

AI-Driven Skincare Recommendation System Using Facial Analysis

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Abstract

The increasing demand for personalized skincare solutions has encouraged the integration of Artificial Intelligence (AI), Machine Learning (ML), and Computer Vision technologies in the skincare industry. Traditional skincare selection methods often rely on generalized advice, trial-and-error approaches, or manual consultation, which may not provide accurate recommendations for different skin conditions. To address this challenge, this paper presents Beauty-Skin AI, an AI-driven skincare recommendation system that analyses facial images and generates personalized skincare insights, routines, and product suggestions. The proposed system combines facial image processing, heuristic feature extraction, Convolutional Neural Networks (CNNs), dataset profile classification, confidence scoring, and rule-based recommendation techniques to analyze skin characteristics such as oiliness, pigmentation, redness, texture irregularities, and dark circles. The system supports multiple image acquisition methods, including image upload, live camera capture, image URLs, and dataset image paths, ensuring flexibility and accessibility. Based on extracted features and predicted skin type, the recommendation engine generates personalized AM/PM skincare routines and suitable skincare products using dataset-driven filtering and lightweight machine learning techniques. Additionally, IndexedDB-based history management enables users to store and compare previous analysis records for long-term tracking. The proposed system demonstrates how hybrid AI techniques can improve personalization, explainability, and usability in intelligent skincare recommendation systems while maintaining scalability for future enhancements and practical real-world deployment.

Keywords: Deep Learning, CNN, Computer Vision, Facial Image Analysis, Skincare Recommendation, Image Processing, Feature extraction, Artificial Intelligence.

1. Introduction

Artificial Intelligence (AI) and Computer Vision technologies are increasingly being used in the beauty and skincare industry to provide personalized skincare solutions. Choosing suitable skincare products is often difficult because many users rely on generalized advice, advertisements, or trial-and-error methods, which may not match individual skin conditions. This can result in ineffective product usage and inconsistent skincare outcomes. To address this challenge, this research presents Beauty-Skin AI, an AI-driven skincare recommendation system that analyzes facial images and provides personalized skincare insights and product recommendations. The system extracts important skin-related features such as oiliness, pigmentation, redness, texture, and dark circles to predict skin type and generate suitable skincare routines. The proposed system combines Computer Vision, Convolutional Neural Networks

(CNNs), heuristic feature extraction, confidence scoring, and rule-based recommendation techniques to improve prediction reliability and personalization. It supports multiple image input methods, including image upload, live camera capture, image URLs, and dataset image paths, making the platform flexible and user-friendly. Developed using Next.js, React, TypeScript, Python, PyTorch, and OpenCV, the system also stores previous analysis records for long-term tracking. The objective of this research is to create an intelligent and accessible skincare recommendation system that improves personalization while remaining scalable for future improvements.

2. Literature Review

Several studies have explored the use of Artificial Intelligence (AI), Machine Learning (ML), and Computer Vision for skincare analysis and

recommendation systems. Existing research mainly focuses on skin type classification, acne detection, and personalized skincare suggestions using deep learning techniques. Previous studies have shown that Convolutional Neural Networks (CNNs) can effectively analyze facial skin conditions such as acne, pigmentation, and texture. Some recommendation systems also use ingredient matching and content-based filtering to suggest suitable skincare products based on skin type. However, many existing systems provide limited personalization, lack explainable feature analysis, and do not support multiple image input methods or history tracking. To address these limitations, Beauty-Skin AI integrates facial image analysis, CNN-based prediction, feature extraction, confidence scoring, and personalized skincare recommendation into a single user-friendly platform. The proposed work addresses these limitations by developing a low-cost multimodal livestock disease detection system that integrates image and audio analysis using CNN and Bidirectional LSTM (BiLSTM) models. The fusion of visual and acoustic features is expected to improve robustness and achieve accuracy above 92% without depending heavily on expensive hardware sensors, making the system suitable for rural and low-resource farming environments[1].

3. Proposed System Architecture and Methodology

The proposed system, Beauty-Skin AI, is designed to analyze facial images and provide personalized skincare recommendations using Artificial Intelligence and Computer Vision techniques. The workflow of the system consists of image acquisition, face[6 – 14] validation, feature extraction, skin type prediction, recommendation generation, and history storage. The system supports multiple image input methods, including image upload, live camera capture, image URLs, and dataset image paths. Before analysis, the image is validated to ensure proper face detection and image quality. After validation, facial features such as oiliness, pigmentation, redness, texture irregularities, and dark circles are extracted using image processing techniques implemented with Python and OpenCV. These features are normalized and used for skin

analysis. A lightweight Convolutional Neural Network (CNN) developed using PyTorch predicts the user's skin type, including dry, oily, normal, combination, and sensitive skin. To improve reliability, the system combines CNN prediction with dataset profile matching and confidence scoring. Based on the predicted skin profile, the recommendation engine generates personalized AM/PM skincare routines and recommends suitable skincare products using rule-based filtering and dataset-driven product matching. Additionally, the system stores previous analysis records using IndexedDB, allowing users to track skincare results over time[2].

4. Expected Performance

The proposed system is developed as a web-based application using modern frontend, backend, and AI technologies. The user interface is built using Next.js, React, TypeScript, and Tailwind CSS, providing a responsive and interactive experience for facial image analysis and skincare recommendations. The backend processing is handled using Next.js API routes and Node.js, which coordinate image handling, feature extraction, and recommendation workflows. For facial image analysis, the system uses Python, OpenCV, and PyTorch to process images and predict skin type through a lightweight CNN model. The application extracts important facial skin features such as oiliness, pigmentation, redness, texture, and dark circles, which are used to generate personalized skincare routines and suitable product recommendations. The system also supports multiple image acquisition methods, including uploaded images, camera capture, image URLs, and dataset image paths. To improve usability, previous analysis records are stored using IndexedDB, allowing users to compare results and track skincare changes over time[3].

5. Results And Discussion

The proposed system successfully performs facial image analysis and generates personalized skincare recommendations based on detected skin characteristics. The application accepts facial images through multiple input methods, including image upload, live camera capture, image URLs, and dataset image paths. After successful face validation, the system extracts important skin features such as

oiliness, pigmentation, redness, texture irregularities, and dark circles to predict skin type and generate suitable skincare suggestions. The system demonstrates effective performance in providing personalized AM/PM skincare routines and recommending skincare products based on the detected skin profile. By combining CNN-based skin type prediction with feature extraction and confidence scoring, the recommendation process becomes more reliable and explainable. Shown as Figure 1 Main Interface., Figure 3 Recommendation Interface[4].

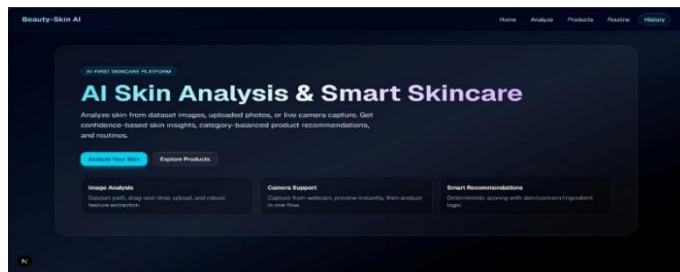


Figure 1 Main Interface

The proposed system improves usability through a clean user interface, multiple image input options, and historical record management using IndexedDB. Overall, the system demonstrates how Artificial Intelligence and Computer Vision can be effectively applied to deliver personalized skincare recommendations in a practical and user-friendly manner. Shown as Figure 2 Skin Analysis Dashboard

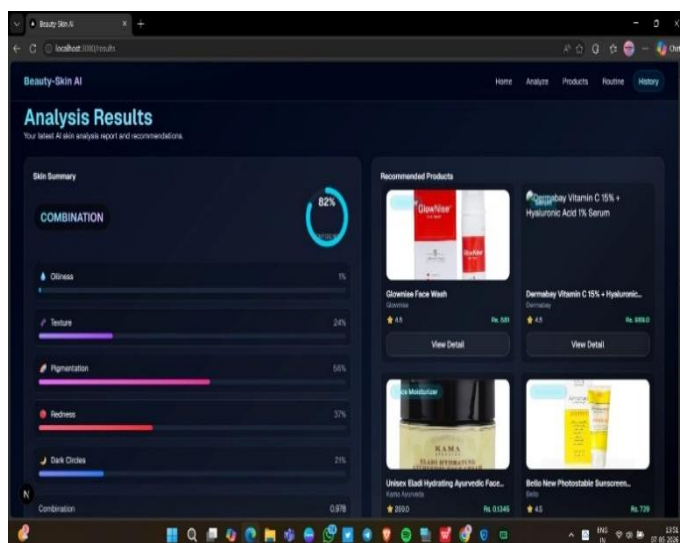


Figure 2 Skin Analysis Dashboard

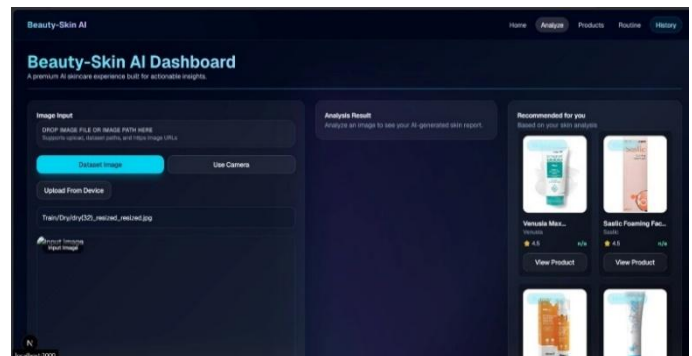


Figure 3 Recommendation Interface

Conclusion

This paper presents Beauty-Skin AI, an AI-driven skincare recommendation system that analyzes facial images to provide personalized skincare insights and product suggestions. The system combines Computer Vision, CNN-based prediction, feature extraction, and recommendation techniques to identify skin characteristics such as oiliness, pigmentation, redness, and texture. The proposed system helps users receive personalized skincare routines through facial analysis while supporting multiple image input methods and history tracking. Overall, the system demonstrates the practical use of Artificial Intelligence in improving skincare personalization and user experience[5].

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