A Survey on Virtual Dressing Room

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Abstract: *A Virtual Dressing Room is an innovative solution that leverages technology to enhance the online shopping experience by allowing users to virtually try on clothes. Utilizing advanced technologies such as augmented reality (AR), artificial intelligence (AI), the virtual dressing room provides an immersive, interactive platform where users can see how clothing items fit and look on them.*

Keywords**:** *Virtual Dressing Room, Online Shopping, Try On Clothes, Augmented Reality (AR), Artificial Intelligence (AI), Immersive Platform, Interactive Experience, Clothing Fit and Look.*

1. Introduction

A virtual dressing room is an innovative technology that allows consumers to try on clothes digitally, using augmented reality (AR), artificial intelligence (AI), without the need for physical interaction. This immersive shopping experience can be accessed via smartphones, computers, or in-store kiosks, offering users a convenient way to visualize how clothes might look on them or fit their body type before making a purchase.

Virtual dressing rooms work by leveraging AR to superimpose images of clothing onto a user's reflection or photo. Some platforms even use AI to recommend sizes based on body measurements and suggest outfits based on personal preferences. This technology aims to bridge the gap between online shopping and in-store experiences by enhancing customer confidence, reducing returns, and making shopping more enjoyable.

As e-commerce continues to grow, virtual dressing rooms are becoming a key component in revolutionizing the retail industry, offering a personalized and interactive shopping experience.

2. Objectives

1. Enhance Customer Experience: Provide an engaging, interactive, and convenient shopping experience that allows customers to virtually try on clothing, helping them make more informed purchase decisions.
2. Reduce Return Rates: By offering a more accurate representation of how clothes fit and look on the customer, virtual dressing rooms aim to reduce the number of returns caused by poor fit or style mismatch.
3. Increase Sales Conversion: Encourage customers to complete purchases by boosting their confidence in their choices, thus improving conversion rates and reducing cart abandonment.
4. Personalization: Offer tailored recommendations based on body size, preferences, and style, ensuring customers find clothing that suits them, leading to better customer satisfaction.
5. Cost Efficiency for Retailers: Reduce the need for physical fitting rooms and related infrastructure, saving costs in store design and enhancing inventory management by offering a virtual trial experience.
6. Support Accessibility: Provide a shopping experience that is accessible to a wider audience, including people who may have difficulty using traditional fitting rooms or those shopping from remote locations.

3. Literature Survey

[1] The summary outlines a mobile application concept for a Virtual Dressing Room that leverages augmented reality (AR) to allow users to try on clothes virtually, revolutionizing the online shopping experience by removing the need for physical fitting rooms. The application features an intuitive user interface where users can select garments from a predefined database, upload custom outfits, and see real-time adjustments on their body. Utilizing Tensor Flow Lite, the app employs deep learning for body pose estimation, identifying key body points to ensure accurate clothing placement. Technologies like Open CV enable the segmentation of clothing using the Grab Cut algorithm and mapping it to body points through affine transformations for precise alignment. The application is optimized for mobile use with lightweight models, ensuring real-time performance within hardware constraints. However, limitations include reduced pose estimation accuracy under poor lighting or excessive movement, performance issues on older devices, and occasional need for manual clothing adjustments, which may impact user experience.

[2] The Virtual Dressing Room application leverages advanced technologies to enhance online shopping by allowing users to try on clothes virtually. Using Augmented Reality (AR), the application overlays garments onto user images in real-time, offering a realistic trial experience. Users register and log in to access features like selecting garments, adding them to a virtual cart, and trying them on virtually. The application employs image processing techniques, including skin detection and body recognition, to isolate the user's body from the background and accurately place garments on the detected body parts. Depth imaging further ensures proper garment fit by accommodating different body shapes and adjusting positioning based on camera distance. However, challenges include ensuring accurate alignment and depth positioning, difficulties in isolating a single user in multi-person scenarios, and limitations in fabric simulation realism, which may impact the application's effectiveness.

[3] The Virtual Fitting Room utilizes advanced technologies to simulate realistic 3D fabric behavior and enhance user experience. The application employs physical property-based fabric simulation to replicate real-world fabric behavior, accounting for characteristics like stretching, bending, damping, and friction. Specific parameters are applied to different fabric types—such as denim, chiffon, cotton, and satin—to differentiate their unique properties. Built using the Unity 3D game engine, the platform leverages its physics-based capabilities to render dynamic fabric movements and lifelike interactions in the virtual environment. Additionally, Microsoft Kinect is used for real-time motion tracking and depth sensing, ensuring virtual garments move synchronously with the user's body. Despite its innovations, the system faces challenges, including high computational demands for realistic 3D simulation, difficulties in accurately modeling diverse fabric properties, and limitations in replicating complex real-world fabric interactions, which may reduce overall realism.

[4] The virtual dressing room integrates cutting-edge technologies to deliver a realistic and interactive user experience. At its core, Deep Neural Networks (DNNs) enable essential functionalities such as detecting body outlines, recognizing clothing items, facilitating virtual fittings, providing personalized style recommendations, and supporting seamless real-time interactions. The system also utilizes pose estimation to identify critical body joints, including shoulders, elbows, and hips, constructing a 3D skeletal framework that ensures virtual clothing aligns accurately with the user's body. To enhance realism, Generative Adversarial Networks (GANs) create highly detailed and adaptive clothing overlays. GANs dynamically adjust the virtual garments to conform to the user's body shape, pose, and movement, delivering a natural and lifelike appearance. Together, these advanced technologies enable a sophisticated and immersive virtual dressing room experience, bridging the gap between physical and digital clothing trials.

[5] The AR-based virtual dressing room utilizes state-of-the-art technologies to deliver a highly interactive and realistic virtual fitting experience. At the heart of the system is Augmented Reality (AR), powered by ARKit on iOS devices, which facilitates real-time body tracking by recognizing and capturing skeletal joint positions through the device's camera. Using AR Body Tracking Configuration, the system constructs a detailed 3D skeleton model that mirrors the user's body movements, allowing virtual garments to overlay accurately and move naturally with the user. This ensures a lifelike representation of how clothing would fit and behave.

To enhance this functionality, Unity 3D serves as the primary development platform, seamlessly integrating ARKit's human body tracking capabilities with Unity's robust rendering engine. Unity enables the system to

superimpose 3D garments on the user in real-time, ensuring smooth and interactive visual feedback. Additionally, Unity handles the rendering and synchronization of motion data with the virtual garments, creating an immersive experience that mimics real-world fitting rooms. Together, these technologies offer users the ability to virtually try on clothes with high precision, combining AR's body tracking and motion capture with the power of 3D modeling and real-time visualization.

[6] The Enhanced Virtual Dressing Room leverages advanced technologies to provide a realistic virtual try-on experience, allowing users to try on clothes without physically wearing them, using either real-time video feeds or uploaded images. The system employs Deep Neural Networks (DNN) for pose estimation, detecting human body joints in images or videos by using pre-trained models that highlight different body parts. Generative Adversarial Networks (GAN) are used to generate realistic virtual try-on images, adjusting the clothing to fit the user's body. The system also incorporates a Semantic Generation Module (SGM), which segments body parts and clothing regions using mask generation techniques, with a U-Net structure as the generator and a pix2pixHD discriminator for enhanced results. However, the system faces some limitations, including limited clothing detection, which restricts its ability to handle a wide variety of clothing items, poor style and texture adaptation, making it challenging to accurately change clothing textures or styles, and stability issues, as the models can struggle with varying lighting conditions, different environments, and unique poses, leading to inconsistent results.

[7] A virtual fitting room using a webcam enhances online shopping by employing advanced technologies to simulate clothing trials. It overlays selected clothing items, such as shirts or dresses, onto the user's image for a virtual try-on experience. Interactive controls allow users to adjust the size, fit, and alignment of the clothing for enhanced realism. Real-time video is captured using a webcam, and computer vision techniques, such as OpenCV, are applied to detect facial features, body posture, and key points. Pose estimation models like MediaPipe or OpenPose identify and map body joints, enabling precise placement of virtual clothing on the user's image. Augmented Reality (AR) frameworks like ARKit or ARCore render virtual garments and align them with the user's body in real-time, ensuring a realistic experience. Machine learning models, often pre-trained using TensorFlow or PyTorch, are utilized for body segmentation and tracking, allowing the system to adapt to different body shapes dynamically. Interactive controls further enable users to adjust the size, fit, and alignment of virtual clothing, making the experience more personalized and immersive. However, the system faces some limitations. Achieving a perfect fit and alignment can be challenging due to individual variations in body shapes and poses, which may lead to inaccuracies in virtual sizing. Performance is also influenced by environmental factors, as poor lighting or busy backgrounds can hinder the effectiveness of overlays. Additionally, the virtual fitting room requires high-quality webcams and significant processing power to function optimally, which can limit its usability on older or less powerful devices. These challenges highlight areas for improvement in the technology's development and implementation.

[8] Virtual try-on for clothes uses cutting-edge technologies to enhance the online shopping experience by simulating how garments fit and look on users. It employs 3D body scanning, either through a camera or uploaded photos, to create an accurate model of the user's body dimensions. Augmented Reality (AR) frameworks like ARKit or ARCore overlay virtual clothing onto the user's real-time image, allowing movement to see how garments fit from different angles. Customization options, powered by interactive UI frameworks, enable users to adjust garment size, color, and style and experiment with mixing and matching different outfits for a personalized look.

The system integrates computer vision techniques, using pose estimation algorithms such as OpenPose or MediaPipe to identify key body landmarks and align clothing with the user's posture. Image segmentation, often implemented with machine learning models like TensorFlow or PyTorch, separates the user from the background and refines the clothing overlay for precision. Despite its advancements, virtual try-on faces challenges such as fit and sizing inaccuracies due to limitations in replicating fabric properties like stretch, texture, and drape. Additionally, it requires reliable devices with good cameras and, in some cases, specific software or apps, which can limit accessibility and usability for certain users.

[9] Tailoring measurement and virtual try-on systems utilize advanced technologies to deliver precise body measurements and realistic outfit visualizations. AI-powered computer vision tools like OpenCV and MediaPipe analyze images or videos to extract body dimensions accurately. Pose estimation models, such as OpenPose and

DensePose, map body postures and key joint positions to align clothing perfectly with the user's shape. For enhanced realism, 3D body scanning uses technologies like photogrammetry or depth-sensing cameras to create detailed virtual models of the user, enabling them to visualize tailored outfits in real time through augmented reality platforms like ARKit or ARCore. Measurement inaccuracies can result from variations in posture, camera angles, or inadequate lighting during scanning. Simulating fabric properties, including stretch, stiffness, and drape, requires complex algorithms and often falls short of replicating real-life behavior. Additionally, the reliance on high-quality cameras, depth sensors, and powerful processing hardware for precise scanning and rendering can limit accessibility, particularly for users with older devices or insufficient computational resources. These limitations highlight the need for further refinement in both the technologies and their implementation.

[10] Virtual dressing rooms using body image cloth mapping employ advanced technologies to create realistic try-on experiences. Computer vision algorithms, such as those implemented with OpenCV or MediaPipe, detect and segment the user's body from images or video. Tools like OpenPose or DensePose map key body points and structure for precise garment alignment. Photogrammetry and LiDAR technologies enable the creation of detailed 3D body models, which serve as the foundation for virtual fitting. Cloth mapping algorithms, incorporating physics-based models like NVIDIA's Flex or Marvelous Designer, simulate fabric behavior, accounting for gravity, friction, and stretch to provide a realistic fit that adapts dynamically to the user's body shape and posture. Despite these advancements, challenges remain. Achieving high accuracy in body mapping can be difficult due to variations in body shape, size, and scanning quality, which may lead to less realistic representations. Additionally, virtual dressing rooms require sensitive personal data, such as body measurements and images, for accurate mapping. This raises privacy and security concerns, as improper encryption or data handling could lead to breaches, underscoring the importance of robust data protection measures in these systems.

[11] Virtual fitting rooms and AI-based online clothing stores enhance shopping by enabling users to create avatars using body measurements or scans and "try on" clothes virtually. These systems offer 3D visualization, allowing users to see how garments fit from multiple angles. Key technologies include computer vision algorithms for pose estimation to detect body posture and key points, depth sensing via cameras like Microsoft Kinect or Intel RealSense to create 3D body models, and object recognition to overlay clothing accurately onto avatars or live video feeds.

Despite their advantages, challenges persist. Fit accuracy can be inconsistent, particularly for complex garments like dresses or tailored suits, leading to potential customer dissatisfaction. Limited representation of diverse body types can result in exclusion for users outside standard size ranges. Additionally, camera and environmental factors, such as poor lighting or low-resolution sensors, can affect performance, causing glitches or inaccurate virtual fittings. These limitations highlight areas for improvement in inclusivity and technical precision.

[12] A Virtual Dressing Room using OpenCV leverages various computer vision techniques to enhance the online shopping experience. It utilizes pose estimation frameworks like OpenPose or MediaPipe to detect and track key body landmarks in real-time, allowing for accurate clothing fitting. OpenCV also enables motion tracking, so clothing adjusts dynamically as the user moves. Additionally, it employs human segmentation through background subtraction methods like MOG2 or KNN, ensuring that clothing can be overlaid seamlessly on the user's image or video feed, enhancing the virtual try-on experience.

However, there are challenges to achieving high realism in these systems. The simulation of clothing fit and fabric behavior can lack precision, especially in how garments stretch, ove, or react to body contours. Complex fabric behaviors, such as wrinkles or how fabric flows, are difficult to replicate without advanced physics engines or deep learning models. Additionally, the fit may not always align perfectly with the body, particularly for complex garments or when the user is in motion. Loose-fitting clothing or garments with intricate patterns may appear unnatural, which can impact the overall effectiveness of the virtual dressing room.

Conclusion

In conclusion, a virtual dressing room represents a transformative shift in the way consumers shop, blending technology with fashion to create a more personalized, engaging, and efficient shopping experience. By leveraging tools like augmented reality (AR), artificial intelligence (AI), virtual dressing rooms allow customers to try on clothes virtually, enhancing their confidence in purchasing decisions while reducing the likelihood of returns.

For retailers, virtual dressing rooms offer a valuable opportunity to optimize inventory, reduce operational costs, and support sustainability by minimizing waste from returns. Additionally, they foster greater customer satisfaction by providing an accessible and interactive platform for trying on clothing, leading to higher conversion rates and stronger brand loyalty.

Ultimately, virtual dressing rooms are reshaping the retail landscape, offering a bridge between the physical and digital worlds and enabling consumers to shop more intuitively and retailers to stay competitive in an increasingly digital marketplace.

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