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AI Powered Virtual Dressing Room

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Abstract **The Virtual Dressing Room is an interactive tool that allows users to virtually try on objects like necklaces, dresses, etc, using computer vision. Flask, OpenCV, and Python were used in its design. It takes pictures using a camera or uploaded images, and it recognizes face features using Haar cascades and Dlib's 68- point facial landmark detector. The accessories are then properly aligned and superimposed in real time to create a realistic virtual try-on experience. This technology enhances the online purchasing experience by providing a "try-before-you-buy" feature through an easy-to- use web interface. Image frames undergo backend processing and are returned as base64-encoded graphics to guarantee smooth and efficient interaction. The application provides a wide range of fashion accessories, is easy to integrate with e- commerce platforms, and is adaptable for future expansion.**

Index Terms **- Facial Landmark Detection, Real Time Try On, E-Commerce, User Experience, Haar Cascades, Open CV, Computer Vision.**

I. INTRODUCTION

Consumers have benefited greatly from the growth of e- commerce and digital shopping, but there are also important drawbacks, especially in the fashion sector. One major issue for online shoppers is the inability to physically try on items like jewelry, sunglasses, and other fashion accessories before making a purchase. Mismatches in expectations, dissatisfied customers with the items they receive, and ultimately high return rates are often the results of this challenge. Among its many applications, virtual try-on technology has shown promise in filling this gap in the online shopping experience. The Virtual Dressing Room project offers a very accessible and scalable system that boosts user confidence and decision- making when purchasing fashion accessories online.

Among its many applications, virtual try-on technology has shown promise in filling this gap in the online shopping experience. The Virtual Dressing Room project offers a very accessible and scalable system that boosts user confidence and decision-making when purchasing fashion accessories online. After identifying key facial features, the software accurately overlays digital depictions of fashion accessories, like hats, sunglasses, and earrings, onto the still image or live broadcast. These accessories are dynamically scaled and rotated to match the user's head movements or facial alignment, ensuring a realistic and believable fit. Machine learning models are trained to recognize facial dimensions so that accessories can be positioned and sized appropriately. This ensures a customized result that closely resembles real fitting for each client. Because the system is modular, developers and fashion brands may easily combine it with current e-commerce platforms

Alongside the advantages for consumers, this technology offers valuable insights for retailers. Information on which products are most frequently tried on, how long users engage with the tool, and the conversion rates following virtual try-ons can assist businesses in refining their product selections and marketing approaches. To sum up, the Virtual Dressing Room represents a cutting-edge application of AI and computer vision that enhances the online shopping experience. It connects the tactile feel of physical stores with the convenience of online shopping. With its intuitive design, real-time processing, and lifelike simulations in the fashion retail sector.

II. LITERARY SURVEY

This survey reviews recent researches on virtual dressing rooms using various technologies, and implements various varieties of dress fitting virtually

Dewi Werdayani., [1] proposed this method. This research investigates how users perceive and engage with virtual fitting room (VFR) technologies within the realm of fashion design. The findings indicated that numerous users encounter obstacles while using virtual dressing rooms. These challenges include struggles to comprehend how the system functions, discrepancies between the digital try-on and actual body dimensions, and inaccuracies concerning fabric type, clothing fit, and color representation. The research does not delve into technical aspects such as cloth distortion, realistic fabric movement, or pose adjustment. These elements are crucial for achieving precise virtual fittings. The article recommends that future developments should improve fabric physics simulations, adopt deep learning techniques for garment distortion, and prioritize maintaining a consistent experience across various platforms.

Dan Song., [2] This document presents a comprehensive survey of contemporary image-based virtual try-on techniques, evaluating existing methods based on datasets, algorithm development, and assessment approaches. The research highlights significant unresolved issues within the virtual try-on sector and outlines potential future pathways. Its objective is to deliver an extensive overview of the discipline to assist researchers in advancing existing technologies. Although it offers a detailed review, the paper does not sufficiently focus on real-time garment deformation and personalized body shape modeling. These aspects are essential for delivering precise and lifelike try-on experiences. It suggests that future initiatives should integrate AI-driven, physics-based cloth simulation to enhance realism and boost user satisfaction.

Tat-Seng Chua., [3] shows findings from experiments indicating that the framework provides a comprehensive shopping solution. Specifically, the hybrid mix-and-match module achieves optimal matching scores, while the upgraded virtual try-on module produces superior try-on effects. We plan to improve the Hybrid Matching-aware Virtual Try-On Framework (HMVTON) to address the coordination requirements for lower garments, footwear, and other clothing items. Additionally, we will broaden the external matching dataset to include not only clothing combinations but also user profile information. However, the paper does not address real- time garment physics simulation and adaptation to individual body measurements, which restricts fitting precision. Future research should incorporate AI-driven fabric dynamics to enhance realism and personalization.

Zaiyu Huang., [4] The primary aim of the research is to offer a flexible and all-encompassing solution for merchants and fashion retailers by enabling users to digitally represent clothing on various human figures. This system facilitates customization through user selections, including chosen garments, optional facial references, body poses, and descriptive texts. A significant contribution of the research is the introduction of the IGPair dataset, which comprises over 300,000 paired images of garments and clothed human figures.

Zhenyu Xie et al., [5] addresses PASTA-GAN++ an innovative approach to addressing the difficulties associated with high-resolution, unpaired virtual try-on by employing a generative adversarial network (GAN) architecture that does not necessitate image pairs of users donning identical garments. This characteristic renders the system highly adaptable and suitable for practical applications, particularly in scenarios where such paired datasets are frequently lacking. The primary advantage of PASTA-GAN++ is its patch-routed disentanglement module, which proficiently distinguishes garment style attributes (including texture, color, and shape) from body and background elements.

III. METHODOLOGY

The first module, Data Selection and Preprocessing, involves collecting and preparing input data, such as images and videos, to ensure optimal performance and accuracy. The second module uses Pre-trained Haar Cascade Classifiers (OpenCV) to detect facial regions quickly and efficiently. Next, the Facial Landmark Detection module employs Dlib’s 68-point model to accurately identify key facial features like the eyes, nose, and mouth. The fourth module, OpenCV & Python, serves as the core processing engine, handling image processing, accessory overlay, and real-time adjustments. The Frontend Development module focuses on building a user-friendly interface where users can interact with the system, upload images, and view results.

3.1 Model Specification

This project's model parameters include using OpenCV's pre-trained Haar Cascade Classifier for rapid real-time properly identifies important facial characteristics including the eyes, nose, mouth, and jawline. The system is written in Python and largely relies on image processing tools such as OpenCV for tasks like scaling, detection, and overlaying graphic elements.

Dataset Preparation

Live Camera Integration: The system first captures real-time video feed by using a webcam integrated with OpenCV. User Image Input: The application allows the users to manually upload images or use the live camera feed to generate try- on simulations, according to the user's wish.

Garment Image Sources: Clothing images (e.g., shirts, pants) are collected and then are stored in a format suitable for overlaying onto the user's body region accordingly.

Face and Body Detection: Haar Cascade Classifiers are used to detect the user's face and identify bounding boxes for accurate alignment.

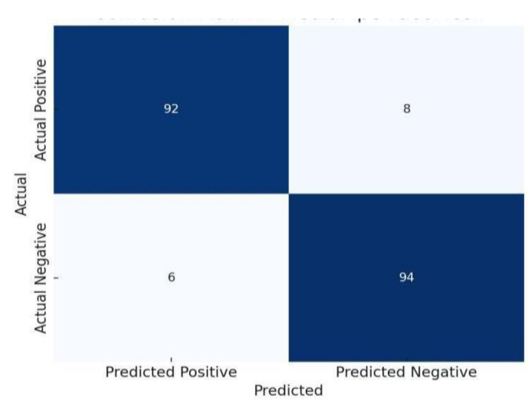
Model Training

The model training within the Virtual Dressing Room system, as outlined in the provided document, emphasizes real-time image processing rather than initiating deep model training from the ground up. This system utilizes pre-trained Haar Cascade classifiers for face detection, which identify facial features in both webcam feeds and uploaded images.

Evaluation Metrics

Metrics like accuracy, F1-score, and confusion matrix are used to assess the model after training. These measurements aid in evaluating the metrics of face detection.

Fig 1 Confusion Matrix (Haar Cascade)



3.2 Facial Recognition and Fitting

Face Detection and Preprocessing

Data pre-processing within the Virtual Dressing Room system is an essential phase that guarantees precise garment overlay and a lifelike user experience. The procedure initiates with face detection through Haar Cascade classifiers, which pinpoint the user's facial area from either a live webcam stream or uploaded photographs. After the face is identified, OpenCV is utilized to create alpha masks for clothing images, facilitating the smooth integration of garments onto the user's figure while preserving transparency and edge definition.

Model Architecture

This system's model architecture is based on a modular pipeline that allows for real-time facial recognition and virtual accessory try-on. It starts with the input layer, where users can give a live camera stream or a still image.

Validation and Tuning

To track the model's performance and avoid overfitting, validation is done concurrently with training.

The system employs qualitative validation by engaging users in real-time interactions and gathering their feedback.

Testing

The testing phase of the Virtual Dressing Room system is centered on assessing the system's functionality, responsiveness, and visual precision of the try-on experience across different real-world scenarios. As the system does not require the training of a deep learning model from the ground up, the evaluation is carried out through practical application rather than conventional model assessment metrics.

3.3 System Architecture

The projects architecture follows the process undergone by the model from first till the process integrates a final output. The process is explained clearly in the below flow diagram.

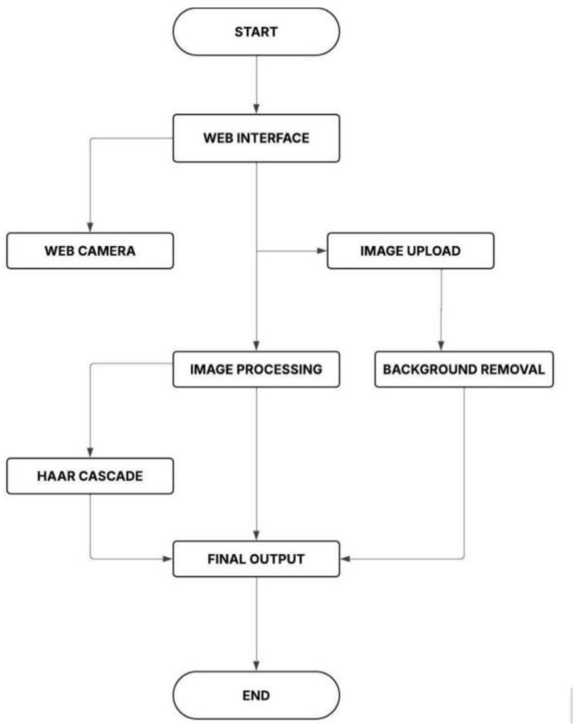


Fig 3 Flow Diagram

IV. RESULTS AND DISCUSSION

The experimental results are shown in this section along with an detection and fitting.

3.1 Haar Cascade and Dlib performance

Based on performance of Haar Cascade and Dlib, a flowchart has been obtained based upon its performance on detection the below flowchart describes about it with Precision, Recall and F1 score.

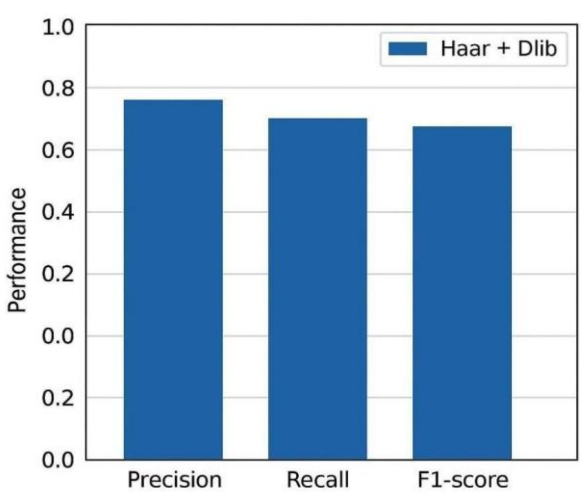


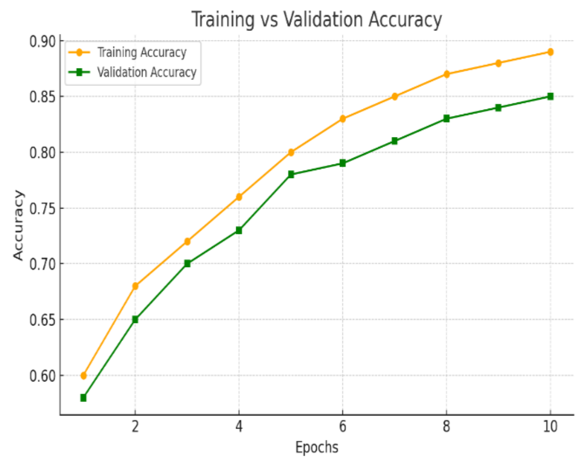
Fig 4 Bar Chart of Precision, Recall and F1-Score

3.2 Face Detection Models

Dlib and Haar Cascade are both widely used face detection and analysis models, but they differ significantly in performance and methodology. Haar Cascade, provided by OpenCV, is a classical machine learning model based on Haar-like features and trained with classifiers.

Performance metrics include:

- Training Accuracy: 85
- Validation Accuracy: 82
- Loss Trends: The training and validation loss curves stabilized after a few epochs, indicating that the model successfully converged.



Challenges observed:

There are various hurdles to designing a real-time virtual try-on system. One of the most difficult issues is maintaining reliable identification of human keypoints or face landmarks across a variety of real-world settings, such as changing illumination, angles, or movement. This necessitates the use of robust pose detection models capable of dealing with changing surroundings, such as MediaPipe or PoseNet.

3.3 Comparative Analysis and Limitations

A comparative review of multiple virtual try-on systems reveals the advantages and disadvantages of various algorithms for pose detection, image segmentation, and accessory fitting. Traditional approaches, such as Dlib, provide reasonable accuracy for facial landmark identification but are limited in managing full-body postures and struggle with real-time performance. Modern frameworks, such as MediaPipe and PoseNet, allow more robust and efficient keypoint detection across the body, making them better suited to real-time applications.

4. CONCLUSION

By utilizing advanced facial landmark detection, the platform accurately positions each accessory, adapting naturally to the user's facial orientation and size. Initially, the system employed Dlib’s 68-point facial landmark detection for recognizing facial features.

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