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Digital Apparel Try-Ons: A Technological Odyssey into the World of Virtual Dressing Rooms and Consumer Engagement

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Abstract

This individual can now enjoy internet shopping whenever they want and from anywhere in the world thanks to the invention of smartphones and tablets. Online shopping has unquestionably taken the place of conventional methods for purchasing apparel and daily necessities. People benefit from a reputation as they pick internet buying. Almost all online retailers offer payment on delivery, free shipment, and special rates these days. These internet merchants have eliminated the hassles of parking, stuck in traffic, and standing in line to make purchases. They have also helped folks who consistently lament their lack of time. This is the primary justification for why most consumers now shop online. They may easily access a wide choice of affordable prices here, and they also get quick customer service and free home delivery. There is no denying that these are a few of the alluring aspects that draw customers in. Even though there is a minor problem that can make people lose interest in online buying, they might not be able to try on garments in such situations. By establishing a virtual changing room setting, the aim is to improve accessibility and time efficiency for trying on clothing. Our proposed methodology consists of three main components: skin color recognition, model alignment, and user image extraction from the video stream. Through user extraction, we may create an augmented reality environment by taking the user area out of the video stream and superimposing it on top of a simulated world within the user interface. To match the 2D cloth models with the use of scaling, rotation, and positioning using the 3D locations of the joints.

Keywords: *Augmented Reality, User image extraction, Virtual changing room, online shopping.*

1. Introduction

Online purchasing of clothes is always risky because there is never a guarantee as to how the item will appear on the individual. Additionally, purchasing clothing or ornaments from stores offline takes a lot of time because customers first need to locate a store before entering the trial room to try on every piece of clothing. By digitizing the process, our suggested solution would assist consumers in saving time when experimenting with clothes. The digital version of an in-store changing room online is a virtual dressing room. It allows buyers to online, as opposed to physically, try on clothing to determine size, fit, or style. Before purchasing an item, the consumer can view its size, style, and fit. Technology of this kind is gaining popularity every day. The item is placed over the customer's image using machine learning technology so they may examine the size, style, and fit of a thing they are considering purchasing. The number of clients who buy their items from internet stores is growing right now. To give the user, the idea that the results are displayed in real-time, each frame of the video will be captured, the clothing will be worn in that frame, and then the user will receive the output with the wearable overlay simultaneously. Because OpenCV is more efficient and well-trained to recognize the user's body—over which the fabric would be superimposed—it is used in applications to reduce processing time and improve user experience. It is a very affordable

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option because there are no hardware expenses involved in the deployment. Additionally, the proposed is platform agnostic, meaning it may run on any device running any operating system given that it has a web browser, a camera, and internet access.

2. Literature Survey

"A Collaborative Virtual Dressing Room for Image Consulting" by Gilda Manfredi [1] proposed in 2023. In recent years, the integration of extended reality (XR) in retail has transformed the shopping experience, notably through the development of virtual dressing room applications. Notably, studies have underscored the potential for further improvement through the incorporation of artificial intelligence (AI) or real shopping assistants in virtual dressing rooms. A unique collaborative synchronous virtual dressing room for image consultancy has been designed in response to this requirement for improvement. Customers can engage with realistic digital clothing that has been carefully chosen by a human image consultant remotely thanks to this cutting-edge technology. Customers and consultants can both benefit from the unique features of this program. Consultants can create garment databases, choose ensembles with different sizes, and interact with one another utilizing simply one RGB camera system. The application offers a virtual shopping basket and a visual depiction of outfit descriptions worn by a customized avatar to the user. This application's main goal is to provide a fully immersive user experience. It does this by using realistic settings, customized avatars that look like actual people, a real-time fabric simulation technique, and a video-chat feature. This work emphasizes the importance of human-AI cooperation for a richer virtual shopping experience, which advances the continuous development of XR applications in retail. "Towards 3D Virtual Dressing Room Based User-Friendly Metaverse Strategy" by Mahmoud Y. Shams, Omar M. Elzeki & Hanaa Salem Marie [2]. In the context of an e-commerce platform, this study presents a novel approach that uses a meta-verse approach to construct an intelligent application that serves as a virtual reality dressing room. The proposed website seeks to create a virtual fashion store that offers ease and privacy to users—men, and women—while they explore different styles. The virtual dressing room, designed to be a real-time solution, offers a transformative experience by eliminating the time-consuming aspects of traditional shopping, such as trying on multiple outfits in fitting rooms. The application utilizes motion-sensing technology, requiring users to stand in front of a webcam for a live image display on the computer screen. With the help of hand gestures over the interpretation Controls, Dimension Controls, and the process of selection Controls, users can move through several apparel categories, including dresses, shirts, and pants. Through this interaction, individuals can try on specific apparel items in real-time, virtually. To help users decide on costs and suitable sizes, the article suggests a fast size algorithm. Furthermore, system security is improved by using RSA for user authentication, especially for mobile clients. The emphasis of this research lies in the real-time generation of images and responsiveness to user interactions within a cost-effective and user-friendly framework. This meta-verse strategy represents an innovative step towards revolutionizing the virtual shopping experience, aligning with the evolving landscape of E-commerce and virtual reality applications. "Virtual Dressing Room Application Using GANs", by Bhagyalakshmi A; Sanjay N; Aravindhan S; Jayakrishnan V [3]. The proposed technique employs a generative adversarial network (GAN) framework for pose-guided virtual try-on, aiming to create photorealistic representations with intricate garment details. The methodology comprises three key components. Firstly, the intended semantic structure of the tried-on garment is predicted by a semantic layout-generating module using the symbolic segmentation of an analogous image. A higher-order difference constraint is then added to the semantic layout by a garment warping module, which makes it easier to convert clothing images while preserving consistency throughout training. Lastly, a module is put into practice to construct each semantic

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element of the human anatomy in an adaptive manner using a variety of inputs, including deformed clothing, a semantic layout, and a reference image. Extensive experiments on a recently obtained dataset demonstrate that this method beats the most advanced computational models in the based-on images virtual try-on challenge. By addressing the nuanced relationship between garment fit and various user postures, this research contributes to advancing the realism and efficacy of virtual clothing try-on applications. “Image-Based Virtual Try-On Through Accurate Warping and Residual” by Kedan Li, Jeffrey Zhang; David Forsyth [4]. This paper introduces POVNet, a comprehensive framework designed to fulfill these requirements, except for variations in body shapes. To retain garment texture at minute scales and high resolution, the system makes use of novel warping techniques and residual data. The process of warping can be applied to a wide range of apparel, making it easier to interchange particular pieces of clothing. Accurate portrayal of subtle elements like shading is ensured by a learnt rendering process that incorporates adversarial loss. The utilization of a distance transform representation ensures the correct placement of elements like hems, cuffs, and stripes. The study showcases the effectiveness of the suggested methodologies by showing significant improvements in garment rendering as compared to the latest techniques. Moreover, the framework exhibits scalability, real-time responsiveness, and robust performance across diverse garment categories. The potential usage of POVNet as a digital changing room UI for fashion e-commerce platforms is highlighted in the study, which reports a significant improvement in user engagement rates. This research contributes significantly to the development of more effective and engaging virtual try-on systems within the realm of online fashion retail. Gilda Manfredi, Nicola Capece, Ugo Erra, Gabriele Gilio, Vincenzo Baldi, and Simone Gerardo di Domenico wrote "Triton: A Virtual Dressing Room with Motion Tracking and Physically Based Garment Simulation." [5] With the help of a few essential components, the suggested approach seeks to deliver a realistic and immersive experience. Among these are the digital clothing representation's exceptional level of photorealism, the avatar's accurate measurements to improve personalization, the incorporation of real-time physical simulation of the clothes, and the way it interacts with the surrounding world through hand or body movements. The difficulty of physically trying on clothing to ascertain the exact size is a major issue that is attracting this attention. Human-computer interaction (HCI) and virtual reality (VR) techniques have been used to lessen this problem. In this work, the TryItOn Virtual Dressing Room (VDR) application—which allows users to virtually try on clothing is introduced. Abhishek M. B., Bindu H. M., Manasa R., and Vibha T. G. proposed a “Smart Virtual Dressing Room” [6]. This research aims to leverage the power of VR/AR technology by detecting the user's face from a live video stream through a webcam and identifying important human body landmarks using specialized algorithms. The key objective is to superimpose selected items—such as clothes, earrings, goggles, and more—onto the detected body parts in real time. The project focuses on implementing an application with a user interface that allows users to explore and virtually try different types of clothes and accessories. A critical challenge addressed in this research is the proper alignment of the user standing in front of the camera with the selected items, ensuring accurate positioning and scaling. Python is chosen as the implementation language for this project due to its rich set of built-in features and the extensive support of its active community. “Augmented Reality Based Virtual Dressing Room Using Unity3D” by Jessica Dias, Divya Chouhan, Preshit Churi, Pranay Parab [7]. The implementation leverages Unity 3D's Human Body Tracking library and AR Kit to recognize and track a person's movements through an iOS device's rear camera. Specifically, the integration of AR Kit's Human Body Tracking 3D sample demonstrates the generation of a 3D skeleton in the world space when a person is detected, requiring a device with an A12 bionic chip running iOS 13. The research

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then delves into the process of rigging a model for motion capture using an AR Kit. The technology recognizes and tracks a person's movements through the rear camera, applying the detected motion to a 3D character model in real-time. This approach effectively transforms the person on camera into a controller for the movement of the 3D model, akin to a virtual puppet. A crucial aspect of the methodology involves an AR Anchor subclass that tracks the movement of a single person. Body tracking is enabled through AR-Body Tracking Configuration, and when AR Kit recognizes a person in the camera feed, it triggers the delegate's function with AR Body Anchor, with the body anchor's transform position defining the world position of the body's hip joint. The subsequent section of the abstract provides detailed instructions for rigging a model for motion capture using various 3D modeling software packages such as Maya, Cinema4D, or Modo. It emphasizes the importance of correctly configuring import settings to ensure the proper orientation of the character and skeleton. The alignment process involves scaling, translating, and rotating the mesh to match the skeleton closely. Additionally, the mesh is bound to the skeleton, and specific considerations are outlined for the expected format, joint names, and hierarchy required by AR Kit's body-tracking functionality. Dr. S. Palanivel Rajan's "Virtual Dressing Room with Web Deployment" suggested creating an online trial room application that records a user video using the system camera and then extracts individual frames to show the user's body [8]. The next steps include real-time transformation, rotation, and scaling of wearable pictures onto the user, as well as joint information extraction. The project is implemented with a web browser, an internet connection, and a device that has an attached or built-in camera by using the Flask web application framework and the OpenCV Python package. It involves investigating approaches to video processing, body extraction, and real-time image transformation. The objective is to provide users with a seamless and accurate representation of how clothes would appear on them virtually. The project introduces an Augmented Reality-based Virtual Trial Room, offering a novel approach where users can digitally try on clothes by superimposing 2D and virtual garments over their monitored selves. The user's movements are dynamically responded to by the apparel, making the experience more interactive and captivating. The web implementation's usage of 2D augmented reality improves the application's usability and accessibility even more. “Implementation of Real-Time Virtual Dressing Room Using Microsoft Kinect SDK and Supervised Learning” by Soma Bandyopadhyay [9]. The proposed work explores the application of augmented reality to create an efficient trial experience for customers, allowing them to virtually try on clothing, jewelry, accessories, and more from the comfort of their homes. A Two-Dimensional (2D) model of clothing can be superimposed onto the user's image in the virtual fitting room by using the Microsoft Kinect Software Development Kit (SDK), which adds a dynamic aspect to the experience. This adds to the virtual try-on experience's realism by giving the impression that clients are wearing the actual dress. The emphasis on addressing security and privacy concerns, particularly for female customers, is a notable contribution of the proposed work. By bringing the trial room experience into the virtual realm, the need for physical spaces is eliminated, thereby minimizing potential security issues associated with traditional trial rooms. Chenxi Li and Fernand Cohen's "In-home application (App) for 3D virtual garment fitting dressing room" [10] proposes an innovative approach to creating a virtual dressing room at home, emphasizing the combination of garment fitting simulation and customized 3D physical model reconstruction. This approach focuses on creating a relational link between the huge scatter points on a 3D generic model to enable precise clothing fitting. Starting with a series of anthropometric organized, interconnected control points on the profile of projections from the generic model, the approach is implemented. The next steps are to personalize the 3D human shape mesh to follow equivalent locations on canonical images, identify equivalent

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saliencies through a loop subdivision method, and locate matching control points on the person's canonical images. It encompasses various aspects crucial to the development and enhancement of virtual dressing rooms. [11] It begins with an examination of existing technologies and their applications, shedding light on challenges like accuracy, user interaction, and realism. The focus then shifts to 3D body model reconstruction, discussing techniques such as image and point cloud reconstruction and evaluating methods based on accuracy, efficiency, and robustness. Additionally, the review delves into garment fitting simulation, offering a comparative analysis of different algorithms. Personalization techniques for adapting generic 3D body models to individual shapes are explored, along with an evaluation of morphing or deforming methods. The integration of technologies, particularly systems combining body model reconstruction and garment fitting simulation, is scrutinized, emphasizing approaches that leverage saliency for realistic virtual tryouts. Dataset utilization, including exploration of datasets like CAESAR, is discussed about reconstruction accuracy. The review concludes with an examination of user-friendly approaches, emphasizing methods requiring minimal user intervention and their suitability for in-home virtual dressing rooms. Design Calculation.

3. Proposed Method

The Customers can virtually, as opposed to in person, try on clothing to verify one or more aspects such as size, fit, or style. A camera is a requirement for identifying, identifying, and tracking human body movements to interact with suggested software content, such as virtual clothing, in real-time. The Graphical User Interface (GUI) of the application is designed to be user-friendly and basic enough for people of all ages to utilize. The clothes catalog, garment information, and camera preview are the essential and main user interfaces. User interfaces have to be designed and constructed utilizing heuristic concepts that are easy to learn, effective, simple to remember, error-free, and pleasurable to satisfy the usability requirements. Additionally, real-time skeleton joint locations of the human body are recognized and identified using the AR core foundation's human body identification and motion tracking model. [12] The live video is provided for the model to achieve a categorization result. Additionally, the existing apparel is transformed into models using body skeleton-based joints and garment dimensions to automatically adjust them to the human body in real-time. In summary, a motion tracking and human body identification model are being built in tandem with the development of an augmented reality virtual fitting room mobile. Figure 1 block diagram of the system is explained.

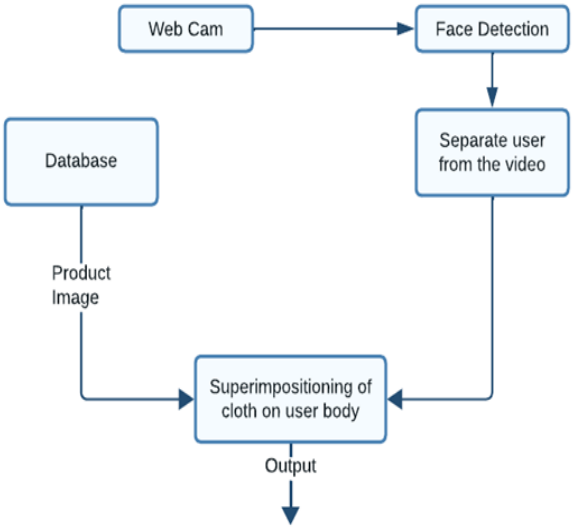

Figure 1 Block Diagram of the System

4. Implementation

By taking a picture of yourself with your camera and utilizing it as input, Virtual Dressing Room allows you to virtually dress yourself in augmented reality. Human faces and bodies are detected in the video using body and face detection algorithms. The product photos have a mask placed on them. Overlaid upon the client's picture is a veiled image. The project's steps are outlined below:

- Taking videos to retrieve user information.
- Identification of the user's body (upper and lower body parts) and face (nose, ears, and eyes).

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- Utilizing the bone and coordinates to position clothing, goggles, jewelry, and accessories.
- Creating the link and building the webpage with HTML and CSS.
- Including a source code integration link.
- Choosing the user's preferred accessories. Selected material appears on the screen as output.
- Computer vision and image processing algorithms are used to achieve face detection, facial landmarks detection, and overlaying sprites on detected faces. Here's a summary of the key algorithms and libraries used:
- OpenCV (cv2): Used for reading video frames, image manipulation, and face detection. Haar cascade classifiers for upper body detection. Drawing rectangles on the image.
- Idlib: Face detection using the “get_frontal_face_detector” function. Facial landmarks detection using the “shape_predictor” function.
- PIL (Python Imaging Library) and ImageTk: Used for displaying images in the Tkinter GUI.
- imutils: Provides convenience functions for face utilities, including converting facial landmarks to NumPy arrays.
- NumPy: Used for numerical operations and handling arrays, particularly in facial landmarks calculations.
- Threading: Employed to run the main computer vision loop concurrently with the Tkinter GUI.

The system is built using Python, incorporating popular libraries such as OpenCV, Idlib, and Tkinter.

4.1 Sprite Management

The core of the implementation involves the management of virtual sprites. Each sprite is associated with a specific button in the user interface, allowing users to dynamically toggle the display of different virtual items. The “put_sprite” function toggles the visibility of a sprite, and the “draw_sprite” function handles the rendering of sprites on the video frames [13].

4.2 Face Recognition and Landmark Positioning

The dlib library is used by the system to carry out facial landmark localization and face detection. For face detection, the "get_frontal_face_detector" function is used, while the “shape_predictor” function is used to obtain facial landmarks. These landmarks are crucial for accurately placing virtual items on the detected faces.

4.3 Virtual Try-On Logic

The core virtual try-on logic is implemented within the cloop function, which runs in a separate thread for real-time processing. The function continuously captures video frames from the user's webcam and processes each frame for face detection and landmark localization. For each detected face, the system evaluates the inclination angle between specific facial landmarks, ensuring accurate alignment of virtual items with the orientation of the face. Additionally, the system checks for specific facial expressions, such as an open mouth, to trigger the display of certain virtual items.[14]

4.4 User Interaction

The Tkinter library is employed to create a user-friendly interface. The Button widget allows users to interactively try on virtual items. The button click event triggers the “add_sprite” function, which updates the system to display the selected sprite.

4.5 Threading for Real-time Processing

The implementation utilizes threading to concurrently run the computer vision loop (cvloop) and the Tkinter GUI. This ensures smooth and responsive interaction, allowing users to try virtual items in real-time.

4.6 Termination and Graceful Exit

To ensure a graceful exit, a termination function is

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set to execute when the user closes the application window. This function clears the threading event, allowing the system to terminate gracefully.

5. Applications and Features

The applications of a virtual dressing room project are diverse and extend across various industries and scenarios. Some of the key applications include:

i. E-Commerce and Fashion Retail Virtual dressing rooms are revolutionizing the way customers shop for clothing and accessories. The technology accounts for sizing, fit, and style, enabling customers to virtually try multiple outfits without visiting a physical store. This application significantly enhances the online shopping experience, as customers can confidently choose items that suit their preferences and body types [15].

ii. Custom Tailoring and Bespoke Fashion Tailors and designers can utilize virtual dressing rooms to collaborate with clients on custom-tailored clothing. Customers can select fabrics, styles, and designs, and see how the final piece will look on a digital representation of themselves. This application ensures a high level of customization and personalization, enabling clients to make choices based on their preferences and needs.

iii. Virtual Styling Services Fashion stylists and consultants can use virtual dressing rooms to offer personalized styling advice to their clients. Through a collaborative online platform, stylists can curate outfits and looks, and clients can virtually try them on. This application bridges the gap between in-person styling sessions, allowing for remote and convenient consultations.

iv. Augmented Reality Advertising and Marketing Brands and marketers are incorporating virtual dressing rooms into their advertising and marketing campaigns. By creating interactive and immersive experiences, they memorably engage users. Customers can virtually try on products featured in advertisements, making the marketing content more interactive and shareable on social media.

Conclusion

The virtual dressing room project represents a dynamic and innovative solution that addresses key challenges in the fashion and retail industry. Through the use of cutting-edge technology like artificial intelligence and augmented reality, this initiative provides customers with a distinctive and engaging shopping experience. It simplifies the process of trying on clothing and accessories online, providing numerous benefits, including increased consumer confidence, reduced returns, and a more sustainable approach to fashion retail. This project not only enhances the customer experience but also offers businesses a competitive advantage and valuable insights into customer behaviour and preferences.

Future Scope

The future of virtual dressing rooms holds great potential for transforming the way of purchasing clothing and accessories, offering a more personalized, convenient, and sustainable shopping experience. Virtual dressing rooms will continue to break down geographical barriers, enabling consumers to shop from international brands and retailers with confidence. Ultimately, virtual dressing rooms are at the forefront of revolutionizing the online shopping experience and will remain a pivotal innovation in the future of retail.

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