Virtual Wardrobe using Augmented Reality

Ayush Verma, Rohan Sharma, Davik Chaudhary, Vaibhav Singh, Shailendra Narayan Singh

Amity University Uttar Pradesh, Noida, India

Corresponding author: Shailendra Narayan Singh, Email: snsingh36@amity.edu

The Virtual Wardrobe[18] represents an innovative breakthrough poised to revolutionize the global fashion landscape, offering the potential to usher in highly advantageous changes to the industry. This application provides users worldwide with the ability to engage with the latest fashion trends, discover the perfect garments to enhance their wardrobes, all while significantly economizing both time and finances when selecting the right outfit. One of the distinguishing features of this application is its capacity to create a three-dimensional representation of an individual, leveraging existing two-dimensional product im-ages to construct an immersive augmented reality environment[19], allowing users to make informed outfit choices without the need for physical try-ons. The inclusion of user-profiles empowers users to maintain their entire wardrobe digitally, thereby enabling highly personalized clothing recommendations[20]. Furthermore, the integration of social sharing functionalities fosters user engagement and promotes exploration of the world of fashion. This platform boasts an intuitive interface and a state-of-the-art technology stack, positioning it to redefine the way individuals perceive and interact with fashion. It equips users with the means to stay current with fashion trends while mitigating the waste of time and financial resources, rendering style accessible and enjoyable for a global audience.

Keywords: Augmented Reality, Image processing, Posenet, Outfit selection, Virtual fitting room, Fashion app, Fashion Recommendation system.

in: *Advancements in Communication and Systems*. Ed. by Ashish Kumar Tripathi and Vivek Shrivastava. Computing and Intelligent Systems, SCRS, India., 2023, pp. 369–377. DOI: https://doi.org/10.56155/978-81-955020-7-3-32

1 Introduction

In the dynamic landscape of the 21st century with technology evolving tremendously every day we require development in every domain to ensure the whole world moves together. The allure of shopping, a pursuit enjoyed by many, is now being redefined by the seamless integration of technology and fashion. As the world grapples with the challenges posed by a rapidly evolving society, the need for innovative solutions be-comes paramount. To ensure every aspect remains connected the fashion department requires us to stay intact with the trends. Post Covin 19 the whole world has gone online. Everything is present at the click of a button and every sort of information can be read online. The latest and most popular addition to the technological market is AI and Machine learning. This innovation is revolutionary and has potential to bring out positive changes to the whole world. Even though we are currently in the exploration of this domain, we have figured out a way to integrate ai with fashion. This revolutionary idea can bring out multiple advantages to the market and save tons of money and time worldwide. Human lives can stop worrying about finding the right cloth, picking the right outfit and being able to focus on different things in life. By introducing AI into the fashion industry we can potentially help people decide clothes to buy using the augmented space which could clone the person into a virtual space which can contain all its clothes and only in a click of a button he will be able to see how the cloth can fit virtually. The limitations of physical space in stores and the costs associated with maintaining elaborate fitting rooms present obstacles that impede the smooth operation of the retail industry. Every boutique requires a dressing room but even that cost can be reduced if people are able to try clothes on their phone using a single application. a novel solution emerges. Imagine a world were trying on clothes is not restricted to the confines of physical stores, where the boundaries between the digital and the tangible blur seamlessly. This paper delves into the realm of the 'Virtual Wardrobe,' an innovative concept that promises to revolutionize the way we perceive and experience fashion. In this research endeavor, we explore the fusion of fashion and technology, particularly the utilization of augmented reality. We delve deep into the intricacies of this amalgamation, dissecting its potential to redefine the very essence of shopping. Our aim is not just to find the right outfit or facilitate the act of purchasing clothes, but to liberate precious time and resources squandered in the pursuit of sartorial perfection. As we embark on this journey, the synergy of fashion and AI unfolds, promising a future where the act of dressing up becomes a virtual, yet profoundly real, experience.

Join us as we unravel the threads of innovation, weaving together a tapestry where technology and fashion coalesce, offering us a glimpse into the future - a future where the virtual wardrobe is not just a concept, but a tangible, transformative reality.

2 Literature Review

Samad et al. [1] proposed the method of image processing using Kinetic knowledge which enables us to find the appropriate length of human body parts. This research has embraced upon the understanding of OpenCV as well as Kinetic sensor. The methodology adapted used shape features together with the joint data improves this detection system by comparing the body proportion ratio of the found object with the golden ratio value [1].

In the year 2018, Gaurav Raturi et. al. [2] proposed “Virtual Mirror: The future of Interaction”, In the article he introduced a technology which had the ability to scan the clothing article using the Kinect camera and a virtual mirror which was a blend of RFID technology and augmented reality which acted as a virtual fitting room [2].

The user just needs to place the clothing article in front of the mirror and within some time the cloth will be superimposed on the user. This highly effective technique resulted in tremendous sales in the stores. It also offers various sizes, color, and design charts for users since technology is just for ease of the people and this enabled them to try various clothes without putting them on.

The in-store experience of virtual mirror resulted in more customer engagement and hence sales growth but the expense of developing a virtual mirror is high due to its integration with the Kinect sensor. It must also be installed on a device with a high-performance speed because it uses a lot of processing power [2].

Patil et al. [3] in his research about Clothes Fitting Web Application Using Augmented Reality Or Three. Js & Posenet [3] utilized a combination of pose estimation, ResNet-50 and PoseNet 2.0 to deliver a really efficient model for people to try on clothes by using a web application. The researchers implemented this great framework by utilizing ResNet 50 which is a neural network consisting of 50 nodes along for pose estimation of an image, it uses computer vision for detecting human beings determining the body parts and enabling the PoseNet 2.0 to perform pose estimation algorithms. The PoseNet 2.0 was implemented on Tensorflow.js so it could work on any regular mobile phones, desktops or ipads [3].

"Tendency to Use the Virtual Fitting Room in Generation Y- Results of Qualitative Study," Miroslaw MOROZ et.al. [4] presented in 2019. The article stated that the ecommerce market has been into rapid boom ever since 2014.People have generated a tendency to purchase more article online but in case of clothes, they prefer in store since the clothes can have a variation of size, color, fit or style. But to deal with this problem the world can shift to using Virtual Fitting rooms which enables them to try the clothes without putting them on. This can result in rapid growth and deal with almost all sort of problem of online cloth shopping. All they need to do is regulate a 3D mannequin which can try the clothes.

In 2019, Miroslaw MOROZ and collaborators [5] conducted a study to examine how individuals from Generation Y (born between 1981 and 1999) engage with Virtual Fit-ting Rooms (VFRs) [22] on PCs and smartphones for assessing clothing items in terms of size, fit, style, and colors. This study compared two types of VFRs: 2D and 3D. The research revealed that participants held mixed opinions about VFRs. The findings indicated that 2D VFRs utilizing augmented reality technology were more prevalent in the market. These 2D VFRs essentially functioned as "virtual mirrors," aiding consumers in making more informed purchasing decisions and reducing the rate of product returns. However, the study also pointed out that "2D overlays" could be relatively intricate, involving complex garment mapping onto the user's body shape. Conversely, "3D mannequins" faced criticism for not fully considering facial features and current hairstyles when presenting clothing options. In summary, the research underscored the diverse views of Generation Y regarding VFRs, with a preference for 2D VFRs due to their practicality and potential to decrease return rates.

Caboni et al.[6] published the journal "Augmented reality in retailing: a review of features, applications and value." The article gives a brief comparison between the MS Kinect and Asus Xtion and enriches the details for adopting the right methodology for developing the most accurate augmented reality.
The article also discusses the VFR(virtual fitting room) applications [6].

“Virtual Fitting Room Augmented Reality Techniques for e-Commerce”, Pereira et al. [7] This paper primarily focuses on two approaches: "AR with Markers" and "AR with Silhouettes."

Regarding "Augmented Reality with Markers," the paper explains the utilization of physical markers like symbols on paper, which AR applications identify and substitute with virtual objects. This process involves image segmentation, wherein pixel colors are converted into binary values for marker recognition. A digital camera is employed to determine the marker's 3D position and orientation. Subsequently, the marker continuously undergoes replacement with 3D virtual objects, referred to as rendering.

In the case of "Augmented Reality with Silhouettes," real-time images are captured via a digital camera, allowing users to interact with virtual clothing items through gestures, eliminating the need for

traditional input devices. Although specific implementation details are not provided, the paper underscores the significance of real-time image capture and gesture-based interaction.

Throughout the paper, there is an overarching emphasis on the critical role of computer vision in enhancing the accuracy and functionality of AR. The paper underscores how AR effectively addresses challenges associated with online clothing shopping, ultimately elevating the overall e-commerce experience.

The paper, titled "Realistic Virtual Try-On of Clothes using Real-Time Augmented Reality Methods" by Eisert et al. [8] Introduces an innovative approach to augmented reality (AR) for virtual clothing try-outs. This study addresses the challenge of accurately tracking a user's body posture and achieving lifelike, instantaneous rendering of virtual clothing. It distinguishes itself from traditional 3D geometric models by harnessing in-formation derived from the original video source. The paper underscores methods like dynamic texture overlay, item segmentation, and estimation of surface deformation, all of which contribute to obtaining authentic-looking outcomes. Notably, the optimization process, incorporating equations related to brightness constancy and pixel-wise errors, plays a pivotal role in precisely monitoring clothing deformations. Their approach to representing clothing using images combines geometric and image data, allowing for realistic rendering. Furthermore, the research explores the potential for fostering social engagement and remote feedback within virtual try-on systems. In summary, this paper offers valuable insights into the utilization of AR within the fashion sector, potentially revolutionizing the online clothing shopping experience and interactive dressing room simulations [8].

The paper titled "Augmented Reality-Based Virtual Dressing Room Using Unity3D" by Dias et al. [9] It centers on tackling the difficulties of online clothing shopping by introducing an Augmented Reality (AR) virtual fitting room. The core concept involves utilizing AR technology to allow users to scan their measurements, virtually experiment with various clothing styles, and visualize how these outfits would appear on them. This innovation aims to enrich the online shopping experience, mitigate issues related to sizing, and reduce the frequency of product returns. The paper underscores the limitations of conventional online apparel shopping, underscoring the necessity for a solution like the proposed AR virtual fitting room. It elaborates on the system's architecture, which relies on AR Kit for body tracking and motion capture on iOS devices and offers a sneak peek of the user interface through visual representations. Additionally, the pa-per hints at potential future enhancements like recommendation systems and compatibility with Android devices. In summary, the paper introduces an inventive approach to enhance the clothing shopping experience by amalgamating technology and fashion [9].

In 2020, Rushikesh Kore and a team of researchers [10] introduced a novel "Virtual Clothes Fitting Application" designed to enhance the online shopping experience using Augmented Reality (AR). This system relies on marker-based AR technology, where users hold a marker in one hand, typically in the form of a QR code or a link. This marker serves as a reference point that is then replaced by a virtual garment model. Through AR superimposition, a 3D representation of the clothing is placed onto the user's body, allowing them to visualize how it would look. The system's implementation is executed using Unity, incorporating essential AR Core features like Motion Tracking and light estimation.

Vuforia is utilized for Android devices to enable this functionality. Additionally, the authors implemented garment modeling, which uses a single image as a reference; how-ever, the accuracy of this modeling is contingent on the quality of the uploaded garment image [10].

3 Methodology

Pose estimation involves the use of computer vision [11] to identify human figures in images and videos, such as pinpointing the position of a person's knee in a photograph. The algorithm for pose estimation can determine the precise locations of key body joints within a given photo or in real-time video footage. This aspect of the project is of paramount significance and relies extensively on PoseNet [15].

ResNet-50 [12], denoted by the "50" in its name, is a convolutional neural network known as a residual network. It's characterized by its substantial number of nodes and layers. ResNet addresses this issue by employing skip connections, which allow information to flow through layers, empowering data scientists to construct more intricate networks. These skip connections enable the network to grasp global features effectively.

Posenet 2.0, when implemented on TensorFlow.js [13], is compatible with standard phones and desktops equipped with an internet connection and a decent webcam. It operates by taking RGB input from the camera and inputting it into a convolutional neural network [14]. The algorithm then computes the following:
List of Key points: Key points consist of both a position and a confidence key.

Pose Confidence Score: This score falls within the range of 0 to 1.

Confidence Key: Ranging from 0 to 1, this metric describes the accuracy level of a specific key point.

Position: These are the 2D X and Y coordinates in the original image where the key point is recognized.
In addition to the RGB input feed, Posenet also considers the following parameters:

Image Scale Factor: This value can vary between 0.2 to 1.0 and defaults to 0.5. The scale factor is used to resize the media before processing. A scale factor of 0.5 correspond to the original size, values below 0.5 reduce the scale, and values above 0.5 increase it.

Horizontal Flip: This parameter is either set to 1 or 0, with a default of 0. It flips the media horizontally before processing.

Output Stride: The value can be 32, 16, or 8, and it defaults to 8. Output stride affects the dimensions of layers in the neural network, which in turn impacts both accuracy and speed. A higher value results in faster processing but reduced accuracy, while lower values yield slower processing but improved accuracy.

For our real-time clothing animation, we opted for the three.js library. Our choice was driven by the need for a solution that strikes a balance between performance and the smooth, fluid animation and overlay of clothes. Additionally, it had to support point-based reverse kinematics effectively. The three.js JavaScript library [16] proved to be an ideal fit for our specific requirements.

Figure 1, titled "Automatic Hierarchical Classification of Kelps Using Deep Residual Features," likely depicts the methodology for automatically categorizing kelps based on deep residual features. This process involves steps such as data preprocessing, feature extraction via deep residual networks, and hierarchical classification techniques.

Likewise, Figure 2, titled "Methodology of Proposed Study," outlines the steps for conducting a research study. This includes research design, data collection methods, analysis techniques, and other relevant procedures.

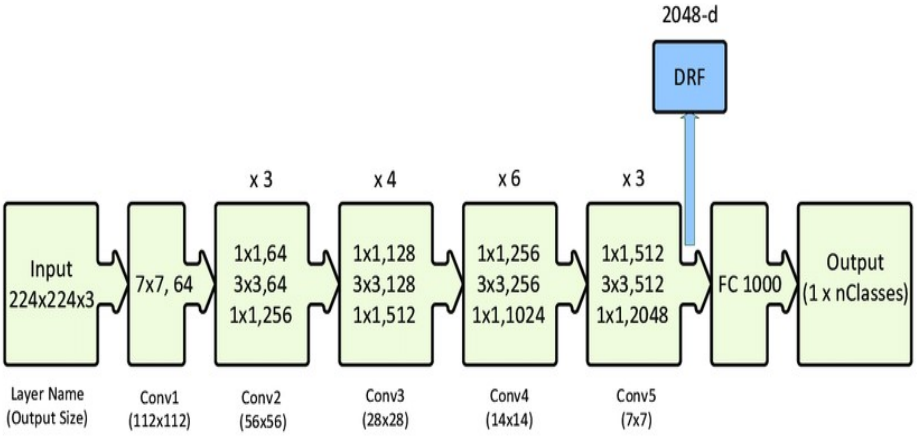

Figure 1. Automatic Hierarchical Classification of Kelps Using Deep Residual Features. Sensors

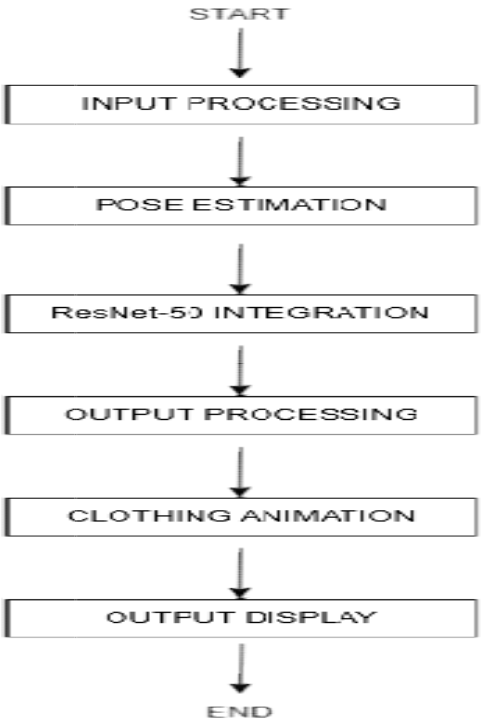

Figure 2. Methodology of Proposed Study

4 Result

The integration of MS Kinect and ASUS Xtion (Pro-Live version) within the virtual wardrobe application offers promising results. Leveraging the relevant characteristics outlined in Table I, such as high-resolution depth sensing and advanced tracking capabilities, these devices facilitate a seamless and immersive user experience. Figure 3 exemplifies the practical application of the "Virtually Shirt Put on" feature within the application. This functionality utilizes the capabilities of MS Kinect or ASUS Xtion to accurately track the user's body movements and overlay virtual garments in real-time. Consequently, users can visually assess how different clothing items fit and appear on their body without physically trying them on. The amalgamation of hardware and software implementation yields a user-friendly interface that enhances the virtual wardrobe experience. Users can effortlessly navigate through clothing options, select desired garments, and promptly preview them using augmented reality technology. This not only streamlines the shopping process but also delivers a more personalized and engaging shopping encounter for users. In essence, the effective integration of MS Kinect and ASUS Xtion within the virtual wardrobe application underscores the potential of augmented reality in transforming the fashion industry. By bridging the gap between online and offline shopping experiences, this technology introduces novel opportunities for retailers and consumers alike, paving the way for a more immersive and interactive shopping landscape.

Figure 3. Virtually Shirt Put on feature using application

Table 1. MS kinect and ASUS xtion (pro-live version) have pertinent characteristics.

Specification	Microsoft Kinect	Asus Xtion Pro-live
Field of view	57°H, 43°V	58°H,45°V
Sensors	RGB & Depth	RGB & Depth
Depth Range	1.2m – 3.5m	0.8m – 3.5m
Depth Steam	QVGA (320X240) 16-bit @ 30 fps	VGA (640x480) @30 fps
RGBStream	VGA (640x480)32-bit @ 30fps	SXGA(1280*1024) @ 30fps
Microphones	3(left)+1(right)	2mikesforstereocapture
PowerSupply	12VDC+5VUSBconnection	5V USBconnection
OSSupport	Win732/64	Win32/64:XP, Win7, Linux Ubuntu 10.10: X86,32/64 bit
Dimensions/Weight	12”x2.5”at3.0 lb	7”x2”x1.5”at0.5lb

5 Discussion

A highly interactive and cross-platform clothing fitting web application can be developed using freely available JavaScript libraries. One such library is PoseNet, which is part of TensorFlow.js, and it offers an accurate and efficient convolutional neural net-work (CNN) [17] for estimating the user's position and pose. This information is then utilized in combination with the three.js library to animate a 3D VRM model [21] of clothing, ensuring it aligns with the user's pose as determined by PoseNet.

Our team has conducted successful testing of an early functional prototype. This prototype includes a responsive fashion e-commerce frontend that allows virtual try-on. It achieves this by overlaying clothing items onto the user's image, with PoseNet 2.0 handling the clothes positioning.

We are currently focused on enhancing our application by integrating cloud-based solutions to improve frame rates and accessibility, particularly on mobile devices and lower-end hardware. Additionally, we are actively addressing depth-related issues that occasionally lead to misalignment between the user's body and the overlaid outfit. Finally, we are working diligently to enhance the realism of our 3D models to seamlessly blend with the user's indoor environment.

References

[1] Samad, Rosdiyana& Yan, Law & Mustafa, Mahfuzah & Abdullah, Nor Rul Hasma&Pebrianti, Dwi. (2018). Multiple Human Body Postures Detection using Kinect. Indonesian Journal of Electrical Engineering and ComputerScience.10.528-536. 10.11591/ijeecs.v10.i2.pp528-536.

[2] Virtual Mirror: The Future of Interaction (https://medium.com/hackernoon/virtual-mirror- thefuture-of-interaction-95755b0d3d60)

[3] Patil, P., Kamble, P., Patil, S., Patil, P., Gavade, S. S., & Patil, A. (2023). Clothes Fitting Web Application Using Augmented Reality OrThree.Js&Posenet. International Journal of Creative Research Thoughts (IJCRT), 11

[4] Miroslav Moroz, Tendency to Use the Virtual Fitting Room in Generation Y - Results of Qualitative Study,(Wroclaw University of Economics, Wroclaw, POLAND miroslaw.moroz@ue.wroc.pl)

[5] Virtual Clothes Fitting Application Based On Augmented Reality For Online Retailers, 2020.

[6] Wearfits, 2019. Demo Fitting Room. [online] Available at: https://demo-new.wearfits.com/#

[7] Caboni, Federica, and Johan Hagberg. "Augmented reality in retailing: a review of features, applications and value." International Journal of Retail & Distribution Management 47.11 (2019): 1125-1140.

[8] Pereira, F., Silva, C., Alves, M. (2011). Virtual Fitting Room Augmented Reality Techniques for e-Commerce. In: Cruz-Cunha, M.M., Varajão, J., Powell, P., Martinho, R. (eds) ENTERprise Information Systems. CENTERIS 2011. Communications in Computer and Information Science, vol 220. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-642-24355-4_7.

[9] Eisert, P., &Hilsmann, A. (2011). Realistic Virtual Try-On of Clothes using Real-Time Augmented Reality Methods. IEEE COMSOC MMTC E-Letter, 6(8).

[10] Dias, Jessica and Chouhan, Divya and Churi, Preshit and Parab, Pranay, Augmented Reality Based Virtual Dressing Room Using Unity3D (April 8, 2022). Available at SSRN: https://ssrn.com/abstract=4111818 or http://dx.doi.org/10.2139/ssrn.4111818

[11] Nanning Zheng , George Loizou , Xiaoyi Jiang , Xuguang Lan &Xuelong Li (2007) Computer vision and pattern recognition, International Journal of Computer Mathematics, 84:9, 1265-1266, DOI: 10.1080/00207160701303912

[12] Koonce, B. (2021). ResNet 50. In: Convolutional Neural Networks with Swift for Tensorflow. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-6168-2_6

[13] Gerard, C. (2021). TensorFlow.js. In: Practical Machine Learning in JavaScript. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4842-6418-8_2

[14] S. Albawi, T. A. Mohammed and S. Al-Zawi, "Understanding of a convolutional neural network," 2017 International Conference on Engineering and Technology (ICET), Antalya, Turkey, 2017, pp. 1-6, doi: 10.1109/ICEngTechnol.2017.8308186.
[15] Yu Chen, Chunhua Shen, Xiu-Shen Wei, Lingqiao Liu, Jian Yang; Proceedings of the IEEE International Conference on Computer Vision (ICCV), 2017, pp. 1212-1221
[16] Danchilla, B. (2012). Three.js Framework. In: Beginning WebGL for HTML5. Apress, Berkeley, CA. https://doi.org/10.1007/978-1-4302-3997-0_7.
[17] Wu, Jianxin. "Introduction to convolutional neural networks." National Key Lab for Novel Software Technology. Nanjing University. China 5.23 (2017): 495.
[18] Shin, Dongjoe, and Yu Chen. "3D garment digitisation for virtual wardrobe using a commodity depth sensor." Proceedings of the IEEE International Conference on Computer Vision Workshops. 2017.
[19] Bichlmeier, Christoph, et al. "The virtual mirror: a new interaction paradigm for augmented reality environments." IEEE Transactions on Medical Imaging 28.9 (2009): 1498-1510.
[20] Packer, Charles, Julian McAuley, and Arnau Ramisa. "Visually-aware personalized recommendation using interpretable image representations." arXiv preprint arXiv:1806.09820 (2018).
[21] Li, Y. L., et al. "Enhancing power distribution system through 3D integrated models, optimized designs, and switching VRM model." 2000 Proceedings. 50th Electronic Components and Technology Conference (Cat. No. 00CH37070). IEEE, 2000.
[22] Erra, Ugo, Giuseppe Scanniello, and Valerio Colonnese. "Exploring the effectiveness of an augmented reality dressing room." Multimedia Tools and Applications 77 (2018): 25077-25107.