits of integrating machine learning algorithms into e-commerce platforms to improve the accuracy and relevance of product recommendations, thereby enhancing the overall user experience.

IV. PROPOSED SYSTEM

The proposed system is designed to classify skin diseases that leverages ViT model for enhanced diagnostic accuracy. SkinSense is developed as a web-based application with a Next.js frontend for an intuitive user experience and a FastAPI backend for efficient model inference and data handling. The proposed framework covers all aspects of building, deploying, and maintaining a deep learning-based system for skin disease classification, ensuring a robust and scalable solution.

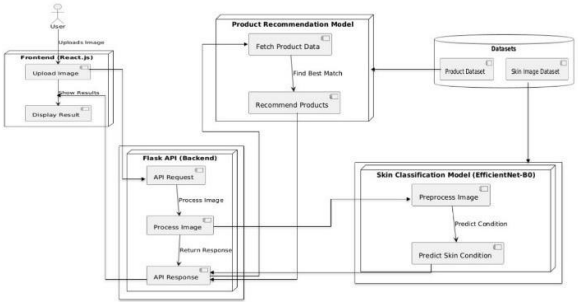


Fig. 1. Architecture of Proposed System

Core components of the proposed system are:-

A. Skin classification

The Skin-Lesions-Classification-Dataset is a freely available dataset on Kaggle, created to support the development of AI-powered tools for skin disease classification. It includes a wide variety of dermatological images, representing different skin conditions. This dataset serves as an essential resource for researchers and developers working on machine learning and deep learning models aimed at improving automated skin disease diagnosis.

The dataset may include common skin conditions such as**:**

1) Benign Keratosis-like Lesions
2) Basal Cell Carcinoma
3) Actinic Keratoses
4) Vascular Lesions
5) Melanoma
6) Melanocytic Nevi
7) Dermatofibroma

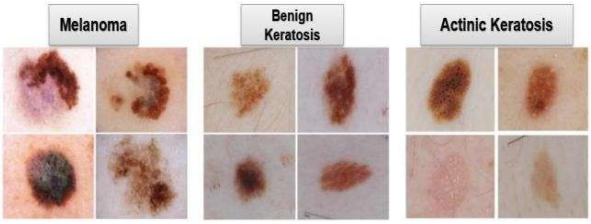


Fig. 2. Skin-Lesions-Classification-Dataset sample

Dataset Preprocessing

Preprocessing techniques applied to above dataset are: -

1) Image resized to 224x224 pixels.
2) Normalization with mean = (0.5, 0.5, 0.5) and std = (0.5, 0.5, 0.5)

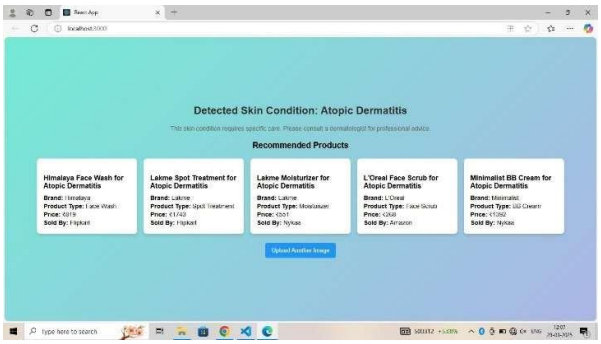
EfficientNet-B0 Model

EfficientNet-B0 is a lightweight convolutional neural network (CNN) optimized for image classification tasks, including medical image analysis. Unlike traditional CNN architectures that scale arbitrarily, EfficientNet employs a compound scaling technique that optimally balances depth, width, and resolution. This results in a highly efficient model that delivers high accuracy with fewer parameters and lower computational cost. In the context of skin disease classification, EfficientNet-B0 is particularly valuable due to its ability to capture fine-grained texture and structural details in dermatological images. It has been pretrained on ImageNet and fine-tuned on specialized skin lesion datasets, making it capable of identifying benign and malignant conditions with high precision.

B. Product Recommendation

SkinMatch utilizes AI-powered image analysis to classify various skin ailments and recommend suitable skincare products based on the diagnosed condition. By integrating machine learning with dermatological insights, SkinMatch suggests targeted solutions such as moisturizers for dry skin, serums for hyperpigmentation, or SPF for sun-sensitive conditions. The system shows promising accuracy, further improvements—such as expanding the dataset, incorporating real-time dermatologist feedback, and refining product recommendations based on skin type and severity—can enhance its effectiveness. In summary, SkinMatch revolutionizes AI-driven dermatology, making skin health management both accessible and personalized through intelligent disease detection and skincare recommendations.

Fig. 3. Product Recommendation



V. RESULT ANALYSIS

Fig. 4. Homepage of SkinMatch website

The SkinMatch homepage has a modern design with a blue gradient. It features "Skin Diseases Classification And Product Recommendation" and emphasizes quick diagnosis using deep learning. A “Upload" button where user need to upload image.

Fig. 5. Upload image section

The "Upload" section enables users to submit a clear, well-illuminated photograph of the area of skin affected for analysis. It includes a drag-and-drop feature, browse option for uploading images and Web cam. After an image is uploaded, users can click and get the product based on skin classification button to obtain an automated diagnosis. This section improves user engagement by offering a smooth and interactive method to classify skin classification and get the product based on it.

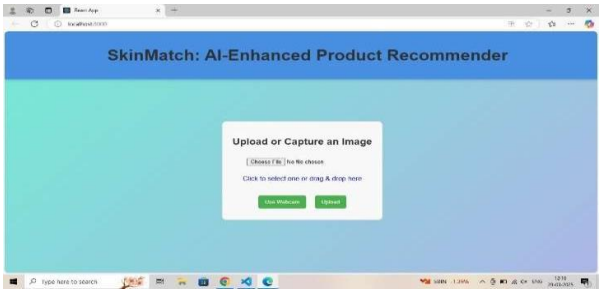


Fig. 6. Skin diagnosis for Atopic Dermattiss and Recommend Product

The image above shows a "Skin Diagnosis Results" page, which evaluates a provided image. The system offers a diagnosis summary featuring a primary detection of Atopic Dermattiss along with top 5 Product recommendation which includes face wash, moisturizer,BB crem ,etc.

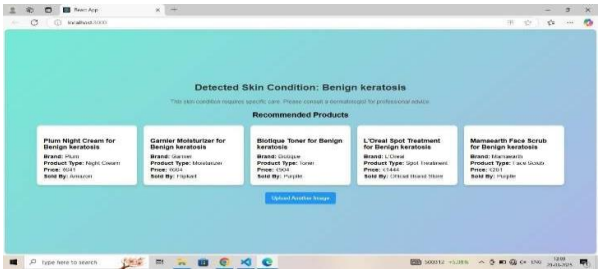


Fig. 7. Skin diagnosis for Benign kertosis and recommendation product

The image above shows a "Skin Diagnosis Results" page, which evaluates a provided image. The system offers a diagnosis summary featuring a primary detection Benign kertosis along with top 5 Product recommendation which includes face wash, moisturizer, BB cream, face scrub.

VI. Conclusion

The final model achieved an accuracy of 92.37%, indicating strong classification performance. SkinMatch effectively illustrates the capabilities of AI-driven solutions in dermatology by delivering precise and efficient classification of skin diseases. By incorporating deep learning models like efficient-B0 model,the system improves both diagnostic accuracy and dependability. The React. js frontend along with the FlaskAPI backend facilitates a smooth user experience, allowing users to upload images of their skin and receive diagnostic results immediately. SkinMatch leverages AI-driven image analysis to classify various skin ailments while recommending suitable skincare products tailored to individual needs. Although the system demonstrates promising results, further enhancements—such as expanding the dataset, incorporating real-time dermatologist feedback, and improving model interpretability—can enhance its clinical relevance and user trust. In summary, SkinMatch bridges AI and dermatology, making skin health management more accessible, efficient, and personalized.

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