

AI-Powered Virtual Cosmetic Try-On and Shade Recommendation for E-Commerce Platform

Author

Ved Sawarkar

Research Scholar

vedsawarkar1@gmail.com

Arnav Taley

Research Scholar

arnavtaley@gmail.com

Gaurang Moharle

Research Scholar

gaurangmo23@gmail.com

Ninad Ghodmare

Research Scholar

ninadghodmare@gmail.com

Swaraj Mahalle

Research Scholar

swarajmahalle16@gmail.com

Prof. A.M. Bhoyar

Guide, PRPCEM

ankitam.bhoyar@gmail.com

Abstract

Online cosmetic shopping presents a challenge because customers cannot physically test products or determine which shades are most suitable for their skin tone. This project proposes an AI-powered e-commerce platform that combines personalized shade recommendation with virtual cosmetic try-on. The system analyzes facial features and skin characteristics to recommend suitable lipstick shades and uses computer vision to detect the user's lips and render the selected shade on the live facial image. MediaPipe, OpenCV, NumPy, and Scikit-learn are used for facial landmark detection, image processing, skin-tone classification, and shade recommendation. The integration of these capabilities with an e-commerce platform provides an interactive product discovery and purchasing experience while reducing uncertainty during cosmetic selection.

Keywords - Artificial Intelligence, Virtual Cosmetic Try-On, Shade Recommendation, Computer Vision, Skin Tone Analysis, Facial Landmark Detection, Lip Segmentation, Image Processing, Machine Learning, E-Commerce.

1. Introduction

Online shopping has significantly changed the way customers purchase cosmetic products. However, cosmetics such as lipstick have a major limitation in an online environment: customers cannot physically test the product before purchasing it. A lipstick shade that appears attractive in a product image may look different when applied to an individual's lips because of variations in skin tone, lighting, lip pigmentation, and facial characteristics. This can lead to uncertainty while selecting products and may result in unsuitable purchases, dissatisfaction, and product returns.

Recent developments in Artificial Intelligence (AI), computer vision, and image processing provide an opportunity to address this limitation. Facial landmark detection can identify important regions of the face, including the lips, from a live camera feed. Once the lip region is detected, image-processing techniques can be used to apply a selected cosmetic shade while maintaining the underlying structure and appearance of the lips.

The proposed project focuses on developing an AI-powered virtual lipstick try-on system integrated with an e-commerce platform. Instead of using a separate application, the user can select a lipstick from the product page, activate the virtual try-on feature, view the selected shade on their own face, compare different shades, and proceed with the purchase. The system also incorporates shade recommendation based on skin-tone analysis to provide additional assistance during product selection.

2. Aims and Objectives

Proposed system is to develop an AI-powered virtual cosmetic try-on and shade recommendation system integrated with an e-commerce platform that enables users to virtually preview lipstick shades on their own face and receive personalized shade recommendations, thereby reducing uncertainty during online cosmetic shopping and improving the overall shopping experience.

1. To detect the user's face and lip region accurately from webcam or camera input using computer vision and facial landmark detection techniques.
2. To analyse the user's skin tone using facial skin regions and image-processing techniques to provide information useful for personalized shade selection.
3. To develop a lipstick shade recommendation mechanism that suggests suitable shades from the available product catalogue based on the user's analysed characteristics.
4. To apply the selected lipstick shade virtually to the detected lip region using image-processing techniques while maintaining a natural appearance.
5. To perform lip segmentation and colour blending so that the lipstick effect remains within the lip boundaries and preserves relevant facial details.
6. To integrate the virtual try-on system with the e-commerce platform, allowing users to access the feature directly from lipstick product pages.
7. To allow users to switch between and compare multiple lipstick shades through the virtual try-on interface before making a purchase.

3. Literature Review

The development of Artificial Intelligence, computer vision, facial analysis, image processing, and augmented reality has created new possibilities for virtual cosmetic applications. Traditional online cosmetic shopping does not allow customers to physically test a lipstick shade before purchasing it, creating uncertainty regarding its appearance on the user's face. Recent research has explored AI-based makeup transfer, facial segmentation, lip segmentation, skin-tone recognition, cosmetic recommendation, and real-time augmented-reality-based try-on systems. These studies provide the technical foundation for developing a virtual cosmetic try-on system that combines facial analysis, personalized shade recommendation, realistic lipstick rendering, and e-commerce integration.

1. AI-based Makeup Transfer:

Li et al. proposed BeautyGAN, an instance-level facial makeup transfer framework based on generative adversarial networks. The study demonstrated the ability of deep generative models to transfer makeup characteristics from one facial image to another while preserving important facial features. This demonstrates the potential of AI-based approaches for realistic cosmetic visualization. However, generative makeup-transfer approaches can involve substantial computational requirements, which may make them less suitable for lightweight real-time cosmetic try-on applications. Chang et al. proposed PairedCycleGAN, an asymmetric style-transfer framework for applying and removing makeup. The study demonstrated how generative models can learn transformations between makeup and non-makeup facial appearances. These approaches provide a foundation for understanding AI-based cosmetic transformation, although the proposed Amore system uses a more lightweight image-processing approach based on facial landmarks, lip masks, colour processing, and blending rather than full-image generative makeup transfer.

2. Facial Segmentation and Real-Time Facial Processing:

Saito et al. presented a real-time facial segmentation and performance-capture approach using RGB input. The work demonstrates the importance of facial segmentation and real-time facial processing for applications that require accurate identification and tracking of facial regions. Such techniques are relevant to virtual cosmetic applications because stable facial-region detection is required before applying cosmetic effects. In the proposed system, facial landmark detection is similarly used as an initial stage for identifying relevant facial and lip regions before performing skin analysis and lipstick rendering.

3. Generative Adversarial Networks:

Goodfellow et al. introduced Generative Adversarial Networks (GANs), establishing a framework in which a generator and discriminator are trained adversarially to produce realistic data. GAN-based approaches subsequently became

relevant to image synthesis and facial makeup-transfer applications such as BeautyGAN [1] and PairedCycleGAN [2]. In the context of the proposed system, this work provides theoretical background for AI-based image transformation, while the implemented virtual try-on approach uses facial landmarks, segmentation, colour processing, and blending rather than a GAN-based generator.

4. AI-Based Cosmetic Rendering:

Chen et al. proposed BeautyGlow, an on-demand makeup-transfer framework based on a reversible generative network. The study demonstrates the application of deep generative techniques for controllable facial makeup transfer and provides evidence that AI-based image transformation can be used for cosmetic visualization. However, generative approaches may require greater computational resources than lightweight image-processing methods. The proposed system therefore focuses specifically on lipstick rendering using facial landmarks, lip segmentation, colour mapping, and alpha blending to support an interactive try-on experience.

5. Real-Time Augmented Reality Cosmetic Try-On:

An et al. presented ARCosmetics, a real-time augmented reality cosmetics try-on system designed for cosmetic visualization. The study demonstrates the feasibility of real-time facial analysis and cosmetic rendering for virtual beauty applications. This work is closely related to the proposed system because both focus on real-time cosmetic try-on. However, the proposed Amore system extends the concept by integrating virtual lipstick try-on with an e-commerce workflow and by incorporating a skin-tone-based shade recommendation component. The user can therefore move from product discovery and personalized shade recommendation to virtual visualization and purchase within the same platform.

6. Lip Segmentation:

Guan et al. investigated lip image segmentation using a fuzzy convolutional neural network. Accurate lip segmentation is important for virtual lipstick try-on because the cosmetic effect must be restricted to the actual lip region while avoiding surrounding facial areas. The study demonstrates the importance of specialized lip segmentation techniques for identifying lip boundaries. In the proposed system, facial landmarks are used to identify the lip region, followed by mask generation and colour processing to restrict the lipstick effect to the required area.

7. Skin-Tone Recognition and Makeup Recommendation:

Kamble et al. proposed a hybrid HSV and YCrCb OpenCV-based mechanism for skin-tone recognition in makeup recommender systems. The study demonstrates the application of colour-space analysis and computer vision techniques for identifying skin tone in the context of cosmetic recommendation. This is directly relevant to the proposed shade recommendation module, where facial skin regions are analysed and colour characteristics are used to classify the user's skin tone and support personalized lipstick shade selection.

8. Illumination and Beauty Product Recommendation:

Afshar et al. investigated the effect of face illumination quality on beauty product recommendation accuracy. The study highlights the importance of controlling or assessing illumination when analysing facial characteristics for cosmetic recommendations. This is particularly relevant to the proposed system because lighting variations can influence the extracted skin colour and consequently affect skin-tone classification and shade recommendation. Therefore, different lighting conditions are considered during testing and validation of the proposed system.

Summary of Literature Review-

The literature review shows that Artificial Intelligence, computer vision, facial segmentation, lip segmentation, colour processing, and augmented reality provide important foundations for virtual cosmetic try-on systems. GAN-based approaches such as BeautyGAN, PairedCycleGAN, and BeautyGlow demonstrate the potential of AI for realistic makeup transfer, while facial processing and lip segmentation support accurate identification of facial and lip regions. Skin-tone recognition using colour-space-based techniques can assist personalized cosmetic recommendations, while real-time AR systems such as ARCosmetics demonstrate the feasibility of virtual cosmetic try-on. Research on face illumination further highlights the importance of lighting conditions for reliable beauty-product recommendations. Overall, the reviewed studies indicate the need for a lightweight and integrated system that combines skin-tone-based shade recommendation, accurate lip detection and segmentation, realistic colour blending, real-time virtual try-on, and

direct e-commerce integration. The proposed Amore Cosmetics system addresses this requirement by bringing these components together within a single online shopping platform.

Table 01: Comparative Literature Review

Ref .	Author(s) & Year	Method / Technique	Application	Key Findings	Limitation / Research Gap
[1]	Li et al., 2018	BeautyGAN; GAN-based makeup transfer	Facial makeup transfer	Demonstrated realistic instance-level makeup transfer	Generative approach is more computationally demanding for lightweight real-time use
[2]	Chang et al., 2018	PairedCycleGAN ; asymmetric style transfer	Applying/removing facial makeup	Demonstrated makeup transformation between facial appearances	Focuses on generative image transformation rather than direct e-commerce try-on
[3]	Saito et al., 2016	Real-time facial segmentation and performance capture	Facial processing from RGB input	Demonstrated real-time facial segmentation/capture	General facial processing rather than cosmetics-specific try-on
[4]	Goodfellow et al., 2014	Generative Adversarial Networks	Image/data generation	Established GAN framework used by later image-generation applications	General-purpose framework rather than cosmetic-specific application
[5]	Chen et al., 2019	BeautyGlow; reversible generative network	On-demand makeup transfer	Supports controllable AI-based makeup transfer	Generative processing may be computationally intensive for lightweight applications
[6]	An et al., 2023	Real-time AR cosmetics try-on	Virtual cosmetic visualization	Demonstrated real-time cosmetic try-on	Does not provide the complete e-commerce + personalized recommendation workflow of the proposed system
[7]	Guan et al., 2020	Fuzzy CNN-based lip segmentation	Lip image segmentation	Improves identification of lip regions	Segmentation is focused on lip images rather than complete cosmetic e-commerce workflow
[8]	Kamble et al., 2024	HSV/YCrCb + OpenCV	Skin-tone recognition and makeup recommendation	Demonstrates colour-space-based skin-tone recognition for recommendation	Skin-tone recognition alone does not provide virtual lipstick try-on and e-commerce integration
[9]	Afshar et al., 2023	Face illumination quality assessment	Beauty product recommendation	Shows importance of illumination quality for recommendation accuracy	Addresses illumination/recommendation rather than complete virtual cosmetic try-on

Limitations of Existing Systems

1. Limited Integration of Components:

Existing studies often focus on individual components such as makeup transfer, lip segmentation, skin-tone recognition, or virtual cosmetic try-on. Integrating these components into a single end-to-end e-commerce workflow remains a practical challenge.

2. Lighting and Skin-Tone Variations:

Facial colour analysis and cosmetic rendering can be affected by changes in illumination and differences in users' skin tones. This can influence skin-tone classification and shade recommendation.

3. Real-Time Processing:

Real-time facial tracking, segmentation, colour processing, and rendering require efficient processing to maintain a smooth user experience.

4. Limited Shade and Skin-Tone Coverage:

Recommendation performance depends on the diversity of the available lipstick shade catalogue and skin-tone data.

5. E-Commerce Integration and Privacy:

Virtual try-on systems need to be integrated with product selection and purchasing workflows while also ensuring appropriate handling of camera images and user data.

Conclusion:

The literature review demonstrates that AI and computer vision can support different components of virtual cosmetic applications, including facial processing, makeup transfer, lip segmentation, skin-tone recognition, cosmetic recommendation, and real-time augmented-reality try-on. GAN-based approaches such as BeautyGAN, PairedCycleGAN, and BeautyGlow demonstrate the potential of AI-based makeup transformation, while facial processing, lip segmentation, and skin-tone recognition provide supporting techniques for localized cosmetic applications. ARCosmetics demonstrates the feasibility of real-time cosmetic try-on, while Afshar et al. highlights the importance of illumination quality for beauty-product recommendation. However, integrating personalized shade recommendation, realistic lipstick rendering, real-time try-on, and direct e-commerce functionality into a unified system remains an important practical requirement. The proposed Amore Cosmetics platform addresses this requirement by combining these components into a single e-commerce workflow.

4. Proposed Methodology

The proposed system integrates an AI-powered virtual cosmetic try-on and shade recommendation module with a complete e-commerce platform. The methodology begins with normal product browsing and continues through personalized shade selection, virtual try-on, cart management, and checkout.

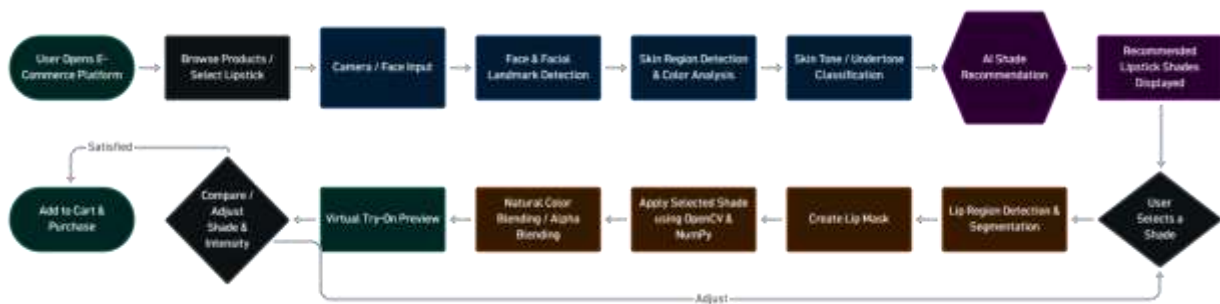


Fig 01: Proposed AI-Powered Virtual Lipstick Try-On and Shade Recommendation Workflow

4.1 Requirement Analysis

The first stage focuses on identifying the requirements of the e-commerce platform and its users. Customers require facilities for user registration, product browsing, lipstick shade selection, AI-based shade recommendation, virtual try-on, cart management, and online purchasing. The system also requires product and shade management, secure authentication, database management, and integration between the e-commerce platform and the AI service. The AI component requires camera/image input, facial landmark detection, skin-tone analysis, lip segmentation, colour processing, and shade recommendation capabilities.

4.2 System Design

In this stage, the overall system architecture, database structure, user interfaces, APIs, and workflow are designed. The proposed system is divided into an e-commerce layer and an AI processing layer. The database is designed to store user information, products, lipstick shades, carts, orders, and related product data. The AI service is designed to process facial information, identify skin characteristics, recommend suitable shades, and perform virtual lipstick rendering.

4.3 E-Commerce Development

The designed system is implemented as a web-based e-commerce application. The development includes the product catalogue, product-detail pages, user authentication, product and shade selection, cart management, checkout, and order processing. The platform provides users with a complete shopping workflow while integrating the AI features directly into the product and shade selection process.

4.4 AI-Based Shade Recommendation

This module analyses the user's facial image to provide personalized lipstick shade recommendations. The system captures the user's face through a camera or image input and detects facial landmarks. Suitable skin regions are identified for colour analysis, and skin colour information is extracted using image-processing techniques. The extracted features are processed to classify the user's skin tone and undertone. The recommendation mechanism then compares these characteristics with the available lipstick shades and displays suitable recommendations to the user.

4.5 Virtual Lipstick Try-On

The virtual try-on module allows users to preview a selected lipstick shade on their own face. Facial landmarks are used to identify the lip region, followed by lip segmentation and creation of a lip mask. The selected lipstick colour is applied to the detected lip region using OpenCV and NumPy. Natural colour blending and alpha blending are applied to preserve the appearance of the lips while providing a realistic preview. Users can switch between shades and adjust the intensity of the applied colour.

4.6 Integration, Testing and Validation

The e-commerce and AI modules are integrated to provide a continuous workflow from product selection to virtual try-on and purchase. The developed modules are tested individually and after integration to verify their functionality. Unit Testing, Integration Testing, System Testing, Usability Testing, Performance Testing, and Security Testing are considered for validating the system. The AI component is evaluated using different faces, skin tones, lighting conditions, and camera angles, with detection accuracy and processing speed considered as important evaluation parameters.

4.7 Deployment

After successful testing and validation, the e-commerce application and AI service are deployed using suitable cloud or server environments. The web application provides access to the product catalogue, recommendation system, virtual try-on, cart, and checkout features. The AI service operates separately and communicates with the e-commerce application through APIs for processing recommendation and try-on requests.

4.8 Maintenance and Improvement

The final stage involves monitoring the deployed system, fixing errors, improving processing performance, and updating the product and shade catalogue. User feedback can be used to improve shade recommendations, colour rendering, usability, and system performance. The system can also be extended to support additional cosmetic products such as eyeshadow, blush, and other virtual makeup features.

4.9 Expected Working of the Proposed System

The proposed system provides a centralized e-commerce workflow in which users browse cosmetic products, select a lipstick, and obtain personalized shade recommendations based on their facial and skin characteristics. Users can then select a recommended or available shade and preview it using the virtual try-on feature. After comparing shades and adjusting the intensity, the user can select the preferred product, add it to the cart, and proceed through checkout and purchase. The overall approach combines e-commerce, AI-based shade recommendation, computer vision, and virtual cosmetic visualization into a single shopping experience.

5. Research Methodology

The research methodology adopted for the proposed AI-Powered Virtual Cosmetic Try-On and Shade Recommendation System for E-Commerce follows an Experimental Research Design combined with an Agile Software Development Methodology. The experimental approach is used to develop and evaluate the face detection, skin-tone analysis, shade recommendation, lip segmentation, and virtual try-on components under different conditions. The Agile approach is used for iterative development, integration, testing, and improvement of the e-commerce and AI modules. The project documentation specifies testing across different faces, skin tones, lighting conditions, and camera angles, with evaluation based on detection accuracy, processing speed, and user satisfaction.

The methodology consists of requirement analysis, data preparation, model and analysis strategy, system design and development, experimental setup, testing, performance evaluation, validation, deployment, and maintenance. The major components of the research methodology are described below.

5.1 Data Preparation

Data preparation is an important stage for developing and evaluating the proposed system. The system works with different types of data, including user facial images or camera frames, facial landmarks, skin-region colour information, skin-tone categories, undertone information, and lipstick shade data.

For skin-tone analysis, facial regions suitable for colour extraction are identified while avoiding irrelevant regions. Colour information is extracted from the selected skin regions and processed for analysis. The prepared data is used for skin-tone classification and shade recommendation.

The lipstick shade catalogue contains information about the available cosmetic shades. The shade information is used by the recommendation mechanism to compare the detected skin characteristics with available products and identify suitable shades.

For the virtual try-on component, camera frames or captured facial images are processed to identify facial and lip regions. The prepared image data is then used for lip segmentation, colour application, blending, and generation of the virtual try-on result.

5.2 Model and Analysis Strategy

The proposed system uses different computer vision, image-processing, and machine-learning techniques for facial analysis, skin-tone classification, shade recommendation, and virtual cosmetic rendering.

1. Face and Landmark Detection

A real-time facial landmark detection method is used to identify important points on the user's face, particularly around the lip region. This provides the coordinates required for subsequent skin analysis and lipstick application. MediaPipe is selected as the primary facial landmark tracking technology in the proposed methodology.

2. Skin Region Detection and Colour Analysis

Suitable facial skin regions are identified for colour analysis. The extracted colour information is processed using image-processing techniques to obtain relevant colour features. Colour-space analysis can be used to represent skin characteristics for subsequent classification.

3. AI-Based Shade Recommendation

The recommendation mechanism compares the user's detected skin characteristics with the available lipstick shade catalogue. Suitable lipstick shades are then presented to the user. The purpose is to provide personalized shade suggestions rather than requiring the user to select a shade without any guidance.

4. Lip Segmentation and Mask Generation

After the user selects a shade, facial landmarks are used to locate the lips. The lip region is segmented and converted into a mask so that the cosmetic colour is applied primarily to the required region.

5. Lipstick Colour Rendering

OpenCV and NumPy are used to process and apply the selected lipstick colour to the detected lip region. Colour blending and alpha blending are used to produce a more natural appearance while retaining the underlying facial and lip characteristics. The project methodology specifically proposes colour mapping and blending for natural rendering under different lighting conditions.

5.3 Technologies and Experimental Environment

The proposed system is implemented as an AI-powered e-commerce web application with a separate AI processing service. According to the established project architecture, the planned technologies include:

- Frontend: Next.js, React, TypeScript, Tailwind CSS
- Backend / E-Commerce APIs: Next.js Route Handlers / Server Actions
- AI Service: Python and FastAPI
- Computer Vision: MediaPipe, OpenCV, NumPy
- Machine Learning: Scikit-learn
- Database: PostgreSQL with Drizzle ORM
- Caching: Redis
- Authentication: Better Auth and Argon2id
- Testing: Vitest and Playwright
- Development Environment: Visual Studio Code / suitable development IDE
- Version Control: Git and GitHub
- Deployment: Vercel and suitable hosting for the AI service

The experimental environment includes the complete e-commerce workflow, beginning with product browsing and continuing through shade recommendation, virtual try-on, cart management, and purchase. The AI component is tested using different facial images or camera inputs, skin tones, lighting conditions, and facial orientations. This follows the experimental setup specified in the project methodology.

5.4 Experimental Procedure

The system is developed iteratively using the Agile methodology. Initially, the requirements and limitations of existing cosmetic try-on systems are analysed. This is followed by system architecture and database design, after which the e-commerce and AI modules are developed and integrated.

The experimental procedure begins with capturing the user's face through a webcam or camera-enabled device. Facial landmarks are detected, followed by skin-region detection and colour analysis for the shade recommendation process. After a shade is recommended or selected, the lip region is detected and segmented. The selected lipstick shade is then applied using image-processing and colour-blending techniques.

The developed system is tested under different experimental conditions, including:

- Different facial appearances
- Different skin tones
- Different lighting conditions
- Different camera angles
- Different lipstick shades
- Different lip shapes and movements

The complete workflow is then tested by integrating the AI functionality with the product page, allowing users to preview a shade, compare different shades, adjust the effect, and proceed to the shopping cart and purchase process. The project documentation identifies accuracy, FPS, usability, and user feedback as key evaluation areas.

5.5 Performance Evaluation and Validation

The proposed system is evaluated using predefined performance and usability parameters. These include facial and lip detection accuracy, skin-tone classification performance, processing speed, virtual try-on rendering quality, system responsiveness, usability, and user satisfaction.

The system undergoes:

1. Unit Testing – Individual modules such as authentication, product management, recommendation, and image processing are tested separately.

2. Integration Testing – Communication between the e-commerce application and AI service is tested.
3. System Testing – The complete e-commerce and AI workflow is evaluated.
4. Performance Testing – Processing time and FPS are measured to assess real-time performance.
5. Usability Testing – The ease of using product selection, shade recommendation, and virtual try-on features is evaluated.
6. Security Testing – Authentication, API access, user data, and camera-related operations are tested.
7. User Acceptance Testing (UAT) – Realistic shopping scenarios are used to evaluate whether the system meets the intended requirements.

Validation is performed across different faces, skin tones, lighting conditions, and camera angles. User feedback is also considered for improving the system's usability and virtual try-on experience.

5.6 Overall Methodology

The overall research process can be summarized as:

Requirement Analysis → Literature Review → Data Preparation → System Design → Model/Algorithm Selection → E-Commerce Development → AI Module Development → System Integration → Experimental Testing → Performance Evaluation → Validation → Deployment and Maintenance

The proposed methodology provides a systematic approach for developing and evaluating an AI-powered virtual cosmetic try-on system integrated with an e-commerce platform. It combines facial landmark detection, skin-tone analysis, shade recommendation, lip segmentation, colour processing, and natural blending with a complete online shopping workflow. The overall approach aims to allow customers to preview lipstick shades before purchase, improve shade selection, and provide a more interactive online cosmetic shopping experience.

6. Limitations and Recommendations

1. Lighting and Skin-Tone Variations:

The accuracy of skin-tone analysis and the natural appearance of lipstick colour can be affected by differences in lighting conditions and variations in users' skin tones. The system therefore requires testing under different real-world lighting conditions.

2. Limited Shade and Skin-Tone Coverage:

The effectiveness of the recommendation system depends on the availability and diversity of lipstick shades and skin-tone categories. A limited shade catalogue or insufficiently diverse data may reduce the applicability of recommendations for some users.

3. Real-Time Processing Limitations:

Real-time face tracking, lip segmentation, colour processing, and rendering require efficient processing to maintain a smooth user experience, particularly on ordinary laptops and mobile devices.

4. Improve AI-Based Recommendation:

Future versions can incorporate more advanced machine-learning techniques and larger, more diverse datasets to improve skin-tone classification and personalized lipstick shade recommendations.

5. Improve Virtual Try-On and Verification:

Future improvements can include more robust landmark stabilization, improved colour rendering under different lighting conditions, stronger camera-data privacy mechanisms, and extensions to other cosmetic products such as eyeshadow and blush.

7. Conclusion

The AI-Powered Virtual Cosmetic Try-On and Shade Recommendation System for E-Commerce provides an integrated web-based solution for addressing the major challenges associated with purchasing cosmetic products online. The proposed system combines product browsing, AI-based shade recommendation, virtual lipstick try-on, shade comparison, cart management, and online purchasing within a single e-commerce platform.

The system uses computer vision and image-processing techniques to detect facial and lip regions, analyse relevant skin characteristics, recommend suitable lipstick shades, and render the selected shade on the user's lips. The virtual try-on component uses facial landmark detection, lip segmentation, colour processing, and blending techniques to generate a realistic preview. The system is directly connected with the e-commerce product-selection and purchase workflow, allowing users to move from shade visualization to cart and checkout.

The proposed methodology combines facial landmark detection, skin-tone analysis, machine learning, lip segmentation, OpenCV-based colour processing, and e-commerce integration. The system can be evaluated using parameters such as detection accuracy, processing speed, rendering quality, usability, user satisfaction, and performance under different faces, skin tones, lighting conditions, and camera angles.

Overall, the proposed system aims to reduce uncertainty during online cosmetic shopping by allowing customers to visualize lipstick shades before purchasing. It provides a more interactive shopping experience and has the potential to reduce incorrect shade selections and product returns. The system also provides a scalable foundation for future cosmetic applications such as virtual eyeshadow, blush, foundation, and other AI-assisted makeup recommendations.

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