Augmented Reality-Based Clothes Trial App or Model

New Era Of Online Shopping

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***Abstract*—In this new world, we are becoming addicted to online shopping. Augmented Reality gives a new dimension to the fashion shopping experience, allowing you to try on clothes virtually from any device and anywhere. The application or Model has high-end augmented Reality, AI-powered body measurement, and 3D modeling for a realistic and interactive fitting experience; capturing the user's dimensions through the camera, the app or Model generates an accurate 3D model, which overlays items from a virtual wardrobe. This solution reduces the need for physical trials and returns and fosters sustainable shopping. The app or Model, targeted at e-commerce and retail platforms, improves convenience accessibility and enhances user satisfaction while narrowing the gap in online-in-store shopping.**

***Index Terms*—Augmented Reality, AI, 3D Model, E-commerce, Shopping, Clothes**

I. Introduction

Technology has increased in many industries in recent years, significantly in the clothing sector, which attempts to fulfill customer needs and expectations. One of these requirements is that clothes be tried before being purchased. Augmented Reality has developed into a modern technology, integrating the virtual and physical worlds into immersive, interactive, dynamic, and easy-to-use experiences. The retail industry is under a telling spate of digitization.

Augmented Reality (AR) can help online retailers solve some fundamental issues that have been dealt with for decades, including customer dissatisfaction because of incorrect product trials, inability to view products and lack of personalization. Many challenges are unique to the industry, such as high return rates and providing a personalized shopping experience, which no other retail segment confronts. Augmented Reality (AR) has taken much interest in different sectors in recent years, generally involving healthcare, education, entertainment, and retail. In 2020, global retail e-commerce sales reached 4.28 trillion; e-commerce revenues are expected to reach 5.4 trillion in 2022. Speaking of fashion, one of the most essential online experiences that online buyers lack is the changing room, where an item or garment can be tried. With improvements in hardware, software, and machine learning algorithms fueling its use, the global market valuation of Augmented Reality (AR) is expected to reach 97.76 billion by 2028. Among these, the retail industry took hold of AR as an efficient tool for renovating online shopping experiences. State-of-the-art AR has a tremendous impact on online apparel shopping.

This technology, in particular, has a significant role in the fashion industry. These solutions allow customers to try on clothes through Augmented Reality (AR) based apps or models without visiting a brick-and-mortar store. Augmented Reality tries to find solutions for clothes using a camera to capture the customer. At the same time, Augmented Reality (AR) technology maps a realistic virtual model of a product

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over the customer in real-time. With Augmented Reality (AR) try-ons, clothes shopping has become far easier and more accessible for consumers. We found that Augmented Reality (AR) in the fashion industry is also a growing trend, as the virtual market size is projected to rise at this inindustry'snnual growth rate of 24.1 percent between 2023 and 2030. For the fashion world, this will demonstrate a revolution. Augmented Reality Reality can bridge the gap between digital and physical retail, generate data to purify product growth and planning and allow brands to match the desires of modern consumers.

II. Background And Related Work

Augmented Reality (AR) technology, which overlays virtual content onto real-world environments, has grown substantially since its inception in the 1990s. Initially applied in fields like aerospace and defense, ARAR'sotential in retail began to emerge around 2012 with virtual fitting rooms. Zara and IKEA, like big companies, pioneered AR integration into retail, allowing consumers to visualize products in their homes or on themselves in virtual mirrors. However, as Huang et al. (2020) noted, early performances struggled with user experience issues such as lagging interfaces and lack of accurate measurements, making these tools less trustworthy for consumers.

The integration of AR with 3D scanning rotation and body modeling has attracted significant interest in recent years. Kim et al. (2022) explored how combining AR with advanced body scanning and AI-powered body modeling can make more personalized and accurate virtual trial experiences. The rise of AI, machine learning, and better sensing technologies drives this change. These innovations provide more precise body measurements and immersive AR experiences, enabling more accurate virtual trails for clothing, footwear, and accessories.

Also, companies like 'W'nnaby' 'have established AR in footwear retail, such as the "W" nana Kicks" "pp, which lets users try on shoes virtually using their phone camera. While such systems are popular, they still face scalability and integration challenges. One of the critical limitations is the need for a system that can accommodate a diverse range of product datasets and customize experiences in real time. The research conducted by our team builds on these systems, incorporating machine learning to enable dynamic real-time customization based on the user's type and preferences.

Moreover, several systems focus on improving realism through cutting-edge techniques like scaling and pose recovery. A system by Frederic et al. utilizes machine learning to optimize the positioning and scaling of virtual garments, overcoming the issue of clothes that do not align with the user's physical body shape. This approach to customization allows the system to adjust dynamically for different body types, ensuring a more accurate and realistic virtual experience.

Our work builds upon these existing AR-based virtual clothes trail technologies, focusing on integrating AI to provide real-time, highly personalized virtual fitting experiences for various users. This allows for a more engaging and user-friendly experience, helping consumers make more informed purchasing decisions.

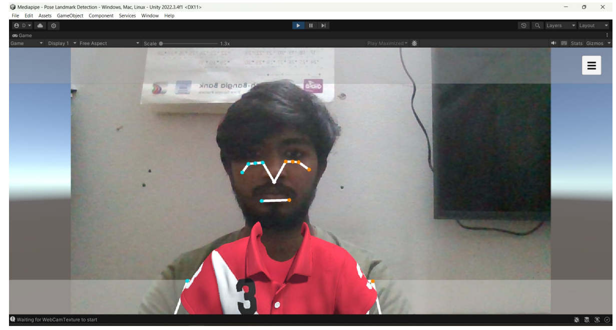

Fig. 1. 3D clothing model set on the human body.

III. Proposed System

Our Augmented Reality-Based Clothing Trial App or Model introduces several advancements to improve virtual clothing trail accuracy, easy-to-use, anywhere-you-can-use, usability, and interactivity. The system is powered by MediaPipe for real-time pose estimation and body tracking, allowing for seamless integration of virtual clothing that fits the user's sense of self in real-time. The Unity engine provides immersive 3D model visualization, offering users a realistic experience of how clothing fits, moves, and adapts to their bodies.

The system utilizes depth sensors to generate accurate 3D body scans, overcoming the limitations of traditional 2D imagery. The rotation in this 2D Model is turned into a 3D model. These scans create a precise 3D model of the user. Our work uses the 3D human model with rotation functions to enhance the overall trail experience by accurately measuring the clothing and the user's body structure. Additionally, AI algorithms analyze user preferences, body shape data, and purchase history to provide personalized garment recommendations. This ensures that the clothing suggestions match the user's style and body dimensions, improving user satisfaction and engagement.

To enhance system performance, we use cloud-based rendering. This approach has the computationally intensive tasks of 3D rendering and garment simulation to the cloud, adding many models in this app, reducing the strain on mobile devices, and ensuring smooth operation even on devices with limited processing power.

Key Features:

1. Real-time body tracking via MediaPipe ensures accurate clothing placement.

2. High-quality 3D garment visualization model using Unity adapts to user movements.

3. AI-based personalization provides tailored clothing recommendations based on user data.

4. Cloud-based rendering to reduce device workload and provide seamless performance.

5. Depth sensors for more accurate body measurements and garment fitting.

With this system, users can try on clothes virtually, from the comfort of their homes, while benefiting from high personalization and accuracy. This solution addresses earlier AR-based virtual fitting room challenges, such as poor alignment and inaccurate clothing fit.

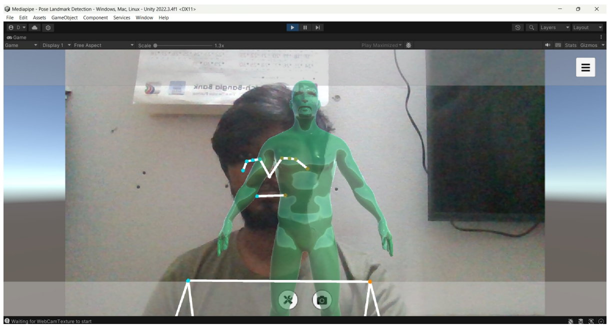

Fig. 2. Model create using MediaPipe.

IV. System Architecture

Our Augmented Reality (AR)-Based Clothing Trial App or Model is designed to combine various components for seamless operation and user experience. The architecture can be broken down into the following main layers:

User Interface (UI) Layer:

Application Frontend: Developed with Unity 3D to ensure a user-friendly interface and interactive experience. AR Display: Utilizes ARKit (iOS) and ARCore (Android) for real-time augmented reality visualization. Also, use the AR library in Unity.

Camera and Data Collection:

MediaPipe Integration: Captures real-time body measurements and key points using an RGB camera to create a detailed 3D body mesh. User Input: Handles user interactions, such as clothing selection and pose adjustments.

Processing and Analysis Layer:

Body Measurement Processing: Utilizes machine learning algorithms to interpret MediaPipe data and customize avatar size and proportions. Avatar Customization Module: Generates and adjusts 3D avatars based on user body metrics, ensuring a personalized fit. Clothing Simulation Engine: Simulates clothing behavior on the avatar, considering fabric properties and interaction with the body.

Augmented Reality Engine:

Rendering and Display: Responsible for superimposing virtual clothing onto real-time video feeds. It uses the AR engine to render 3D models with realistic physics and visual fidelity. Background Removal and Reconstruction: Extracts users from their environment and places them in a virtual space for a clean trial experience.

Backend Infrastructure:

Cloud Services: These store user data and clothing templates, providing processing power for more intensive computations. Database Management: Centralized database for user profiles, clothing catalogs, and transaction records.

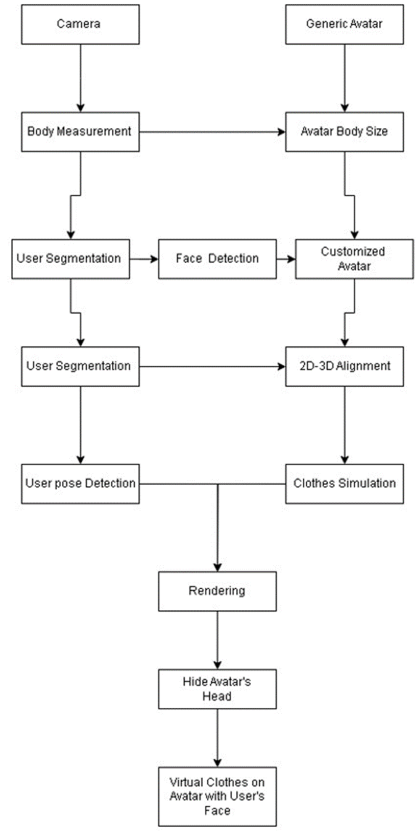

Fig. 3. System Diagram.

V. Methodology

To develop an augmented reality (AR) application for virtual clothing trials, we employed a structured approach incorporating computer vision, machine learning, and augmented reality (AR) technologies.

• Data Collection and Preprocessing: We used MediaPipe, an advanced framework for real-time computer vision, to obtain precise body measurements. MeMediaPipe'sody mesh solution captures 3D key points on the human body and allows us to accurately assess dimensions such as shoulder width, waist, chest, and hip measurements. This data is essential for aligning clothing with the user in the AR space.

• Avatar Generation and Customization: The Model uses measurements to create a personalized 3D avatar that accurately represents the user's shape using MediaPipe. This avatar was designed using a combination of software tools that facilitate 3D modeling and adjustments for user-specific body features, ensuring an interactive and realistic experience.

• Clothing Simulation: Clothing models were integrated into the system and calibrated to fit the user-generated avatars. The simulation used physics-based algorithms and needed some equations to set clothes on avatars for fabric flow, wrinkles, and interactions with different body types. This step involved creating clothing templates that could be modified based on the user's measurements.

• AR Rendering Pipeline: We used AR platforms like Unity 3D combined with ARKit/ARCore to render clothing for the avatars. These platforms facilitated overlaying virtual garments onto real-time camera feeds, leveraging AR techniques to accurately display clothing as if it were physically present on the user.

• Testing and Optimization: Comprehensive testing was completed to ensure the robustness and responsiveness of the application or Model across different body types, lighting conditions, and device specifications. Optimization techniques, such as model simplification and efficient rendering algorithms, were applied to maintain high performance without compromising visual quality.

VI. EQUATIONS

We aimed to determine the mathematical relationships aligning virtual clothing with the human body structure. To achieve this, we iteratively tested multiple equations, analyzing how the virtual dress could adapt to the body landmarks detected by MediaPipe. Finally, we derived an equation based on the linear function:

$$y = mx + c \tag{1}$$

Explanation: m represents the slope between key body landmarks (e.g., shoulders, waist, hips) calculated using the coordinate points provided by MediaPipe AI model body detection. c is the constant offset to correct the alignment and ensure that the clothing accurately follows the natural body curve. This equation allowed us to map the virtual dress coordinates with high precision to the detected human model structure. The slope adjustments are fine-tuned based on real-world body proportions, while the MediaPipe AI model ensures robust and dynamic detection of body key points.

Additionally, for 3D body alignment, we extend this equation into three-dimensional space to accommodate depth Z.

$$z = kx + d \tag{2}$$

Here, k and d act as the slope and offset values along the depth plane, providing a holistic 3D alignment of the clothing to the user's virtual Model.

This method achieved a highly adaptive and realistic fit for virtual, augmented reality clothing trials, regardless of user pose or body proportions.

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