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SkinAI : A Multi-Model Framework for Skin Analysis and Product Recommendation

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Abstract- This study presents an AI-driven allergy checker designed explicitly for skincare. It reviews the user's allergies, skin type, and skin conditions and suggests a product and skincare routine based on those factors. The random forest model is used to classify skin type while the Light GBM model evaluates the skincare routine recommendations. Then a K-Nearest Neighbors (KNN) algorithm uses the allergy information the user provides to make the recommendations. A YOLOv8 model also analyzes the image the user provides and determines if there are skin conditions visible to the naked eye. In review, the system developed is able to provide appropriate personalized data-driven recommendations for skincare products and routines with a lower likelihood of allergic body complications, while also allowing for informed selections of skincare according to allergenic history.

Keywords – Artificial Intelligence, YOLOv8, K-Nearest Neighbors (KNN), Light GBM, Random Forest, Skin Disease Detection, Allergy-aware AI.

I. INTRODUCTION

In contemporary culture, skin care has come to represent an aspect of personal health and self-worth. Nevertheless, for many consumers, navigating to a new skin care regime can be quite complicated to the difference in skin types, allergies, and skin conditions that could potentially lead to acne, dry skin, or pigmentation. Without this type of tailored support, even with the best intentions, users often choose incompatible products that can produce adverse skin responses and unsatisfactory outcomes. Keeping this in mind, the creation of Skin AI: Smart Skincare Companion provides a skin care analysis and recommendation tool to utilize a specialized intelligent system to provide Artificial Intelligence (AI) and Machine Learning (ML) technology capabilities to offer recommendations about product selection of skin care that take into consideration the individualized attributes of that user.

Skin AI utilizes machine learning processes and deep learning systems for high accuracy of skin quality detection and product recommendations. Product recommendations are provided at the time of visit to the Skin AI system considering the configurable individual preferences that person including allergies, and suitability for use for safe and effective products. In conclusion, Skin AI represents an opportunity for personalization more accurately within the use of beauty technology and health technology with recommendations. Skin AI is effective, safe, precise, and timely.

II. PROBLEM STATEMENT

Skincare is an important aspect of people's overall wellbeing and self-esteem in modern times. However, there are still many who struggle to pick the right product through trial-and-error with consideration for their differing skin types, sensitivities, and virtually any skin condition such as acne, dryness, pigmentation, etc. Most people will settle for trial-and error with recommendations until they find something that works, but that can also lead to allergies, lost money, and wasted time. To add to the issue, much of the advice in skincare lacks consideration for providing individual recommendations. Obviously when there is no expert advice and no individual consideration, it makes plans for skin care more complicated, particularly for the user with known skin issues and/or allergies. In particular, if it's not determined whether an online recommendation provided is factual, there are a lot of variables to suggest that the clothing line or semi individual recommendation could lead to unreliable, inferior, and at worst dangerous results. It is clear that there are practical needs in skin care for an intelligent system that can identify skin types, recognize all variables for the user (skin type, known skin issues, and already know environmental allergies), and recommend recommendations on products based the correct data set.

III. LITERATURE SURVEY

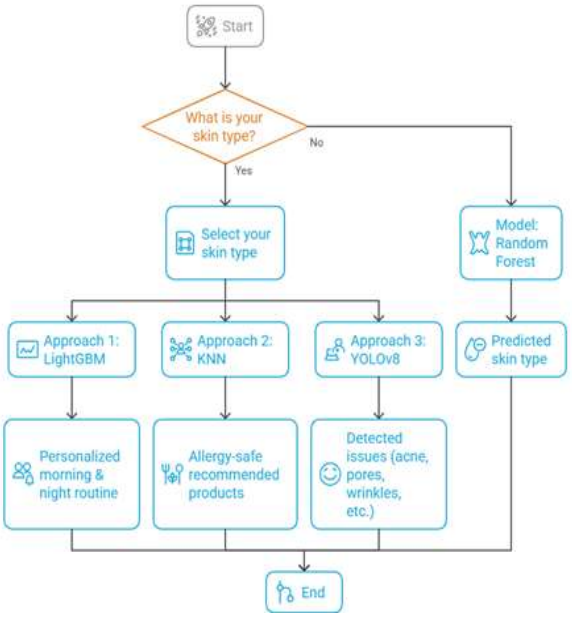
Abhishrut Dutta, Anand Ranjan, Jahid Hussain, Aaryan Ved, and Vikram Kumar proposed a CNN based model for automatic skin disease detection. The system improved the speed and accuracy of diagnosis but faced limitations in dataset diversity

and model generalization. [1] T. K. Hanchinal, V. D. Bhavani, and V. B. Mindolli introduced an intelligent beauty product recommendation system using deep learning. Their approach generated personalized skincare suggestions but lacked allergy-based filtering and faced privacy and bias concerns. [2] Tarisafitri and Aljabar developed a lightweight skin disease classification model using the MobileNetV2 architecture.

The method achieved efficient performance suitable for mobile deployment but struggled with small datasets and imbalanced classes. [3] Anushka More, Shravani Deolekar, Gauri Takarkhede, and Prof. Aparna Santra Biswas designed a facial skin analysis and product recommendation system. Their system enabled real-time personalized recommendations but had difficulty detecting subtle skin issues and required complex real-time deployment. [4] Tanu Vats, Ritika Hasija, and Aishita Batra conducted a comparative study of various recommender system including collaborative, content-based, and hybrid methods. [5]

IV. OBJECTIVES

1. To develop an AI-based system for detecting common skin issues from user-uploaded images.
2. To generate safe and personalized skincare recommendations using skin type and allergy data.
3. To enhance accuracy through deep learning and machine learning models such as YOLOv8, KNN, LightGBM, and Random Forest.
4. To build a user-friendly web interface using ReactJS, Flask, and SQLite for secure local deployment.
5. To provide real-time, explainable feedback for informed skincare decisions.



V. SYSTEM DESIGN

The new system is setup on a three-tier framework consisting of front-end, back-end and database layers. The front-end is developed using React to create an interactive and user-friendly experience to enter data and view outputs. The back-end is built using Flask, which routes the data, integrates the machine learning models, and does the models' predictions. The SQLite database efficiently stores user data, skin information, and the outputs from the models. The system uses four models: Random Forest for skin type classification, Light GBM for skincare routine recommendation, K Nearest Neighbors (KNN) for recommending products that are allergy-safe, and YOLOv8 for detecting skin conditions. The modular architecture here allows for future scalability, accuracy, and seamless interfacing between modules to allow prescriptive and personalized skincare recommendations for each user.

VI. TECHNOLOGIES USED / IMPLEMENTATION

The system was constructed with a variety of current web development frameworks, databases, and machine learning models to enable effective recommendations and high performance:

Front-End Development (React): The front end of the app is created with React, allowing us to quickly build a responsive website with an interactive experience. The user can input their skin in-depth, take pictures, and then receive related recommendations - all without skipping a beat.

Back-End Development (Flask - Python): A lightweight web framework called Flask, which is built in Python, manages all of the API requests, integrates machine learning models, keeps track of users engaging with the site, and securely connects the database.

Database (SQLite): We had utilized an SQLite database to store the user's profiles, user records of rapid skin type, products, and all mapping to potential allergies. The database will provide consistency and stability while quickly retrieving the information.

Machine Learning Models:

Skin type classification (Random Forest Model): This models identifies the skin type of the user (dry, normal, oily, or combination) based on the inputted attributes.

Skin routine recommendation (Light GBM Model): This model will provide the user with a skincare routine relevant to their skin type and conditions.

Product recommendation (KNN Model): This model identifies recommendations for skincare products that do not trigger allergies using the ingredient sets used to make the products.

Skin condition detection (YOLOv8 Model): This model detects conditions of the skin by either analyzing uploaded images or use users camera on their phone.

Libraries & Tools:

- Pandas and NumPy for data handling and preprocessing. - OpenCV for image processing.
- Scikit-learn for classical machine learning model implementation.
- Pickle for model serialization and integration in the backend.

VII. RESULTS AND DISCUSSION

A. **Login Page-** Login page of Skin AI with user authentication interface.

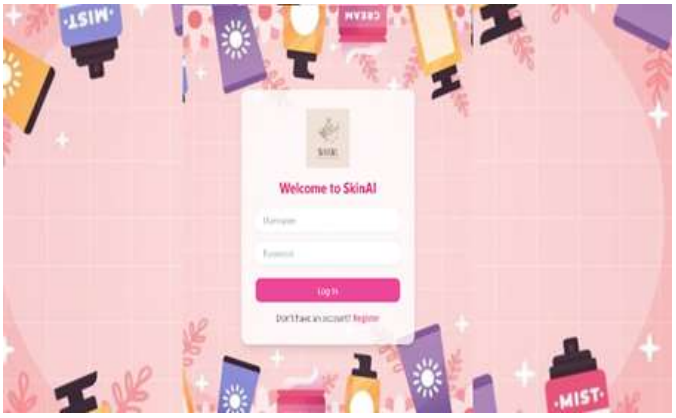


Fig.1. Login Page

B. Dashboard: Welcome page of Skin AI introducing the platform and its personalized skincare features

Fig.2. Dashboard

C. **Skin Type Analysis:** Skin type detection page showing user input and predicted skin type**.**

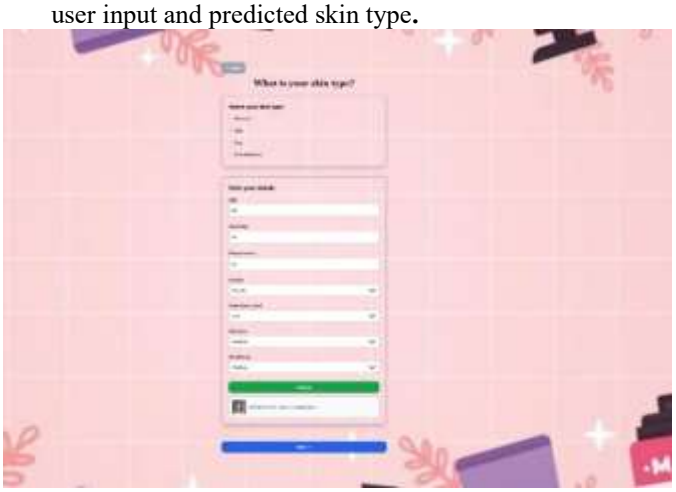


Fig.3. Skin Type Analysis

D. **Approaches:** Interface offering options for skincare routine analysis, allergy selection, and image-based skin analysis.

Fig.4. Approaches

E. **Skin Routine:** Skincare Routine Analysis displaying customized morning and night skincare plans with treatment suggestions.

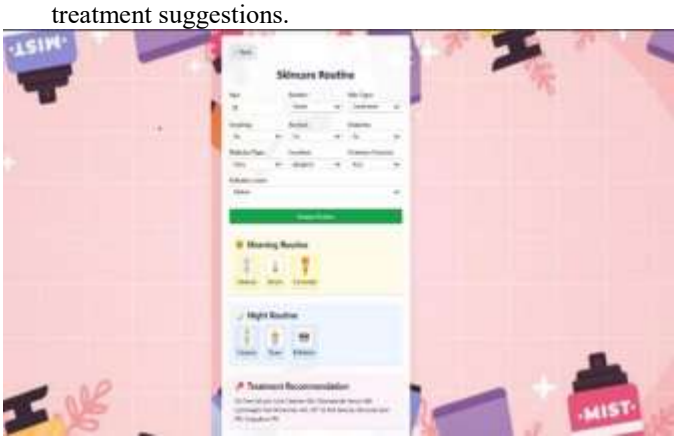


Fig.5. Skin Routine Analysis

F. **Product Recommendation 1:** Skincare Allergy Checker allowing users to input skin type, condition, and allergies.Personalized skincare product recommendations generated based on user preferences and brand selection.

Fig.5[a]. Product Recommendation 1

Fig.5[b]. Product Recommendation 2

G. **Skin Condition Analysis:** This page enabling users to upload images for AI-based skin issue detection

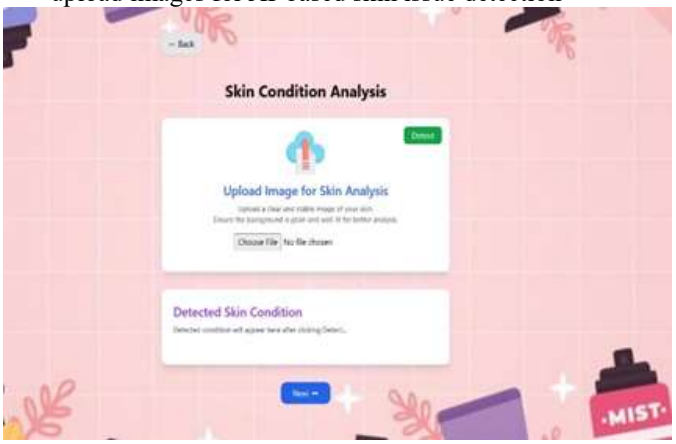


Fig.6. Skin Condition Analysis

VIII. CONCLUSION

The intelligent skincare system suggested can offer tailored product recommendations and a personalized routine, which is customized to individual user needs. The system applies machine learning and deep learning models to classify skin types and offer products that match the skin type while also detecting various skin conditions. The frontend is built in React to allow for an interactive user experience, and the Flask backend is reliable for data handling and database integration. All in all, the intelligent skincare system describes a new direction for AI-Driven solutions for personal skincare management while reducing the trial-and-error phase and striving for healthier skincare routines.

FUTURE SCOPE

The system has potential for further enhancement to provide more comprehensive skincare support:

1. **Advanced Skin Condition and Disease Detection:** Future versions will incorporate more sophisticated models to detect a wider range of skin conditions and potential diseases, offering early alerts and preventive recommendations.
2. **Virtual Assistant Integration:** An AI-powered virtual assistant will guide users through personalized skincare routines, provide explanations for recommended steps, and answer skincare-related queries interactively.
3. **Continuous Learning and Adaptation:** The system can learn from user feedback and historical data to refine recommendations, improving accuracy and personalization over time.
4. **Integration with Health and Lifestyle Data:** Future updates may include data from wearable devices or health apps, allowing holistic recommendations based on diet, sleep, environmental factors, and lifestyle habits.

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