

Smart 3D Virtual Try-On System with Personalized AI Fashion Stylist

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Abstract - Online fashion shopping has become increasingly popular due to the convenience and accessibility provided by e-commerce platforms. However, one of the major challenges in online clothing stores is that customers cannot physically try garments before purchasing them. This limitation often leads to uncertainty about how a garment will appear on a user, resulting in dissatisfaction or product returns. To address this problem, this paper presents a Smart 3D Virtual Try-On System with Personalized AI Fashion Stylist. The proposed system analyzes a user's uploaded image to detect skin tone and generate personalized fashion recommendations. Based on this analysis, the system suggests clothing colors and styles that complement the user's appearance. The selected garments are then fitted onto a digital avatar and displayed through both 2D and 3D visualizations, allowing users to observe outfits from multiple perspectives. By integrating image processing, artificial intelligence, and 3D visualization technologies, the system provides an interactive and personalized online shopping experience. The developed prototype demonstrates that the proposed approach can improve customer confidence and reduce uncertainty in online fashion selection.

Keywords: *Virtual Try-On, Artificial Intelligence, Image Processing, Fashion Recommendation, 3D Visualization, Online Shopping*

1. INTRODUCTION

The rapid growth of online shopping has significantly transformed the fashion retail industry. Consumers

increasingly prefer online platforms because they offer convenience, wide product availability, and easy price comparisons. However, online fashion shopping still faces several challenges, particularly when customers attempt to select garments without physically trying them.

Traditional online stores display clothing items using static images of models or mannequins. While these images provide basic visual information, they do not accurately represent how garments will appear on individual users. Differences in body shape, posture, and skin tone can greatly influence the appearance of clothing. As a result, customers may feel uncertain when making purchasing decisions.

Virtual try-on technology has emerged as a promising solution to this issue. Virtual try-on systems allow users to preview clothing digitally before purchasing them. By combining image processing, artificial intelligence, and visualization technologies, these systems simulate how garments might appear on a person.

The proposed **Smart 3D Virtual Try-On System with Personalized AI Fashion Stylist** aims to enhance the online shopping experience by providing personalized clothing recommendations and interactive visualization. The system analyzes the user's uploaded image to detect skin tone and suggest clothing styles that match the user's appearance. The selected garment is then displayed on a digital avatar using both **2D and 3D visualization techniques**, allowing users to explore the outfit interactively.

2. System Overview

The proposed system consists of several modules that work together to provide personalized fashion recommendations and virtual try-on visualization. These modules include image input, skin tone detection, dress recommendation, avatar generation, dress fitting, and visualization modules. The system workflow begins when the user logs into the application and uploads an image. The system analyzes the image to detect the user's skin tone and generate clothing recommendations. After selecting a garment, the system fits the clothing item onto a predefined digital avatar. The final output is presented in both 2D and 3D views, allowing the user to observe the outfit from different angles.

preprocessing, skin tone detection, and fashion recommendation. The recommendation results are then sent to the visualization modules which generate the final try-on output.

This modular architecture ensures that the system remains scalable and flexible. New features such as body measurement detection, advanced fashion recommendation algorithms, or augmented reality visualization can be easily integrated in the future without affecting the existing modules. The architecture also allows efficient debugging and system maintenance since each module operates independently while contributing to the overall system functionality.

2.2 Technologies Used in the System

The proposed system is developed using a combination of modern web technologies and image processing libraries. These technologies work together to enable image analysis, recommendation generation, and interactive visualization.

The backend of the system is implemented using **Python**, which provides strong support for image processing and machine learning tasks. Python libraries such as OpenCV are used to perform operations like image preprocessing, color detection, and feature extraction. These tools enable accurate identification of skin regions and color values from the uploaded images.

For the visualization component, **Three.js** is used to render interactive 3D models in the web browser. This library allows the system to display virtual avatars and simulate clothing visualization in a realistic environment. The frontend interface is designed using HTML, CSS, and JavaScript to provide a responsive and user-friendly experience.

By integrating these technologies, the system provides a complete solution that combines artificial intelligence, image processing, and 3D visualization in a single platform

2.3 Image Preprocessing

Before performing skin tone detection, the uploaded image undergoes several preprocessing steps to improve accuracy. These preprocessing techniques help remove noise, standardize image size, and enhance relevant features that are

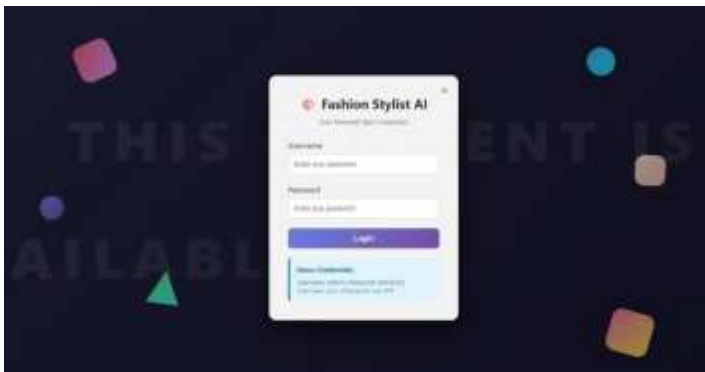


Fig 1: Login Interface of the AI Fashion Stylist System

The login interface provides secure access to the system and allows users to enter their credentials before accessing the fashion recommendation features.

2.1 System Architecture

The overall architecture of the proposed Smart 3D Virtual Try-On System follows a modular design where each module performs a specific function within the application workflow. The architecture consists of user interface components, image processing modules, recommendation algorithms, and visualization components. These modules interact with each other through structured data flow to ensure smooth system operation.

The user interface module is responsible for interacting with the user and collecting input such as login credentials and uploaded images. Once the user provides the image, the backend processing modules perform various operations including image

. The first preprocessing step involves resizing the uploaded image to a fixed resolution. Standardizing the image size ensures that the system can process images efficiently and maintain consistent performance across different inputs. After resizing, the system performs normalization to adjust brightness and contrast levels. Another important preprocessing step is noise reduction. Noise in images can affect the accuracy of skin detection algorithms. Therefore, filtering techniques are applied to smooth the image and remove unnecessary variations. Once preprocessing is complete, the refined image is passed to the skin tone detection module for further analysis. These preprocessing operations improve the reliability of the system and ensure that the skin tone detection process produces accurate results.

3. Image Upload and User Input

The system begins by collecting user input through an image upload interface. Users can either upload an existing photograph. The uploaded image is validated to ensure that it meets the required quality standards. The system checks the image resolution and format to ensure compatibility with image processing modules. Once validated, the image is forwarded to the skin tone detection module for further analysis. The interface is designed to be simple and user-friendly so that users can easily provide their photographs without requiring technical knowledge. The system also performs basic preprocessing operations such as image resizing and normalization to prepare the image for further processing. These preprocessing steps help improve the accuracy of the analysis performed in later stages of the system. By ensuring proper input quality, the image upload module plays an important role in enabling reliable and accurate fashion recommendations within the virtual try-on system.



Fig 2: User Image Upload Interface

4. Skin Tone Detection and Style Analysis

The skin tone detection module analyzes the uploaded image to identify the user's skin tone. The system detects visible skin regions and performs color analysis to determine the dominant skin color. Based on the analysis, the system categorizes the skin tone into predefined groups and generates fashion suggestions. These suggestions include recommended colors, clothing styles, and styling tips that match the user's complexion.

To achieve accurate detection, the system focuses on extracting skin pixels from relevant regions of the image while ignoring background elements and non-skin areas. Color values from the detected skin regions are analyzed to measure the intensity and distribution of tones present in the image. The dominant color information is then used to classify the skin tone into categories such as light, medium, or dark. This classification helps the system determine which clothing colors are most suitable for the user's appearance. By providing personalized style recommendations based on skin tone analysis, the module enhances the overall user experience and improves the effectiveness of the virtual fashion assistant.

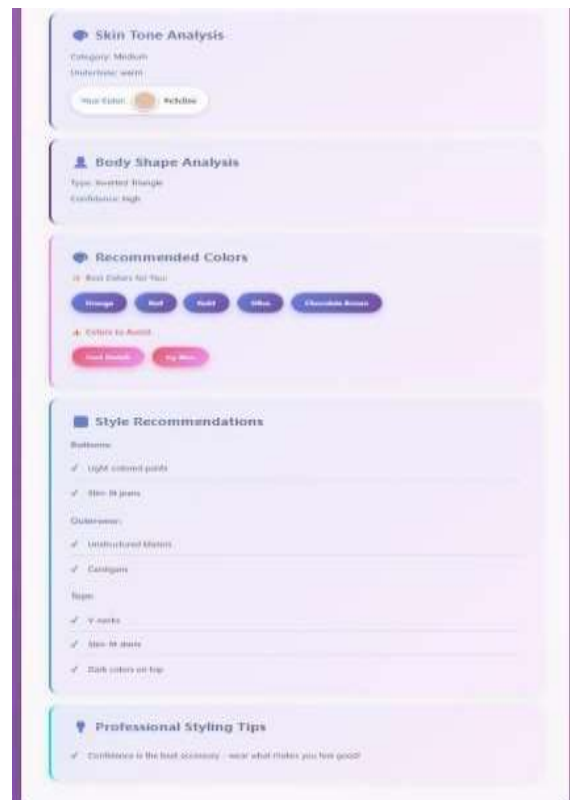


Fig 3: Skin Tone and Style Analysis Output

5. AI Fashion Stylist Dashboard

After completing the analysis, the system presents the results through a personalized dashboard. The dashboard allows users to explore fashion recommendations and manage their preferences.

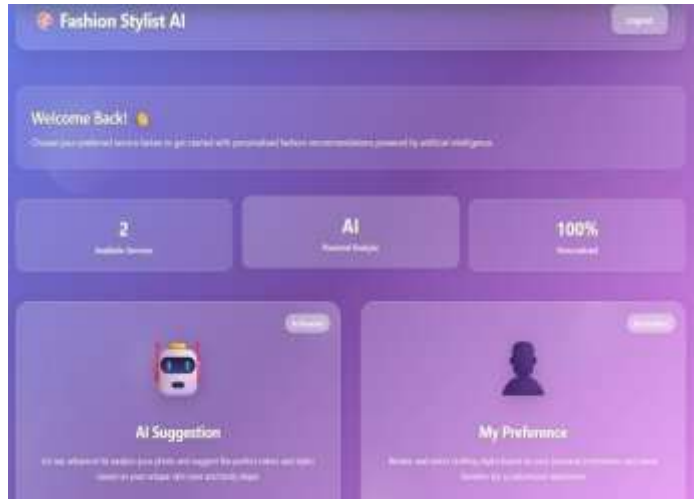


Fig 4: AI Fashion Stylist Dashboard Interface

The dashboard displays AI-generated suggestions and allows users to browse available clothing items. This interface acts as the central hub of the application. It provides a clear overview of the user's style analysis, including recommended colors, clothing styles, and personalized fashion tips. Users can navigate through different sections of the dashboard to explore suggested outfits and view clothing items that match their style profile. The dashboard also enables users to access the virtual try-on feature, where they can preview selected garments on the digital avatar. By organizing the recommendations in a structured and interactive layout, the dashboard improves usability and makes it easier for users to interact with the system. This module therefore plays an important role in connecting the analysis results with the virtual try-on experience provided by the application.

6. Dress Selection and Virtual Try-On

Users can browse different clothing items and select garments they wish to try on. The system displays a collection of clothing items along with pricing information and a "Try On" option.

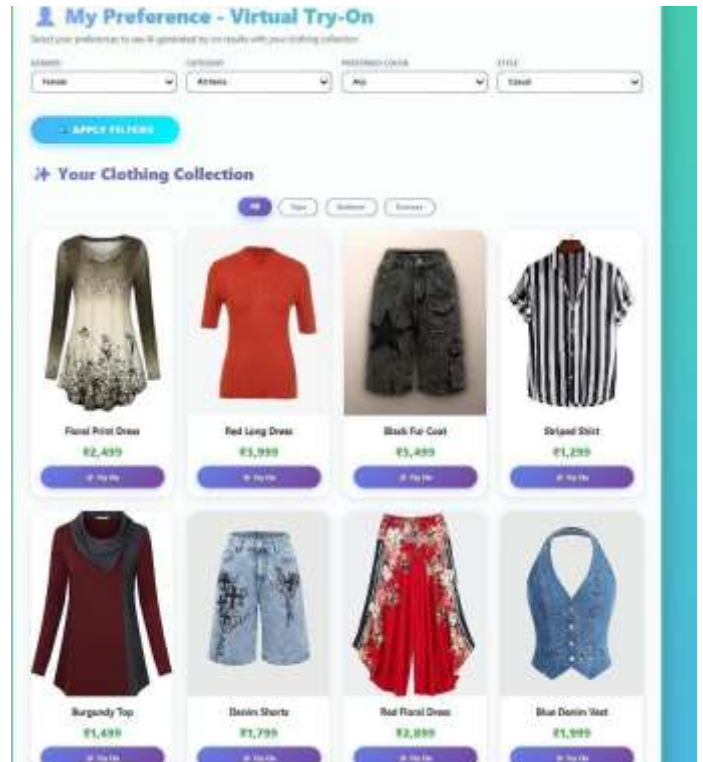


Fig 5: Dress Selection Interface

The dress selection page presents garments in an organized gallery layout, making it easy for users to explore different fashion options. Each item includes details such as the product image, name, price, and a button that allows the user to instantly try the selected outfit. This interface helps users quickly compare different clothing styles and choose the garments that best match their preferences. The system also ensures that the displayed clothing items are compatible with the virtual try-on module so that the fitting process can be performed smoothly.

After selecting a garment, the system loads the virtual try-on studio where the selected clothing item is applied to a digital avatar.



Fig 6: Virtual Try-On Studio Interface

The avatar acts as a virtual mannequin that allows garments to be displayed consistently. Users can choose between **2D view** and **3D model view** to observe the outfit. The 2D view provides a simple front-facing preview of the selected clothing item, allowing users to quickly evaluate how the outfit appears. The 3D view enables users to interact with the avatar and rotate the model to observe the clothing from different angles. This interactive visualization helps users better understand the appearance and style of the garment before making a purchase decision. By providing both 2D and 3D visualization options, the system enhances the realism of the virtual try-on experience and improves user engagement.

7. Virtual Try-On Results

The system generates visual outputs that show how the selected garment appears on the avatar. The 2D view provides a simple preview of the outfit.



Fig 7: 2D and 3D Virtual Try-On Results

The 3D visualization allows users to interact with the avatar and view the outfit from different angles, improving the overall realism of the try-on experience. Users can rotate the avatar model to observe how the clothing appears from the front, side, and other perspectives. This interactive view helps users better understand the overall look and style of the selected garment. The visualization module ensures that the clothing is properly aligned with the avatar's body structure to produce a realistic appearance. By providing both static and interactive views, the system enables users to evaluate garments more effectively before making a purchase decision. These visualization results demonstrate the practical usefulness of the virtual try-on system in enhancing the online shopping experience.

8. Results and Discussion

Testing results demonstrate that the proposed system successfully integrates image analysis and virtual visualization technologies. Users can easily upload images, receive personalized fashion suggestions, and preview garments through interactive visualization. The system was tested using different user images to ensure that the skin tone detection and recommendation modules work accurately. The results show that the system is capable of generating suitable clothing suggestions based on the detected skin tone. In addition, the virtual try-on module was able to display garments clearly on the digital avatar without distortion.

The system improves the online shopping experience by reducing uncertainty in clothing selection. Users reported that the ability to view garments on a virtual model helps them better understand how outfits may appear before purchasing. The interactive 3D view further enhances user engagement by allowing users to explore different viewing angles. Overall, the results indicate that the system provides a practical solution for improving customer confidence in online fashion shopping platforms.

8.1 Performance Evaluation

To evaluate the effectiveness of the proposed system, several tests were conducted using different user images and clothing selections. The performance evaluation focused on analyzing the accuracy of skin tone detection, the quality of fashion recommendations, and the realism of the virtual try-on visualization.

During testing, multiple images with different lighting conditions and skin tones were uploaded to the system. The skin tone detection module successfully identified dominant skin colors in most cases and generated appropriate fashion recommendations. The recommendation module provided clothing colors and styles that complemented the detected skin tone.

The virtual try-on module also demonstrated good performance in rendering garments on the digital avatar. The 2D preview provided quick visualization, while the 3D model allowed interactive exploration of the outfit. Users were able to rotate the avatar and observe the clothing from different angles without noticeable delays. These results indicate that the proposed system performs effectively and can provide a useful tool for enhancing the online fashion shopping experience.

8.2 Limitations of the System

Although the proposed system demonstrates promising results, there are some limitations that should be considered. One limitation is that the current system uses a predefined avatar rather than generating a personalized 3D model of the user's body. As a result, the visualization may not perfectly represent the user's actual body shape.

Another limitation is that the skin tone detection process may be affected by extreme lighting conditions in the uploaded images. If the image is too dark or too bright, the color analysis may produce slightly inaccurate results. Improving the robustness of the detection algorithm could help address this issue in future versions of the system.

Additionally, the current prototype supports only a limited collection of clothing items. Expanding the clothing database would provide users with more fashion options and improve the overall usefulness of the application.

Despite these limitations, the system still demonstrates the potential of combining artificial intelligence and visualization technologies to enhance the online fashion shopping experience.

8.3 User Experience and Practical Applications

The proposed Smart 3D Virtual Try-On System provides a more interactive and personalized shopping experience compared to traditional online fashion platforms. Users often hesitate to purchase clothing online because they are unable to visualize how the garment will appear on them. By integrating artificial intelligence and visualization technology, the system helps reduce this uncertainty and supports better decision-making during the shopping process.

The virtual try-on feature allows users to experiment with different clothing styles and colors without physically visiting a store. This saves time and provides convenience for users who prefer online shopping. The interactive 3D visualization further improves the experience by allowing users to rotate the avatar and observe the outfit from multiple perspectives. Such functionality increases user confidence in selecting garments that match their personal style.

From a business perspective, the system can help e-commerce platforms reduce product return rates caused by incorrect size or

style selection. Retail companies can integrate similar virtual try-on solutions into their websites to enhance customer engagement and improve overall sales performance. By providing personalized fashion recommendations, the system also helps users discover clothing styles that suit their appearance and preferences.

In addition to online retail applications, the technology can also be used in fashion design, virtual fashion shows, and digital wardrobe management systems. Designers can use virtual try-on tools to visualize clothing concepts before production. Similarly, customers can experiment with different outfits digitally before making purchasing decisions. These possibilities demonstrate the potential of virtual fashion technologies in transforming the future of the fashion industry.

8.4 Future Scope

The proposed system provides a strong foundation for developing advanced virtual fashion platforms. In future versions, additional technologies such as augmented reality (AR) and real-time body scanning can be integrated to create more realistic try-on experiences. Augmented reality can allow users to visualize clothing directly on their own body through mobile devices or cameras.

Another possible improvement is the use of deep learning models for more accurate fashion recommendations. Machine learning algorithms could analyze user preferences, fashion trends, and purchase history to generate more personalized style suggestions. Expanding the clothing database and supporting multiple body types would further improve the usability of the system.

Future systems may also include automatic body measurement detection to generate more accurate avatar models that closely match the user's body shape. This would improve the realism of the virtual try-on process and provide users with a better understanding of how the clothing might fit them in real life. Integration with online shopping platforms could further enhance the user experience by allowing users to directly purchase the recommended clothing items.

Additionally, advanced garment simulation techniques could be implemented to simulate fabric movement and draping effects. This would make the virtual try-on results more realistic and visually .

9. Conclusion

This paper presented a **Smart 3D Virtual Try-On System with Personalized AI Fashion Stylist** designed to enhance the online fashion shopping experience. The system combines image processing, artificial intelligence, and 3D visualization technologies to provide personalized clothing recommendations and interactive try-on functionality. By analyzing the user's skin tone and generating suitable fashion suggestions, the system helps users select clothing that complements their appearance.

The developed prototype demonstrates that the proposed approach improves user engagement and confidence in online garment selection. The integration of virtual try-on visualization allows users to preview clothing items in a more interactive and realistic manner. This reduces uncertainty during the purchasing process and supports better decision making for customers.

Future improvements may include integrating real-time body scanning, augmented reality visualization, and advanced garment simulation techniques to further enhance realism. The system may also be expanded to support a larger collection of clothing items and additional personalization features. Overall, the proposed approach shows strong potential for improving digital fashion platforms and creating a more interactive online shopping environment.

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