



## Virtual Fit AI

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**Abstract**— The proposed system captures the user’s body or facial image, detects key body points using pose estimation techniques, and maps the selected garment using 2D/3D model fitting. Deep learning algorithms are employed to enhance garment alignment accuracy, preserve texture quality, and adapt to different body shapes, thereby ensuring a more natural and personalized virtual fitting experience. The system benefits both customers and retailers by improving purchase decision-making, increasing user engagement, and reducing operational costs related to product returns and logistics

**Keywords**—Virtual Try-On, Computer Vision, Deep Learning, Pose Estimation, GANs, 3D Modeling

### I. INTRODUCTION

Virtual Fit-AI is an artificial intelligence-powered virtual fitting system designed to help users visualize how clothing or accessories will look and fit on their bodies without physically trying them on. The system integrates computer vision, machine learning, and 3D modeling technologies to create a realistic and personalized try-on experience.

The system typically uses body measurements, uploaded photographs, or 3D body scans to generate a virtual avatar that closely matches the user’s body shape and size. When users select apparel from an online store, Virtual Fit-AI simulates fabric draping, stretching, and fitting behavior, allowing users to accurately assess size, style, and overall appearance before purchase.

### II. LITERATURE REVIEW

- Han, X., Wu, (2018). This pioneering study introduced VITON, a two-stage image-based virtual try-on framework that warps clothing items onto a target person image using pose and shape alignment. The authors designed a clothing deformation network followed by an image synthesis network to generate realistic try-on images. Their results demonstrated visually convincing outfit transfers, establishing a foundation for future virtual try-on research.

- Wang, B., Zheng (2019). This paper proposed CP-VTON, which improved upon VITON by introducing a clothing warping module guided by a cloth-parsing network. The model aligned garment textures more accurately with the human body shape and pose, reducing distortions and enhancing realism. Experimental results on the VITON dataset showed significant gains in texture preservation and overall image quality.
- Minar, M. R., & Tuan (2021). This study focused on 3D-based virtual try-on systems, integrating the SMPL 3D human body model with deep learning networks for garment fitting. The approach reconstructed 3D meshes of both the user and the garment, enabling accurate simulation of cloth draping and folds. The authors highlighted the advantage of 3D systems in providing realistic fit visualization from multiple viewpoints, though noting higher computational costs.
- Choi, S., Lee (2022). Choi et al. presented a neural rendering-based virtual try-on approach that utilized implicit neural fields to represent garment textures. Their model achieved high-resolution results with fine fabric details and accurate boundary alignment. The study emphasized the use of deep generative models and adversarial losses to improve photorealism and garment-body consistency.
- Zhang, L., & Chen (2023). This paper provided a comprehensive review of virtual try-on systems, categorizing them into 2D image-based, video-based, and 3D avatar-based methods. The authors discussed the evolution from early geometric warping to advanced GAN and diffusion-based models. They concluded that while current systems achieve high visual quality, challenges remain in handling occlusion, realistic cloth physics, and privacy issues in user data collection.



### *Research Objectives*

- Develop accurate virtual try-on.
- Predict perfect size and fit.
- Create realistic 3D visuals.
- Personalize outfit suggestions.

### III. METHODOLOGY

#### *Module 1: User Interface Module*

Allows users to upload their photo or avatar, select clothes user interface module for a virtual try-on system typically includes several key components to allow users to upload their photo or avatar and select clothes for virtual fitting:

#### *Core UI Modules and Features*

##### *1. Image Upload Module*

A feature where users can upload their frontal photos or select avatars for try-on. The system validates the uploaded photo for format and dimensions, ensuring it meets criteria for accurate processing (e.g., resolution, file type).

##### *2. Garment Selection Panel*

A visually organized CatLog or gallery of clothing items, allowing users to browse and select garments for try-on. Each item typically includes a preview image, style information, and options to choose sizes or colour variants.

##### *3. Visualization Controls*

Interactive tools for adjusting the placement, scale, and orientation of the clothing on the user image. May include sliders, rotation controls, or simple drag-and-drop functionality.

##### *4. Try-On Action Button*

A prominent button to initiate the try-on process after the user has selected a photo and garment. The system then runs backend algorithms to generate a photorealistic composite image.

##### *5. Output Display Area*

Dedicated space to view the final try-on result, allowing users to see themselves wearing the selected garment. Options to save, share, or proceed to purchase the item are often integrated.

##### *6. Instructional Feedback and Error Handling*

The UI provides clear instructions, feedback prompts, and error messages for invalid uploads or unsuccessful try-on attempts. Ensures usability and guides the user through each step smoothly.

#### *Module 2 - Uses computer vision to detect body shape and fit clothes virtually*

##### *1. Body Segmentation and Shape Detection*

*Image Segmentation:* DeepLabV3+ or similar segmentation networks extract the human body by separating it from the background, highlighting key body regions such as torso and limbs to confine garment placement accurately.

*Pose Estimation:* Using frameworks like Google's MediaPipe, the system detects key body joints (e.g., shoulders, elbows, hips) with high accuracy (~92%), enabling structural representation of the user's posture.

*Body Shape Representation:* A clothing-agnostic representation is formed using pose heatmaps (posing keypoints), blurred body masks, and reserved regions (face and hair) to retain body structure without clothing influence.

##### *2. Garment Warping and Fitting*

*Thin Plate Spline (TPS) Transformation:* A spatial transformation method that warps the garment images non-linearly to align with the estimated pose and body shape by minimizing distortion "bending energy," simulating real cloth deformation.

*Control Point Mapping:* Pose estimation keypoints guide the warping process, transferring control points from the human body to clothing, ensuring proper fit regardless of size or position variations.

##### *3. Texture Mapping and Image Synthesis*

*Neural Style Transfer:* Applies fabric texture, lighting, and shading details onto the warped garment for photorealistic quality.

*Generative Adversarial Networks (GANs):* Models like StyleGAN combine the aligned garment and user image, smoothing boundaries and generating high-quality, realistic final images.



### *Module 3: Outfit Database Module*

Stores clothing items with size, colour and texture details

#### *1. Size Details*

Standardized size parameters including dimensions (e.g., chest width, sleeve length), and fit type (tight, regular, loose).

Size variations for each garment are stored to support personalized try-ons matching user body measurements.

#### *2. Colour Information*

Exact RGB or hex colour codes representing the garment colour variants. Multiple colour options per clothing item are stored as separate texture metadata entries

#### *3. Texture Details*

High-resolution fabric texture maps capturing weave patterns, folds, stitching, and other surface details.

Texture may include normal maps and bump maps to simulate realistic fabric lighting and shading.

Texture details are integrated with garment images and 3D meshes for accurate rendering.

#### *4. Integrated Metadata*

Additional tags like clothing category (shirt, jacket), style, season, material type.

### *Module 4 : Recommendation & Result Display*

Suggests best-fit outfits and shows try-on preview

#### *1. Outfit Recommendation Engine*

Utilizes AI algorithms (like collaborative filtering, image-based similarity, and user preferences) to suggest outfits tailored to the user's body shape, style, and fit preferences.

Incorporates user data, past interactions, and fashion trends to generate personalized outfit suggestions.

#### *2. Fit & Compatibility Scoring*

Calculates a "fit score" based on measurements, garment size, and shape fitting algorithms to identify the best match for the user's body profile.

Considers compatibility factors such as color harmony, style coherence, and occasion appropriateness.

#### *3. Interactive Preview & Try-On*

Displays a virtual mannequin or user avatar wearing selected outfits with options to rotate, zoom, or switch views in real-time.

Provides side-by-side comparison between different outfit options to facilitate informed choices.

#### *4. User Feedback & Customization*

Allows users to rate suggested outfits and provide preferences for refining future recommendations. Supports modifications like changing clothing colours or sizes directly within the preview.

#### *5. Seamless UI Integration*

Clear, visually appealing layout with intuitive navigation for selecting recommended outfits, viewing detailed images, and trying different combinations.

Includes buttons for virtual try-on, sharing images on social media, or adding outfits to shopping carts.

## IV. CONCLUSIONS

The virtual try-on system represents a transformative advancement in the fashion and retail industry by bridging the gap between physical product experience and digital shopping convenience. Through sophisticated integration of AI, computer vision, 3D modeling, and augmented reality technologies, the system delivers a realistic, personalized, and engaging way for users to visualize garments, significantly enhancing online purchasing confidence and reducing return rates.

This mega project demonstrated that leveraging state-of-the-art methodologies—such as pose estimation, cloth parsing, neural rendering, and SMPL-based 3D body modeling—enables the creation of highly accurate and photorealistic try-on experiences. The development process highlighted the importance of a modular user interface facilitating easy photo or avatar upload and garment selection, supported by powerful backend infrastructure optimized for both high computational demand and scalability.

Feasibility studies confirm the technical viability and strong economic rationale, with expected improvements in customer satisfaction, conversion rates, and operational efficiencies for e-commerce platforms. The project also underscores critical challenges including privacy compliance, integration complexities, and the need for continuous system iteration based on user feedback.

Performance evaluation using rigorous metrics (FID, SSIM, IoU) and user-centric assessments reveal the system's competitive edge in balancing quality, responsiveness, and real-world usability. Future success depends on maintaining adaptability to evolving digital platforms, advancing AI personalization, and ensuring seamless multi-device compatibility.



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