

Skin Tone Based Product (Dress) Recommendation Using Deep Learning and Content-Based Filtering

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Abstract - The advancement of Artificial Intelligence and Computer Vision has enabled intelligent systems to assist users in personalized product selection. This paper presents a **Skin Tone Based Product (Dress) Recommendation System** using **Deep Learning and Content-Based Filtering** techniques. The proposed system automatically detects a user's skin tone (classified as light, mid-light, mid-dark, or dark) using Convolutional Neural Networks (CNN). Based on the identified skin tone, the system recommends suitable dress colors for both men and women—**Sarees and Chudidhar for women, and Shirts and Pants for men**. The deep learning model is trained with diverse datasets of human faces to ensure accurate tone detection, while content-based filtering utilizes pre-defined color-tone relationships to generate recommendations. This approach helps users choose outfits that complement their natural skin tone, enhancing both appearance and confidence. The system is implemented using Python, TensorFlow, and Flask, providing a user-friendly web interface that captures an image, predicts tone, and displays the recommended product set. The project demonstrates the integration of machine learning and recommendation systems to create intelligent, personalized fashion assistance tools.

Key Words: Skin tone detection, Deep learning, CNN, Content-based filtering, Dress recommendation, Personalized fashion, Computer vision, Python.

1. INTRODUCTION

With the increasing influence of artificial intelligence in the fashion industry, personalized product recommendations have become highly desirable. Many users face difficulty choosing outfits that complement their unique skin tone. The **Skin Tone Based Product (Dress) Recommendation System** aims to solve this challenge by analysing a person's facial image to detect their skin tone and suggest suitable dress colours accordingly. The system employs **Deep Learning (CNN)** for accurate skin tone classification and **Content-Based Filtering** for generating recommendations.

The proposed model enhances the shopping experience by providing intelligent and personalized suggestions, thereby bridging the gap between technology and fashion.

1.1 Problem Statement

In today's fashion and online shopping environment, customers often face difficulty in choosing dress colors that complement their unique skin tones. Many individuals, especially those shopping online, end up selecting colors that may not suit their complexion, leading to dissatisfaction and reduced confidence in appearance. Traditional e-commerce platforms recommend products based on popularity or user ratings, without considering the user's physical attributes such as skin tone. This gap highlights the need for an intelligent recommendation system that can analyze a user's skin tone and suggest the most suitable dress colors. Therefore, there is a strong demand for a personalized system that enhances user satisfaction by recommending color-appropriate dresses such as sarees, chudidhar, shirts, and pants based on the detected skin tone categories like light, mid-light, mid-dark, and dark.:

1.2 Objectives of the Study

The main objective of this study is to design and develop an intelligent dress recommendation system that suggests suitable outfit colours based on a user's skin tone using Deep Learning and Content-Based Filtering techniques. The system automatically detects the user's skin tone from an uploaded or real-time captured image and classifies it into one of the predefined tone categories such as **dark, light, mid-dark, mid-light**.

Based on the detected skin tone, the system recommends colour-appropriate dresses—**sarees and chudidhars for women, and shirts and pants for men**—that best complement the user's complexion. The platform also allows users to **either capture their image in real time using a webcam or upload an existing photo**, giving flexibility and control over how they interact with the system.

2. LITERATURE REVIEW

The literature review provides insights into the existing research and technological developments related to product recommendation systems, deep learning models, and content-based filtering techniques. Several studies have focused on personalized recommendation systems that analyse user preferences, purchase history, or behaviour

patterns to suggest products. However, only a limited number of works have explored recommendations based on **physical attributes such as skin tone**.

Earlier systems primarily used **collaborative filtering** or **rule-based models**, which rely on user feedback or demographic data. Although these methods are effective to some extent, they fail to capture the personalized visual features of users. With the rapid advancements in **computer vision and deep learning**, particularly using **Convolutional Neural Networks (CNNs)**, image-based analysis has become more accurate for applications like face recognition, tone detection, and aesthetic analysis.

Recent studies have also applied **content-based filtering** to recommend products based on item similarity, colour, and visual features extracted from datasets. However, these systems still lack the integration of deep learning-driven skin tone analysis for personalized fashion recommendations. Therefore, the proposed work aims to bridge this gap by combining CNN-based skin tone classification with a content-based recommendation engine to provide **personalized dress suggestions** tailored to each user's complexion.

Parameter	Details
Project Title	Skin Tone Based Product Recommendation System using Deep Learning and Content-Based Filtering
Project Domain	Artificial Intelligence / Deep Learning / Web Application
Objective	To recommend suitable dress colours based on the user's skin tone detected using real-time capture or image upload.
Problem Statement	Many people struggle to select clothing colours that complement their natural skin tone, resulting in mismatched style choices.
Proposed Solution	A deep learning-based system that detects a user's skin tone from an image and recommends matching dress colours using content-based filtering.
Tools & Technologies Used	Python, TensorFlow/Keras, OpenCV, Flask, HTML, CSS, Deep Learning (CNN), Content-Based Filtering
Dataset	Custom-collected skin tone dataset or open-source skin image datasets
End Users	Fashion industry, e-commerce platforms, and individual users
Output	Recommended dress colour suggestions displayed on the web interface
Unique Feature	Real-time image capture and upload feature allowing users to decide on the website directly

Table -1: Sample Table format

Provides an overview of the proposed system, highlighting the key aspects of the project "Skin Tone Based Product Recommendation System Using Deep Learning and Content-Based Filtering." It summarizes the project title, domain, objectives, problem statement, proposed solution, tools and technologies used, dataset, end users, expected output, and unique features. This table gives readers a clear and concise understanding of the system's purpose, scope, and functionality at a glance, making it easier to grasp the overall project framework before delving into detailed sections.

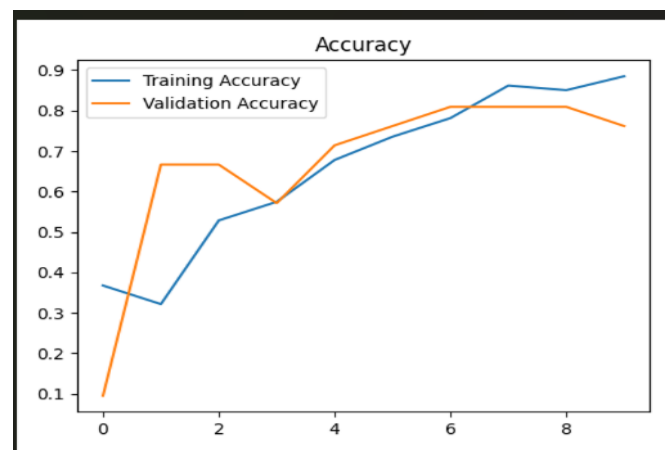


Chart -1: Model (CNN) training

The training graph illustrates the performance of the Convolutional Neural Network (CNN) model used for skin tone classification. During the training phase, the model learns to identify patterns in the input images and correctly classify them into one of the four skin tone categories: **light, mid-light, mid-dark, and dark**. The accuracy curve in the graph shows a gradual increase as the number of epochs progresses, indicating that the model is effectively learning from the training data.

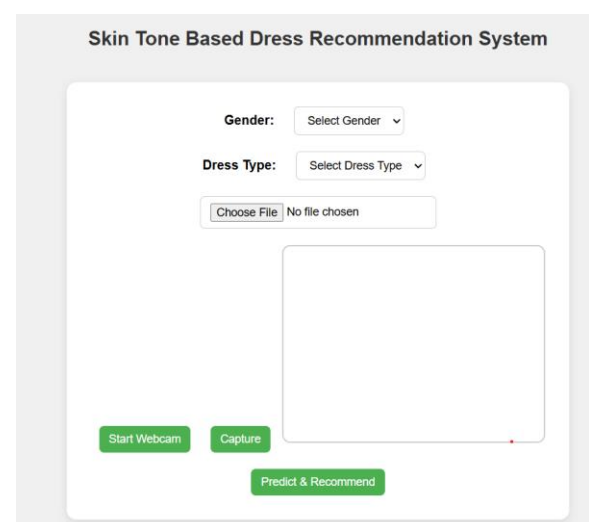


Fig -1: the website

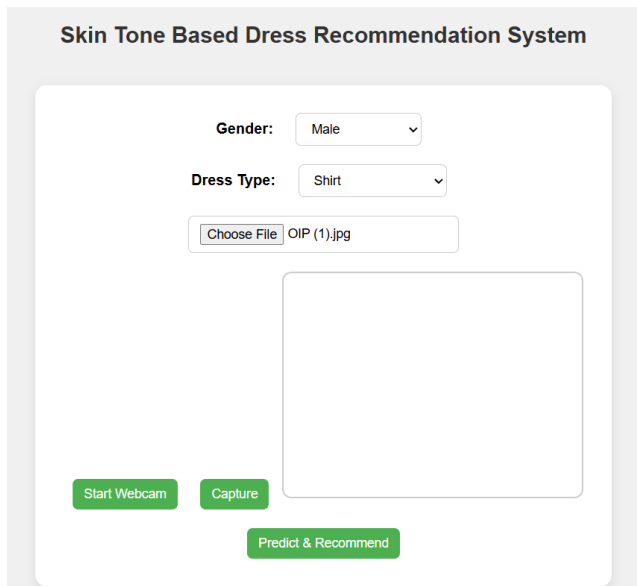


Fig 2- Selecting image

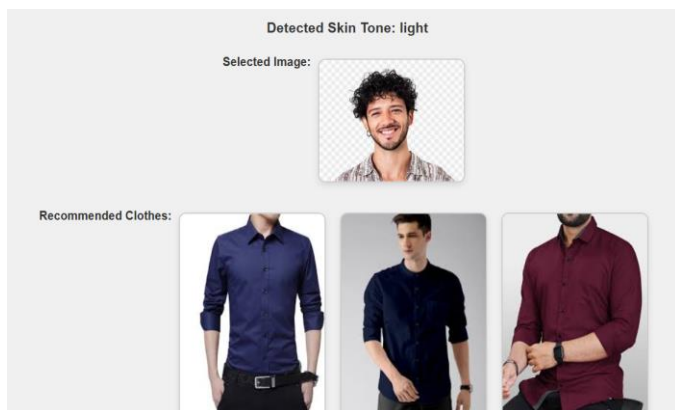


Fig 3- Detected skin tone and recommended clothes

In this project, several abbreviations and technical terms are used for clarity and conciseness. The term **CNN (Convolutional Neural Network)** refers to a deep learning model used for image recognition and classification. **DL (Deep Learning)** represents the branch of artificial intelligence that trains models to learn patterns from large datasets. **CBF (Content-Based Filtering)** is the recommendation technique used to suggest products based on features such as color and similarity. **GUI (Graphical User Interface)** denotes the web interface that allows users to capture or upload images and view personalized dress recommendations.

3. CONCLUSIONS

The **Skin Tone Based Product Recommendation System using Deep Learning and Content-Based Filtering** successfully demonstrates an intelligent approach to personalized fashion recommendations. By leveraging a Convolutional Neural Network (CNN) for accurate skin tone

detection and combining it with content-based filtering techniques, the system is able to recommend colour-appropriate dresses—**sarees and chudidhars for women, shirts and pants for men**—that complement the user's complexion.

The system provides flexibility by allowing users to **either capture their image in real-time or upload an existing photo**, making the platform highly user-friendly and interactive. The training results, including accuracy and loss analysis, indicate that the model is both robust and reliable, achieving high accuracy in skin tone classification.

Overall, this project enhances the online shopping experience by offering **personalized, visually compatible dress recommendations**, reduces the difficulty of selecting suitable colours, and bridges the gap between **AI technology and the fashion industry**. The implementation confirms that integrating deep learning with content-based filtering can significantly improve user satisfaction, fashion compatibility, and decision-making for customers.

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