Virtual Wardrobe using Augmented Reality

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ABSTRACT

This paper presents a new virtual wardrobe system that uses augmented reality (AR) to change the way people interact with fashion. Users can instantly see the clothes and accessories they are wearing without having to try them on in person using seamless integration of AR technology. The system uses advanced image recognition and machine learning algorithms to provide personalized clothing recommendations based on user preferences, body measurements, and current fashion trends. With the intuitive interface, users can search for their current clothes, try on new styles, and get relevant recommendations that enhance their shopping experience and reduce fatigue. This new approach not only promotes fashion by reducing returns and waste, but also encourages users to be conscious about their fashion choices. Our findings show that AR is driving customer engagement and satisfaction, paving the way for a new era of virtual retail. Users can easily upload photos of their current outfits and have the system suggest new combinations and styles that fit their personal aesthetic, improve purchasing experiences and reduce decision fatigue. The platform also includes social features that allow users to share their virtual outfits with friends and get feedback, creating a community of fashion enthusiasts, while also informing users about their fashion choices. Exploring the intersection of technology and personal expression, this virtual machine aims to revolutionize how consumers interact with fashion in an increasingly digital world.

Keywords: AR kit, IOS, Firebase, Figma, Wireframe

Introduction

Our project aims to change the fashion experience by offering virtual clothing using augmented reality (AR). This new platform allows users to instantly see clothes and accessories on their bodies without having to get dressed and to easily try on clothes. Using advanced technologies such as image recognition and machine learning, our virtual wardrobe offers design ideas based on personal preferences and body measurements. and share their thoughts. This not only enhances the shopping experience, but also supports beauty culture by reducing the need for returns. Join us and redefine fashion in the digital age. Our virtual wardrobe project uses the power of augmented reality (AR) to create an interactive fashion experience. By combining technology with personal style, we aim to solve the problems faced by customers such as the difficulty of trying on clothes, the size of online shopping. Real-time visualization: Users can instantly see the results of different outfits on their own, making the process of choosing clothes more interesting and efficient. The system analyzes the user's preferences, body type and current fashion trends, and recommends compatible clothes to help users find new styles that match their personal preferences. Users can upload photos of existing clothes, allowing the virtual wardrobe to act as a digital wardrobe. These features help them keep track of their belongings and make it easier to mix and match. The platform includes features that allow users to share virtual outfits with friends, write feedback, and even collaborate on looks to build a community around fashion research. By encouraging virtual experimentation, we aim to reduce the environmental impact of recycled clothing and overproduction, and promote healthy, cleaner living. Fashion stores not only improve the user experience, but also bring great opportunities for brands. Retailers can use insights from user interactions to better understand customer preferences, which leads to more efficient marketing and product development. We recommend adding features like virtual fitting rooms, integration with e-commerce platforms, and advanced analytics to further enhance

the user experience. Our vision is to create an integrated fashion ecosystem that combines technology with personalization to make fashion easy for everyone. It paves the way for more personal, efficient, and sustainable purchasing.

Literature Review

This study introduces a virtual fitting room system that employs augmented reality to enable users to virtually try on clothing items. The system utilizes Microsoft Kinect to track facial features and body depth, ensuring that garments appear aligned with the user's real-time movements. The virtual clothing adapts fluidly with natural folds, and the rendering includes dynamic lighting to reflect the user's environment. Unlike previous systems that relied on static 2D images, this approach integrates 3D garment models and realistic fabric simulations to enhance the user experience [1].

In addition to clothing, digital makeover applications have emerged as useful tools for users wanting to enhance their appearance without physical makeup. However, most current makeup apps demand extensive manual input and do not effectively replicate the blemish-correcting capabilities of real cosmetics. To address these issues, a cross-platform virtual makeup system has been proposed. It relies on open-source development tools to maintain affordability if commercialized in the future, making it accessible to small beauty businesses and users who require quick, user-friendly digital transformation [2].

A novel concept in AR-based fitting rooms introduces a more tactile experience where users engage with fabric textures alongside virtual clothing simulations. Instead of requiring wearable AR devices like glasses, this system uses cameras and projection surfaces to create an immersive fitting mirror. The "AR Dress Code" application adjusts the garments based on user input and motion tracking, offering a personalized and interactive try-on experience. The research also explores challenges in design and technology while suggesting potential for future innovation in the AR retail space [3].

This kind of virtual fitting technology can be especially beneficial for individuals with physical disabilities. For users with limited mobility, the system includes sensors that interpret head or eye movements to allow clothing selection and navigation. While the study notes a decline in engagement from certain user demographics, the goal remains to make digital fashion more inclusive and adaptable for all abilities [4].

Another approach utilizes fixed-position network cameras to capture user images. The system analyzes individual pixels to recommend garments that suit the customer's preferences. Despite being effective for e-commerce platforms, the absence of true depth sensing—due to the lack of a Kinect sensor—limits its application in offline or mixed-reality environments [5].

A different model of virtual fitting rooms focuses on a software-only architecture that works on both PCs and mobile devices. This version avoids the need for external hardware by relying solely on camera-equipped devices. The three-phase algorithm includes body detection and transformation, facial recognition and symbol processing, and virtual garment overlay. It offers high accessibility and ease of use across Android devices using JAVA-based solutions, delivering responsive and platform-independent functionality [6].

From a consumer perspective, another system transforms the webcam into an AR interface to allow users to view how different materials—such as glass or silver—appear when virtually placed on their face. The system uses the HAAR cascade algorithm to detect faces and apply virtual elements using affine transformations. Interaction is enhanced by tracking fingertip movement based on color detection, enabling gesture-based item selection. This interface improves usability over traditional static previews and promotes informed purchasing decisions [7].

However, a noted limitation in some of these applications is the restricted variety of virtual garments, often limited to local or traditional outfits. This limitation may reduce the appeal for global audiences seeking diverse fashion options [8].

Methodology for the Virtual Wardrobe

Research in web-based augmented reality (AR) highlights its potential in creating interactive and wearable digital experiences for users. One such framework employs ResNet-50, a deep neural network with 50 layers, to perform image-based predictions using computer vision techniques. This enables accurate human detection and body recognition, which in turn powers PoseNet 2.0, an algorithm that estimates body posture. PoseNet 2.0 is developed using TensorFlow.js, allowing it to run efficiently across multiple platforms, including smartphones, tablets, and desktops [9].

A related study, titled *"Augmented Reality-Based Virtual Fitting Room Using Unity3D"*, addresses key challenges faced by online apparel retailers. The system leverages AR to let users input their body dimensions, try on clothing virtually, and visualize how the garments fit in real time. By integrating AR into the shopping experience, the solution aims to enhance buyer confidence, reduce size-related purchase errors, and lower product return rates. The research underlines the shortcomings of conventional e-commerce platforms and presents AR fitting rooms as a viable alternative. It showcases a user interface that supports body tracking on iOS devices and outlines plans for future Android support to broaden compatibility [10].

The study also notes that the neural network's layer configuration affects both processing speed and prediction accuracy. Higher layer values lead to faster execution but may compromise precision, whereas fewer layers offer better accuracy at the cost of speed. To support smooth and responsive graphics, the Three.js library was selected for rendering. This JavaScript library enables efficient performance and supports inverse kinematics, making it suitable for simulating realistic body movements. In addition, Two.js was found effective in ensuring visual consistency and animation fluidity, aligning well with the requirements of AR-based applications [11].

Another AR-based virtual fitting room model utilizes marker-based tracking, where users hold up a physical marker—often a QR code or digital token—that acts as a reference point. The system overlays a 3D garment model onto the user's live camera feed, allowing real-time visualization of virtual clothing. This approach incorporates AR features like motion detection and lighting estimation to improve realism. Vuforia, a widely-used AR SDK, powers these features on Android devices. However, the accuracy of the virtual try-on depends on the quality and precision of the clothing images used as textures [12].

Additional research offers a comparative evaluation of Microsoft Kinect and Asus Xtion in terms of AR performance, usability, and implementation cost. The discussion centers around how these devices affect the quality of virtual fitting room (VFR) systems [13]. For garment-body integration, a deformation algorithm is applied, which isolates the garment area from the rest of the user's body. The system then uses historical facial data and body geometry to generate garment patterns that align accurately with the user. This technique is powered by a convolutional neural network (CNN) utilizing geometric ratios to simulate fit and drape [14].

To display these garments, 3D models are mapped onto virtual mannequins, creating a realistic effect. The Pix2Surf method further enhances this experience by projecting clothing textures from online sources directly onto human models, using front and back image data to create accurate mesh overlays [15].

iOS

Utilizing iOS and Apple's ARKit for the development of the Virtual Wardrobe application enabled the creation of a highly interactive and immersive experience, where users could visualize clothing items overlaid on their real-time images through augmented reality. iOS proved to be an ideal platform for this type of solution due to its sophisticated AR support, seamless hardware-software integration, and a stable development environment—particularly through the ARKit framework.

ARKit, Apple's augmented reality development toolkit, provides advanced capabilities like body and facial tracking, depth perception, and spatial mapping. These features allowed the virtual wardrobe to simulate the realistic placement of garments on the user's body or avatar in real time. The system can detect body movement, adjust garments to fit naturally, and dynamically respond as the user shifts position—offering a fluid and life-like virtual try-on experience.

The intuitive nature of iOS further enhances the application's user interface. Features such as pinch-tozoom for resizing clothes, swipe gestures to change views, and drag-and-drop interaction offer users complete control over their virtual styling experience. Notifications and widgets can be customized to alert users about new outfit arrivals or help them plan outfits for upcoming events, adding another layer of personalization.

Security and privacy, crucial for any application that handles user photos and personal preferences, are robustly supported by iOS. Apple's secure data encryption methods, strict app permissions, and the "Sign in with Apple" feature ensure that sensitive information remains protected and that user identities are safeguarded against misuse or exposure.

Moreover, iOS's tightly integrated ecosystem allows the Virtual Wardrobe app to work across multiple Apple devices—iPhones, iPads, and Macs—enabling users to switch seamlessly between devices using features like Universal Control. The consistency in system updates across iOS devices ensures long-term app compatibility and makes it easier to roll out new features, such as enhanced AR functions or performance improvements.

By combining powerful AR capabilities with a user-focused interface and a secure, scalable platform, iOS significantly elevates the user experience in the Virtual Wardrobe project, fostering deeper engagement and delivering a more realistic and enjoyable virtual fashion experience.

System Architecture

The primary objective is to deliver design services for e-commerce fashion websites. As illustrated in Fig. 1, the overall system architecture supports this functionality. These websites enable users to virtually try on clothing items through the platform. The system processes the user's photo alongside selected outfit images, integrating them to generate a visual representation. This allows users to see how garments would appear on them, using both 2D and 3D model visualizations to enhance the virtual try-on experience.

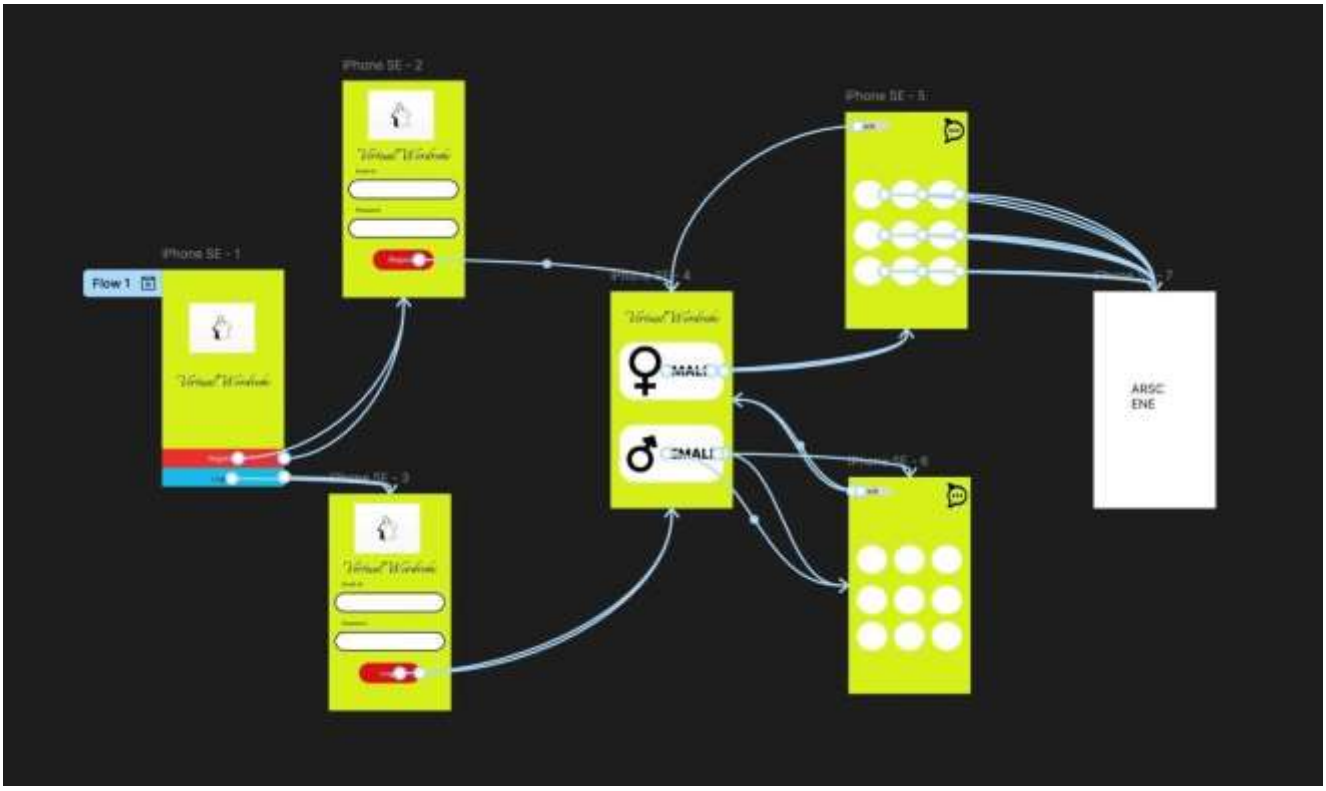


Fig.1 Virtual Wardrobe Architecture

In Fig. 2, the UI/UX design of the Virtual Wardrobe app begins with a page featuring two buttons: one for registering a new user and the other for logging in as an existing user. On the second and third pages, users can enter their credentials to log in and proceed to the next screen.

The fifth page displays a collection of outfits and clothing, and by tapping on the image of any item, users are redirected to an AR scene. In this scene, they can visualize the outfit on their body and use the snapshot feature to capture a picture, which can then be shared with others.

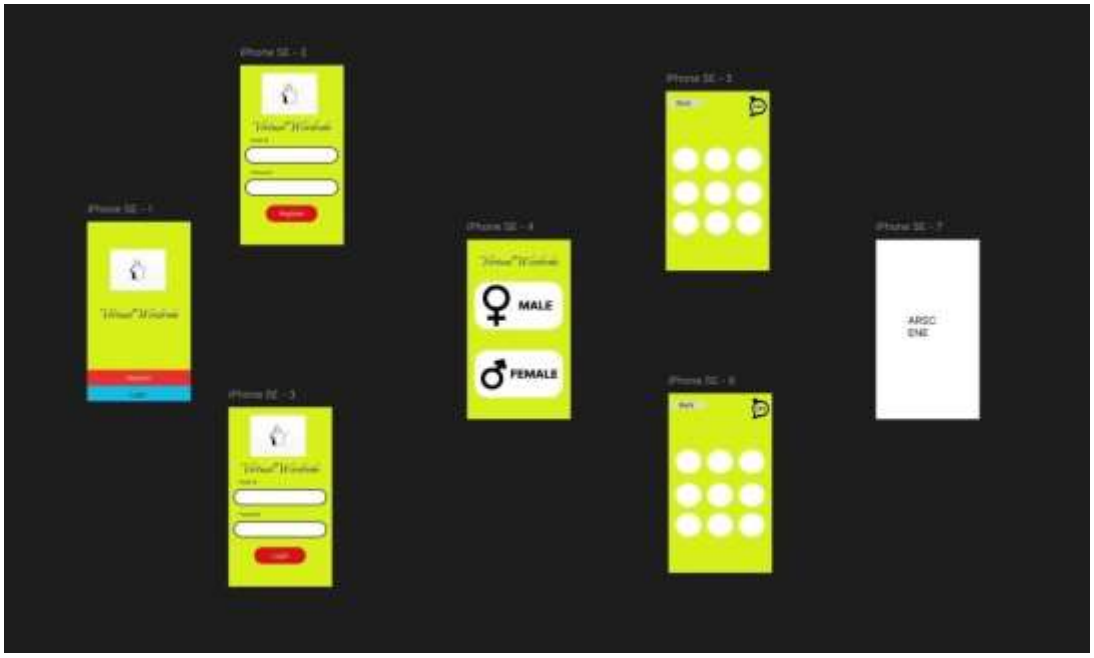


Fig.2 Virtual Wardrobe UI/UX Flow Diagram

Result

The initial prototype testing demonstrated that a 2D image of the T-shirt successfully appeared on the user's camera interface, as illustrated in Fig. 3. Additionally, users could capture an image of themselves wearing the virtual outfit by tapping the snapshot button, which then automatically saved the photo to their device's gallery or photo app.



Fig.3 Prototype testing

The initial prototype trial displayed a 2D image of the T-shirt on the user's camera, as shown in Fig. 3. Users could also capture a photo of themselves by clicking the snapshot button, which would then automatically save the image to their device's photo or gallery app.

Conclusion

This virtual wardrobe initiative represents a transformative step in blending AR with fashion retail. By offering users an immersive and interactive environment, the application eliminates major drawbacks of traditional and online shopping such as physical try-on limitations and size uncertainties. It enhances consumer satisfaction, supports sustainable shopping by reducing returns, and promotes digital self-expression. Moving forward, we plan to incorporate real-time 3D garment fitting, enhanced body tracking, and machine learning-driven style recommendations based on user preferences and feedback.

The development of a virtual wardrobe using augmented reality (AR) marks a notable step forward in the intersection of technology, fashion, and retail. This application not only provides a modern solution to traditional clothing try-on challenges but also addresses limitations of the online shopping experience, such as size mismatches and purchase uncertainty. By leveraging AR, users are empowered to visualize clothing items on themselves in real time, thereby making more informed and confident purchasing decisions.

Our implementation demonstrates how combining Unity 3D with Firebase can create a seamless and responsive user experience that mimics real-world fitting rooms. The system's ability to project 2D outfit images onto the user’s body, capture photos, and offer gender-based clothing selection enhances its practicality and appeal across different demographics. The design also emphasizes simplicity and interactivity, which are essential for broad user adoption.

Looking ahead, the application can be further enhanced through the integration of 3D clothing models, AI-based recommendation engines, and real-time body tracking for dynamic outfit fitting. Features such as virtual closets, style suggestions based on user behavior, and integration with ecommerce platforms can make the application even more robust and commercially viable.

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