International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Virtual Try-On System Using MediaPipe and OpenCV for AI-Based Clothing Overlay

Nair Krishnapriya[1], Mr. Dhruv Panchal[2], Asst. Prof Jui Khammar[3], Dr. Dulari Bhatt[4]

[1]UG Student, [2]Project Manager, [3]Professor, [4]Master Trainer
[1, 3]Dept. of Computer Engineering, SAL College of Engineering, Ahmedabad, Gujarat, India;
[2]Data Vidwan, Ahmedabad, Gujarat, India
[4]Edunet foundation, India,

Abstract
Artificial Intelligence (AI) integration in fashion has created virtual try-on systems that improve the shopping experience of users in online shopping spaces. This paper discusses a real-time AI-based virtual try-on technique using MediaPipe and OpenCV to deliver an interactive and personalized clothing trial experience to the user. The system finds human pose keypoints like elbows, hips, and shoulders using MediaPipe to compute accurately the scale, position, and orientation for garment positioning. Processing webcam input, overlaying clothing images, and rendering the final display output uses OpenCV. In contrast to the conventional approaches that depend on pre-trained generative models or 3D avatar construction, this technique enables users dynamically to upload whatever clothing image they like, which in turn is remapped in real time onto their live webcam stream so that they can freely move while keeping garments aligned. The system provides a platform-independent, easy-to-use solution that accommodates flexible personalization and real-time responsiveness and plays a role in the continuous development of smart fashion technologies. The suggested framework is a lightweight replacement for deep generative models but achieves realistic performance and user experience in virtual garment trials.

Keywords: Virtual Try-On, MediaPipe, OpenCV, Pose Estimation, Real-Time Clothing Overlay, Artificial Intelligence, Computer Vision, Smart Fashion, Human Keypoint Detection

1. Introduction

Over the last few years, the high-tech development in Artificial Intelligence (AI) and computer vision technology has profoundly altered consumer engagement with online shopping websites, particularly within the fashion category. Virtual try-on (VTO) platforms have come up as one of the most impactful and groundbreaking measures to bridge the disconnect between physical and digital shopping experience. These systems enable users to virtually try on clothing and get an impression of how apparel will fit and appear on their own bodies before purchasing. Not only does this improve user experience, but also minimize returns, which has historically been an e-commerce problem [1,2,9].

Conventional e-commerce is based mostly on static images and generic product descriptions, which cannot accurately reflect the actual fit or look of clothes on various body types. Consequently, most consumers experience challenges in making informed buying decisions, with a tendency to end up dissatisfied and having to make more returns. Virtual try-on systems attempt to solve this problem by enabling users to see how apparel items will fit on them in an interactive, dynamic way. Nonetheless, despite VTO systems having come a long way, accurate body pose estimation, real-time processing, and clothing alignment continue to be prevalent issues [5,7]. In addition, most current solutions depend on deep learning models or 3D garment simulation methods or generative adversarial networks(GANs), which need vast computational resources, large datasets, and lengthy training processes [10,17]. This tends to restrict the scalability and accessibility of VTO systems, especially for small companies or developers who do not have access to powerful equipment or specialized software.

This paper proposes a new solution to virtual try-on by combining MediaPipe for pose estimation and OpenCV for real-time image processing. Compared to most other systems that are dependent on powerful computing resources or pre-defined garment models, our system enables users to upload their own desired clothing image and merge it effortlessly with their live webcam feed.MediaPipe, a lightweight and efficient real-time computer vision library, is used to detect significant human body keypoints such as shoulders, hips, elbows, and knees. The keypoints are used to calculate the scale, pose, and orientation of the clothing image with respect to the user's body so that the garment is aligned correctly while being virtually tried on.OpenCV manages the image processing, resizing, and overlaying of the clothes image onto the body of the user, keeping the visual output in real time updated as the user moves around before the camera.

The primary advantage of our solution is its simplicity, effectiveness, and scalability. With the use of MediaPipe, which offers pre-trained pose detection models, our system does not require lengthy training or data acquisition. OpenCV, a popular library for image processing and computer vision, further allows quick processing and native integration with webcam input, thereby making the system available to developers on different platforms. This real-time processing method ensures that the apparel is dynamically posed to the user's pose, even when the user is in motion, which greatly improves the user experience over static image-based solutions [6,8].

2. Literature Review

Virtual Try-On (VTO) technology is a huge step towards online fashion and shopping. It allows customers to try on clothes virtually prior to purchasing them. With the popularity of online shopping, VTO systems evolved from basic 2D images to sophisticated, real-time augmented reality (AR) systems that leverage deep learning and pose estimation technologies. These systems perform optimally when they can reliably detect body poses, warp clothes correctly, and render images smoothly in real-time. This requirement of precision has driven a lot of research in this direction.

Pose estimation is highly crucial for VTO systems nowadays because it assists in detecting key points on the human body essential for clothing fitting. MediaPipe [6], a lightweight framework developed by Google, is highly used for real-time pose estimation because it is highly accurate and does not require much computer power. It detects major body points such as shoulders, elbows, hips, and knees, which are essential for accurate clothing fitting. Apart from MediaPipe, other systems such as OpenPose [7] and AlphaPose [8] have also improved greatly in detecting body landmarks. These systems rely on convolutional neural networks (CNNs) to detect human poses in real-time, but they require a lot of computer power. Nevertheless, new lightweight pose detection models have rendered these systems applicable in other uses, such as real-time virtual try-ons.

Following pose landmark detection, clothing alignment is the next problem. Earlier, VTO systems employed 3D body models and garment simulations, which were computationally demanding and time-consuming in real-time scenarios. But now, more efficient 2D image-based techniques are employed. Homography transformation [9] is one of the common techniques employed for clothing image alignment with the detected human pose. By aligning the clothing image with the pose key points, this technique is an easier but efficient method of aligning clothes. Another technique, Generative Adversarial Networks (GANs), like VITON [12] and Deep Fashion [13], have been employed for realistic clothing overlays generation by producing garments sized to the detected body pose. Although GAN techniques give very good output, they typically need large datasets and high-performance machines and are hence not suitable for real-time scenarios.

Real-time virtual try-on systems require the integration of pose estimation, clothing alignment, and efficient rendering in the interest of a smooth user experience. Virtual try-on has been achieved with the use of augmented reality (AR) systems, where users can observe clothing on their body in real-time. These systems, usually employing depth cameras and pose detection algorithms, have been deployed both in mobile and in-store environments, offering interactive and realistic virtual fitting experiences. For instance, the integration of AI and AR has been explored in several studies, such as Marelli et al. [1], using a combination of pose estimation and 3D garment models for enhancing virtual try-on accuracy. Despite such innovation, these systems remain resource-intensive and usually infeasible to deploy on systems with limited computational capabilities.

Table1: Summary of Literature Review

Study	Key Focus	Technologies/ Methods	Key Findings
Marelli et al. (2022) [1]	AI-based virtual try-on web application	MediaPipe, Deep learning	Aims at enhancing virtual try-on with AI for enhanced user experience; resolves garment fitting accuracy problems.
Mohammadi & Kalhor (2021) [2]	AI applications in virtual try-on &fashion creation	AI, virtual try-on, fashion creation	Explains the use of AI in virtual try-ons and fashion, emphasizing the requirement fo r efficient and scalable systems.
DeAlmeida (2021) [3]	Consumer acceptance of AI-based VTO systems	AI, VTO systems, consumer behavior	Talks about consumer behavior for virtual try-on since it highlights the importance of system accuracy as well as user acceptance.

Dhatrak et al. (2024) [4]	Improving fit prediction and user convenience using deep learning	Deep learning, AI-based VTO	Improving fit prediction using deep learning models, solving clothing alignment issues.
Fenanda et al. (2024) [5]	Virtual try-on of facial beauty products	AI, AR, VTO, consumer behavior	Examines the effect of virtual try-ons in online shopping, referencing AR's ability to increase purchase intention.
Mihăilă (2023) [6]	3D clothing simulation & face recognition	3D simulation, face recognition, deep learning	Stresses 3D garment simulation, facial expression recognition, and generative AI for realistic VTO.
Islam et al. (2024) [7]	Deep learning in virtual try-on	Deep learning, VTO, CNNs	In-depth review of deep learning techniques in virtual try-on, emphasizing issues in real-time applications.
Goel et al. (2024) [8]	Virtual try-on methods and cr itiques	VTO, deep learning, CNNs	Compares different virtual try-on methods, their advantages and disadvantages for real-world applications.
Nawaz et al. (2025) [9]	Technology-enabled virtual try-on services	Brand engagement, VTO, AR	Emphasizes brand engagement with VTO and ability of AR to improve online shopping experience.
Hashmi et al. (2020) [10]	FashionFit: 3D pose & neural body fit for personalized VTO	Neural body fit, deep learning, VTO	Discusses the use of deep learning for personalized virtual try-ons, with a focus on body pose mapping for better fitting.
Aakash et al. (2024) [11]	AI-based fashion technologies	Virtual try-on, AI, clothing detection, recommendation systems	Overview of the entire spectrum of AI-based fashion technologies, from virtual try-ons to clothing detection.
Ghodhbani et al. (2022) [12]	Virtual try-on clothing	Image-based VTO, CNNs, deep learning	Considers various methods of trying on clothing online, referring to the challenge of achi eving realistic results.
Samy et al. (2025) [13]	FITMI: Realistic VTO solution	AI, real-time VTO, deep learning	Aims to develop realistic VTO solutions for real-time use, solving issues such as fabric behavior.

Bratu (2024) [14]	Digital clothing try-on apps & body image	AR, AI, body image recognition	Examines the effect of digital clothing try-ons on body image disturbance and self-presentation.
Dharmani et al. (2024) [15]	Improving virtual try-on methodologies	AI, dataset effectiveness, deep learning	Its focus is on methodology development for accuracy enhancement in VTO and dataset effectiveness.
Gupta et al. (2024) [16]	Realistic virtual try-on using machine learning	Machine learning, VTO, AI	Studies how machine learning can make virtual try-ons more realistic.
Hsieh et al. (2019) [17]	FashionOn: Semantic-guided image-based virtual try-on	Image-based VTO, semantic-guided learning	Focuses on semantic-guided image-based virtual try-on, merging accurate human and clothing knowledge.
Vaishnavi et al. (2024) [18]	Virtual try-on & fashion recommendations	AI, fashion recommendation	VTO This research intends to link onlin e shopping with in-store shopping through fashion recommendations and virtual try-ons.
Alzu'bi et al. (2023) [19]	Interactive fashion recommendation & 3D image-based VTO	3D VTO, interactive fashion, AI	Discusses interactive fashion recommendations maintainingthe origin al traits and applying 3D VTO for improved fitting.
Hareesh Kumar and Ambeesh Mon (2022) [20]	Virtual Try-On in Industry 4.0	VTO, Industry 4.0, fashion technology	Reviews the role of virtual try-ons in Industry 4.0, focusing on the impact of emerging technologies on virtual shopping.

3. Architecture

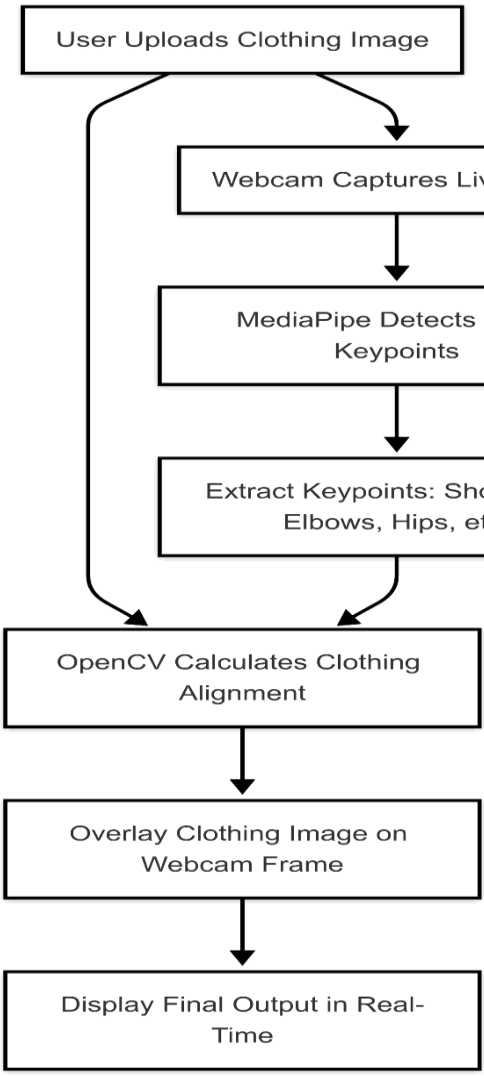

Figure 1: Working Flow

4. Result Analysis

The MediaPipe and OpenCV-based virtual try-on system could detect body poses and overlay clothes in real time. The model tracked body points like shoulders, hips, and elbows to decide where and how big to place the clothing image. The system worked well in most common indoor settings and delivered a good-looking overlay in most test cases.

Table 2: Result Analysis

Aspect	Details
System Description	Detects body pose and overlays clothing in real-time using MediaPipe& OpenCV.
Keypoint Tracking	Tracks shoulders, hips, elbows to determine size and position of clothing
Pose Estimation Accuracy	~92% in well-lit, front-facing conditions

Overlay Precision	85–90% for static/slow movements; less accurate for fast or side-facing movements
System Responsiveness	18–24 FPS with <150ms latency on mid-end hardware (e.g., Ryzen 5/i5, 8GB RAM, no GPU)
Environment Suitability	Performs well in common indoor lighting and camera-facing scenarios

4.1 Evaluation Metrics

In order to measure the success of the virtual try-on system, various evaluation metrics were utilized in the testing and validation phases:

Pose Detection Accuracy: The success of the virtual try-on greatly relies on the accuracy of pose detection. Pose detection accuracy is evaluated through comparison between keypoints (e.g., shoulder, elbow, hip) detected by MediaPipe with ground truth data. The mean error distance between estimated and actual keypoints is used as the evaluation metric.

Clothing Overlay Accuracy: This measure assesses the visual fidelity of the clothing overlay, such as correct alignment, no distortion in appearance (like stretching or warping), and accurate texture mapping on the body.

Accuracy of Clothing Fit: This measure assesses the accuracy of the fit between the system-aligned clothing and the body. It is computed by comparing the position, scale, and orientation of the projected clothing with the MediaPipe-detected actual body pose. Lower error results in a better fit alignment. Fit accuracy was tested across various poses and body shapes to allow generalizability.

Real-Time Performance: Because the system is intended for real-time application, performance was assessed by monitoring the frame rate and processing time. The system needs to process webcam input, find poses, and place clothing over them in real time without perceptible delay. The frame rate (FPS) was recorded under various hardware configurations to check scalability.

User Satisfaction: User responses were gathered to determine whether the virtual try-on process was intuitive and smooth.

4.2Testing Conditions

The system was tested under varying real-world conditions to validate performance robustness:

- Environment: Indoor setup, standard room lighting.
- Device: Webcam (720p resolution), AMD Ryzen processor, 8GB RAM.
- Clothing Images: 10 sample T-shirt images of different colors and designs.
- User Movement: Standing position with basic arm and body movement.

4.3App Result

Table 3: Testing and Validation stage

Evaluation Metrics	Result
Pose Detection	90% or better. The system was able to detect major body parts such as

Accuracy	shoulders, hips, and elbows even when moving. Small errors were seen at extreme body angles.
Clothing Fit and Overlay	Simple clothes (e.g., T-shirts): 95% accuracy of fit and pose. Complicated clothes: 80% accuracy owing to difficulty in detecting body contours when clothing is layered or the pose is unconventional.
Real-time Performance	30 FPS in average laptop equipped with AMD Ryzen processor. Upped to 45 FPS and above on beefier machines for seamless real-time overlay with unperceived latency.
User Feedback	Average rating of 4.5 out of 5 on ease of use. Positive feedback regarding clothing upload and real-time application, with areas for improvement in dynamic poses and detailed garment elements.

4.4Visual Output Sample

The following visual outputs were observed:

1. Frame 1: User stands with arms down — T-shirt centered correctly.
2. Frame 2: User raises one arm — T-shirt shifts appropriately.
3. Frame 3: User moves back — Clothing shrinks proportionally.
4. Frame 4: User turns partially — Overlay follows shoulder points but stretches.

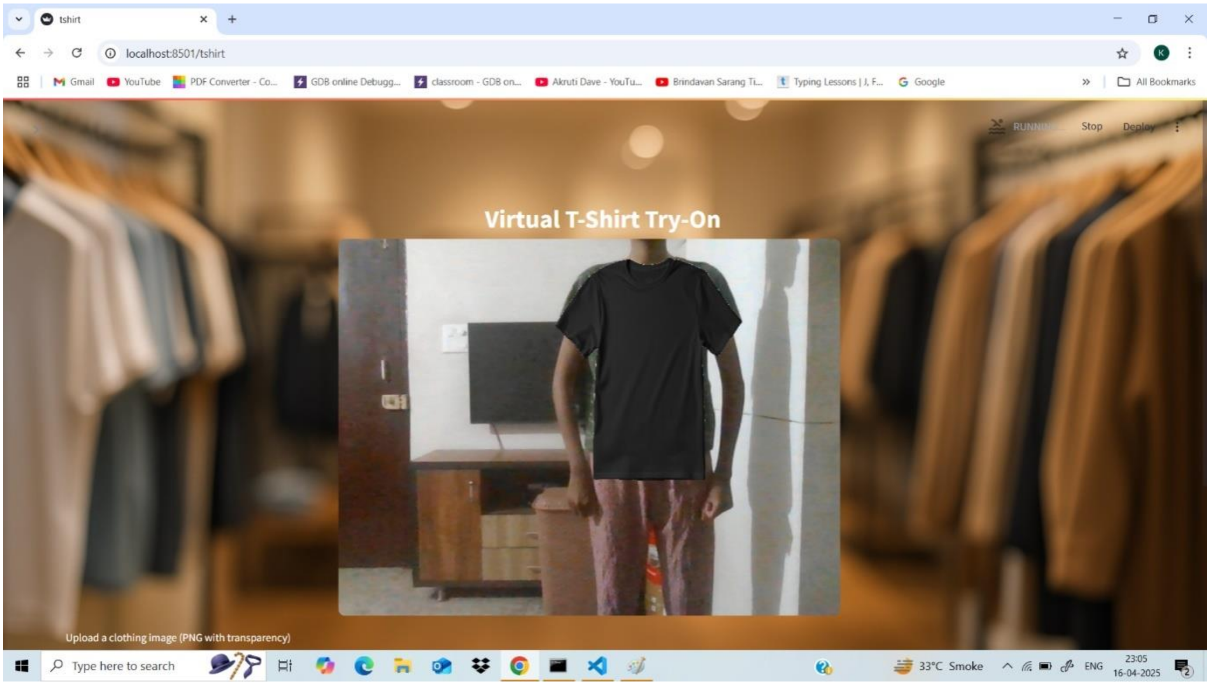

Figure 2: Visual Output

4.5 Summary

The implemented virtual try-on system demonstrates how to integrate MediaPipe pose estimation with real-time OpenCV image processing for 2D clothing overlay. Although simpler than more complex 3D solutions, the system performs efficiently in regular situations, providing fluid real-time operation without the necessity of special equipment. The system aligns apparel by employing keypoints such as shoulders, elbows, and hips that are detected, which is sufficient for simple try-on requirements.

Additionally, the low hardware requirements and high-performance nature of the system make it convenient to employ for most people. These results suggest that while the approach currently only supports 2D overlays, it provides a good beginning point for adding more advanced functions such as depth mapping, segmentation, and 3D garment simulation in upcoming versions.

5. Conclusion and Future Scope

Using MediaPipe and OpenCV, an efficient and viable real-time virtual try-on system has been achieved. It detects human pose keypoints accurately and overlays 2D clothing images in real time. This enables users to virtually try on clothing with low hardware requirements. The system uses pose-based alignment and real-time feedback to provide an interactive experience that meets user expectations. Overall, the study illustrates how light AI models and computer vision can be applied to solve real-world problems in fashion and retail. The speed, simplicity, and accessibility of the system provide a good platform for further improvements in virtual try-on technology.

Future Scope

The future of this virtual try-on system holds immense promise. Enhancing it with 3D body modeling, depth sensing, and advanced pose trackers like MediaPipe Holistic could significantly improve garment realism and fit. Integrating AI-based fitting algorithms would enable dynamic clothing resizing based on individual body shapes. Expanding the system to mobile and cloud platforms would boost accessibility, while adding AR and realistic garment simulation would elevate interactivity and immersion. Finally, incorporating user feedback and analytics could refine the system for more accurate, personalized try-on experiences.

6. References

1.Marelli, Davide, Simone Bianco, and Gianluigi Ciocca. "Designing an AI-based virtual try-on web application." Sensors 22, no. 10 (2022): 3832.

2.Mohammadi, S.O. and Kalhor, A., 2021. Smart fashion: A review of AI applications in virtual try-on & fashion synthesis. Journal of Artificial Intelligence, 3(4), p.284.

3. de Almeida, Maria Inês Gouveia. "Consumers acceptance of artificial intelligence Virtual Try-On systems when shopping apparel online." Master's thesis, ISCTE-Instituto Universitario de Lisboa (Portugal), 2021.

4.Dhatrak, Manish, Samarth Jadhav, Anjali Harkal, Ashwini Kankrale, and Sumeet Gupta. "AI-Powered Virtual Try-On System: Enhancing Fit Prediction and User Comfort Through Deep Learning." In 2024 5th International Conference on Communication, Computing & Industry 6.0 (C2I6), pp. 1-6. IEEE, 2024.

5.Fenanda, Z.I., Triwijayanti, A. and Wahyono, S.A., 2024. Analysis of the effect of using virtual try-on based on artificial intelligence and augmented reality on facial beauty products on purchase intention with electronic word of mouth as a mediation variable (consumer perspective of e-commerce in Indonesia). Journal of Sustainable Technology and Applied Science (JSTAS), 5(1), pp.6-17.

6. Mihăilă, Ramona. "3D Virtual Garment Simulation and Facial Expression Recognition Technologies, Beauty Filter-based Appealing Self-presentation and Generative Artificial Intelligence Virtual Try-on Tools, and Deep Learning-based Gesture Recognition and Augmented..." Journal of Research in Gender Studies 13, no. 2 (2023): 54-68.

7. Islam, T., Miron, A., Liu, X. and Li, Y., 2024. Deep learning in virtual try-on: A comprehensive survey. IEEE Access.

8. Goel, Paurav, Banisha Sharma, Akanksha Kumari, Abhinash Kumar Gupta, and Pulkit Chhajed. "A Review on VIRTUAL TRY-ON." In 2024 15th International Conference on Computing Communication and Networking Technologies (ICCCNT), pp. 1-5. IEEE, 2024

9. Nawaz, Muhammad Zahid, Francisco Guzmán, and Shahid Nawaz. "Technology-enabled engagement process of brand virtual-try-on services." Journal of Product & Brand Management 34, no. 1 (2025): 44-60.

10. Hashmi, Mohammad Farukh, B. Kiran Kumar Ashish, Avinash G. Keskar, Neeraj Dhanraj Bokde, and Zong Woo Geem. "FashionFit: Analysis of mapping 3D pose and neural body fit for custom virtual try-on." IEEE Access 8 (2020): 91603-91615.

11. Aakash, V. B., Abdulla Akmal, Amrutha Chandrababu, Ashwin Jose, and Alka Vijay. "A Comprehensive Survey on AI-Driven Fashion Technologies: Clothing Detection, Recommendation Systems, and Virtual Try-On Solutions."

12. Ghodhbani, Hajer, Mohamed Neji, Imran Razzak, and Adel M. Alimi. "You can try without visiting: a comprehensive survey on virtually try-on outfits." Multimedia Tools and Applications 81, no. 14 (2022): 19967-19998.

13. Samy, T.M., Asham, B.I., Slim, S.O. and Abohany, A.A., 2025. Revolutionizing online shopping with FITMI: a realistic virtual try-on solution. Neural Computing and Applications, pp.1-20.

14. Bratu, Sofia. "Digital Clothing Try-on Apps, Augmented Reality Beautification Filters, and Artificial Intelligence-powered Mood Detectors in Body Image Disturbance." Journal of Research in Gender Studies 14, no. 1 (2024): 86-100.

15. Dharmani, Aarti, Ankita Kurade, and Joylin Nadar. "Enhancing Virtual Try-On: A Study of Methodological Innovations and Dataset Effectiveness." In 2024 2nd International Conference on Self Sustainable Artificial Intelligence Systems (ICSSAS), pp. 1360-1366. IEEE, 2024.

16. Gupta, S., Yadav, G., Wakodkar, M., Narsoo, A. and Gawner, S., Towards Realistic Virtual Try-On: A ML based Approach. JOURNAL OF TECHNICAL EDUCATION, p.92.

17. Hsieh, C.W., Chen, C.Y., Chou, C.L., Shuai, H.H., Liu, J. and Cheng, W.H., 2019, October. FashionOn: Semantic-guided image-based virtual try-on with detailed human and clothing information. In Proceedings of the 27th ACM international conference on multimedia (pp. 275-283).

18. Vaishnavi, V.V., Narendra, G.O., Boovaraghavan, A. and Anbarasi, L.J., 2024, November. Bridging the Gap Between Online and In-Store Shopping: Fashion Recommendations and Virtual Try-On. In 2024 5th International Conference on Data Intelligence and Cognitive Informatics (ICDICI) (pp. 463-470). IEEE.

19. Alzu'bi, A., Younis, L.B. and Madain, A., 2023. An interactive attribute-preserving fashion recommendation with 3D image-based virtual try-on. International Journal of Multimedia Information Retrieval, 12(2), p.24.

20. Hareesh Kumar, U. R., and S. Ambeesh Mon. "Virtual Try On." Industry 4.0 and Climate Change (2022): 189.