Beauty Care Shopping using 3D Modelling

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Abstract: The rapid evolution of e-commerce has brought a transformative shift in the beauty care industry, where consumers are increasingly seeking innovative and personalized shopping experiences. Traditional online shopping platforms for beauty products typically offer limited interaction, often leaving customers to rely solely on product descriptions and images. In contrast, this project explores the integration of 3D modeling technology into the e-commerce landscape, specifically within the beauty care sector, to create a more engaging, interactive, and personalized online shopping experience. By leveraging 3D models, consumers can interact with beauty products in a more immersive way, gaining detailed insights into product textures, packaging, and functionalities. The platform allows users to explore and virtually try on beauty products, such as skincare, makeup, and fragrances, through advanced 3D visualization. This enhances the consumer's ability to make informed decisions, reducing the uncertainty that often accompanies online beauty product purchases. Using augmented reality (AR) and 3D modeling tools, users can virtually test makeup products on their faces, view skincare product textures in real-time, and explore product features in greater detail.

1.Introduction

As per the records of Beauty Trends Daily (24 Jan 2024), 1.1 million users engaged with 3D-modeled product previews on a leading beauty products e-commerce platform, significantly enhancing customer experience. According to Global Beauty Insights (June 2023), over 30,000 customers reported a higher satisfaction rate when purchasing cosmetics with 3D try-on features compared to traditional product images.

The website design utilizes interactive features that make it easy for users to navigate through various beauty care categories, applying filters and customizing their experience based on their preferences, skin types, and desired results. Moreover, the implementation of 3D modeling provides a high level of personalization, allowing users to visualize how products will look or feel before making a purchase. The introduction of this technology not only improves user satisfaction.

This approach aims to overcome common online shopping challenges, such as the inability to physically touch or try products, by enhancing customer trust and ensuring that the products meet individual preferences. Furthermore, by offering a visually rich and interactive shopping environment, this e-commerce platform aims to build long-term customer loyalty and differentiate itself in an increasingly competitive beauty industry.

Ultimately, this project seeks to redefine the digital shopping journey by merging cutting-edge technologies with the beauty care industry's growing demand for more personalized, engaging, and informative shopping experiences. Through the integration of 3D modeling, e-commerce platforms can enhance user engagement, build consumer trust, and drive sales growth.

Thus, to speed up the voting process and avoid such type of problems, we have proposed the new system.

2. Literature Survey

As per industry best practices and evolving consumer preferences, the beauty e-commerce sector has been driven

to enhance user experience through innovative technologies.

For this, over the last decade, leading beauty retailers have been implementing advanced 3D modeling and augmented reality (AR) technologies.

To ensure efficacy, reduced time consumption, and cost efficiency, the beauty e-commerce industry is rapidly adopting advanced technologies. Right now, 3D modeling and augmented reality (AR) try-on features are being effectively utilized to provide customers with an immersive shopping experience.

These technologies ensure that users can virtually test products before purchasing, reducing return rates and enhancing satisfaction.

However, challenges still exist in ensuring accurate skin tone detection and real-time facial mapping for personalized recommendations.

To overcome these issues, AI-powered face recognition and AR technology have been embedded in beauty e-commerce platforms. The goal is to achieve a 95% user engagement rate in virtual try-on experiences, but currently, the adoption rate is around 70% due to limited accessibility and device compatibility.

The beauty retail system has undergone significant transformations in the past few years. The traditional method of testing products in-store is gradually being replaced by digital alternatives such as virtual try-on mirrors, AI-powered shade matching, and interactive 3D product previews. However, the accuracy of these systems still depends on lighting conditions, skin undertones, and mobile camera quality.

To address these issues, a web-based smart beauty shopping system has been developed, integrating real-time 3D face scanning and AI-powered skincare diagnostics.

The system enables customers to test beauty products from anywhere in the world, reducing dependency on physical stores. Utilizing facial recognition and skin analysis, the platform suggests the most suitable products while preventing fraudulent reviews and fake influencer promotions.

The system is further enhanced with blockchain technology, ensuring secure and tamper-proof customer data storage. With AI-driven recommendations and personalized skincare analysis, beauty e-commerce platforms can offer a more authentic and trustworthy shopping experience.

Ultimately, this project seeks to redefine the digital shopping journey by merging cutting-edge technologies with the beauty care industry's growing demand for more personalized, engaging, and informative shopping experiences. Through the integration of 3D modeling, e-commerce platforms can enhance user engagement, build consumer trust, and drive sales growth.

AI skincare recommendations are effectively utilized to enhance the customer shopping journey. These technologies ensure precise shade matching, realistic product previews, and a seamless purchasing experience.

However, challenges still persist in ensuring accurate skin tone detection, preventing counterfeit products, and enhancing consumer trust in online beauty shopping. To overcome these issues, blockchain-based product verification and AI-powered skin analysis have been embedded in beauty e-commerce platforms. The goal is to achieve a 95% accuracy rate in virtual product recommendations, but adoption currently stands at around 70% due to mobile device limitations and internet accessibility.

The beauty retail system has undergone significant digital transformations over the past decade. Traditional in-store product trials are being replaced by AI-powered skin assessment tools, interactive 3D product views, and smart virtual mirrors that allow customers to try on cosmetics without physical testers. However, the effectiveness of these systems depends on advanced AI algorithms, lighting conditions, and device compatibility.

To address these challenges, a web-based smart beauty shopping platform has been developed, integrating AI-driven facial recognition and blockchain technology to authenticate genuine beauty products and provide customers with real-time personalized recommendations. The system allows shoppers to test beauty products from anywhere, reducing the risk of purchasing incorrect shades or counterfeit products.

To enhance security and prevent fraudulent product sales, blockchain technology is used to store customer purchase history and verify product authenticity. Similar to biometric authentication in smartphones, customers can unlock exclusive discounts and personalized recommendations using facial recognition technology. This reduces the chances of incorrect purchases and enhances the overall shopping experience.

The system also allows users to track beauty trends, compare past purchases, and access secure product reviews stored on the blockchain, preventing manipulated feedback. Customers can access personalized beauty insights via an AI-powered dashboard, helping them choose the best skincare and makeup products based on scientific skin analysis and past purchase behavior.

By combining AI, blockchain, and 3D modeling, the beauty industry is moving towards a more personalized, secure, and efficient online shopping experience, ensuring that customers make informed beauty purchases with higher accuracy and satisfaction.

3. Methodology
A. Open CV
An open-source library, is used for computer vision tasks, including face recognition and skin analysis.

AI-powered facial recognition analyzes skin tone, texture, and features to recommend personalized beauty products.

B. Haar Cascade

Haar feature-based cascade classifiers are used for object detection to enable virtual try-on features (lipstick, foundation, blush).

The algorithm is trained with positive and negative images of different facial structures and skin types.

The Haar feature formula:

$$F(Haar) = \sum F_{white} - \sum F_{black}$$

$\sum F_{white}$ = Sum of pixels in the bright

$\sum F_{black}$ = Sum of pixels in the dark area

C. LBPH Algorithm

Local Binary Pattern Histogram (LBPH) is used to analyze skin texture and recommend suitable skincare products.

The LBPH algorithm processes the image by thresholding pixel neighborhoods and converting them into binary values, which are then stored as histograms.

Formula for LBPH:

$$LBP_{P,R}(x_c, y_c) = \sum_{p=0}^{P-1} s(g_p - g_c) 2^p$$

where:
- g_{pg_pgp} = Pixel intensity in the neighborhood g_{cg_cgc} = Center pixel intensity
- PPP = Number of neighboring pixels

4. Output Results

Initially, the user needs to register on the system by providing information such as Mobile Number, City, Age, Password, etc. This information is stored in the user dataset. The system captures the user's face at the time of registration using a webcam and stores it in the face dataset for template matching.

For login, the user must enter their Mobile Number/Email and Password or use Facial Recognition Authentication. To ensure high accuracy, the system requires a high-quality camera for efficieny facial detection and recognition. The system captures video and converts it into multiple frames to improve accuracy.

Facial recognition technology identifies and verifies a user's identity using their face. It can recognize users in photos, videos, or real-time streams, enhancing security for authentication.

Additionally, the system supports a 3D modeling and virtual try-on feature. Users can select beauty products such as lipsticks, foundation, and eyeliner, which will be applied to a 3D face model in real-time, allowing them to preview how the product looks before making a purchase. This biometric security feature improves both user experience and account security while ensuring seamless shopping and checkout.

5. Conclusion

The implementation of facial recognition technology in an e-commerce platform for beauty products offers a secure, seamless, and user-friendly shopping experience. By integrating biometric authentication, the system enhances security by preventing fraudulent logins while providing users with a hassle-free way to access their accounts.

Additionally, the 3D virtual try-on feature revolutionizes the online shopping experience by allowing customers to visualize beauty products on their face before making a purchase. This reduces product returns, increases customer satisfaction, and boosts sales.

To ensure inclusivity, the system must provide alternative login options for users who may not have access to a webcam or prefer traditional authentication methods. Furthermore, robust privacy and security measures must be implemented to protect users' personal data.

Overall, integrating facial recognition and 3D modeling into a beauty e-commerce platform significantly enhances user experience, security, and engagement, making online shopping more interactive, efficient, and personalized.

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