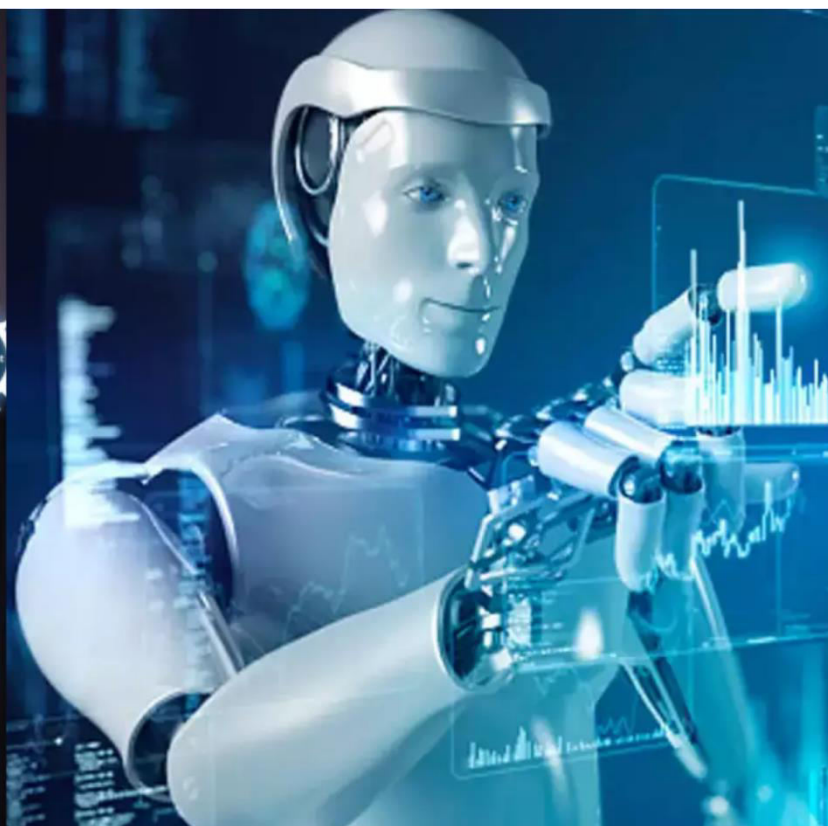




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A Review on Stylevision: Intelligent 3D Virtual Fashion and Clothing Simulation System

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ABSTRACT: The growing popularity of online fashion retail has shifted consumer behavior from physical store-based shopping to digital purchasing platforms. However, the inability to physically try on garments before purchase remains a major limitation in online shopping. This leads to uncertainty in size, fit, color matching, and styling, which increases product returns and reduces customer satisfaction. To address this problem, STYLEVISION is presented as an intelligent 3D virtual clothing simulation system that enables users to visualize selected garments directly on their real body image or live camera view. Unlike traditional virtual try-on methods that depend on 3D avatars, STYLEVISION performs direct human body pose estimation, segmentation, and dimension detection to achieve accurate garment overlay and realistic fitting. Additionally, the system performs color theory-based outfit matching and body shape analysis to recommend the most suitable clothing styles. The implementation leverages deep learning-based segmentation models, generative models for garment warping, and an interactive AR-based preview interface. Experimental results demonstrate enhanced realism of garment fitting, improved decision-making confidence, and reduced likelihood of product returns in fashion e-commerce environments.

The rapid advancement of augmented reality and computer vision technologies has transformed the retail clothing experience. Traditional online shopping lacks the physical try-on experience, leading to uncertainty in size, style, and fit. STYLEVISION is an intelligent 3D virtual fashion try-on system that allows users to visualize selected garments on their body either through live camera feed or uploaded images. Instead of relying on generic 3D avatars, the system performs human pose estimation, body segmentation, and dimensional measurement to accurately overlay garments on real human images. The system adapts clothing shape, drape, and scale using AI-based fitting and warping algorithms. Additionally, it performs body shape recognition and color analysis to suggest personalized clothing recommendations. This reduces return rates, enhances customer confidence, and improves user engagement in online fashion platforms.

KEYWORDS: Virtual Try-On, Deep Learning, Pose Estimation, Augmented Reality, Body Segmentation, Computer Vision, Fashion Technology, Recommender System.

I. INTRODUCTION

Online fashion shopping has grown significantly, but customers still face difficulties in determining how garments will look and fit on their bodies. This results in dissatisfaction and high return rates. Physical try-on options are limited and time-consuming. Recent advancements in deep learning, AR, and human pose estimation enable seamless virtual clothing visualization without physical trials. The proposed system, STYLEVISION, enhances user experience by allowing them to virtually try on clothes in real-time or through uploaded images. The system accurately identifies body contours, posture, and proportions, adjusts the garment accordingly, and provides intelligent clothing style recommendations. The aim is to bridge the gap between physical and digital fashion experiences, increase purchase confidence, and support personalized fashion styling.

The digital transformation of the fashion industry has led to the widespread use of e-commerce platforms for apparel shopping. Although online platforms offer convenience and accessibility, customers often struggle with selecting suitable clothing due to the absence of a physical try-on experience. This uncertainty leads to hesitation, dissatisfaction, and high

product return rates. Factors such as incorrect size selection, mismatch in fitting, and unrealistic product images further complicate the online shopping process.

Advances in computer vision and augmented reality have made it possible to simulate real-world clothing try-on experiences digitally. Traditional systems generally rely on 3D mannequin models or static human templates, which do not accurately represent the individual user's body shape or pose. As a result, the fit and appearance of garments appear unrealistic, reducing trust in the virtual try-on feature.

To solve these limitations, the proposed system STYLEVISION utilizes deep learning-based body recognition, segmentation, and measurement extraction to accurately map garments onto the user's body. The user either uploads an image or uses the live camera interface. The system then performs pose key-point detection (e.g., using OpenPose or MediaPipe), extracts body segmentation masks, and measures relative proportions. After selecting a garment, the Fit & Warp engine dynamically reshapes and adjusts clothing contours using advanced warping algorithms and texture preservation models.

Fashion retail has evolved rapidly due to the convenience and accessibility of online shopping platforms. However, customers still struggle to evaluate how clothing will appear and fit on their body when viewed only through model images or size charts. Human bodies vary significantly in shape, proportion, posture, and color undertones, making it difficult to choose clothing that looks and feels right without physically trying it on. In traditional shopping, a consumer can try multiple outfits before making a purchase, but this level of interaction is missing online.

With the advancement of machine learning, augmented reality, and computer vision, it is now possible to create virtual try-on systems that simulate how a garment would look on an individual. However, many existing systems still rely on pre-built avatars or 3D body models that do not match the user's real physical characteristics. This causes unrealistic garment fitting and reduces user trust.

STYLEVISION addresses this need by offering a direct human-body-based virtual clothing simulation without requiring 3D body scanning. By analyzing the user's real posture, silhouette, height-to-width proportions, skin tone, and shoulder-hip ratio, STYLEVISION creates a realistic and dynamic virtual try-on environment. The system also enhances personalization by recommending clothing based on body shape aesthetics, color compatibility, and fashion preferences.

The result is a system that not only shows how clothing would visually appear but also assists users in making confident and stylistically informed purchase decisions. The proposed system, STYLEVISION, avoids these limitations by performing direct try-on over the user's real image, eliminating the need for 3D avatar creation. Using advanced pose estimation algorithms, the system identifies key body joints and determines body orientation. A segmentation model extracts the user's silhouette from the background. A garment warping model then realigns garment textures and dimensions to match the user's physical shape and posture. The result is a highly realistic try-on visualization that respects natural body proportions.

Objectives-

- Implement real-time 3D clothing simulation with realistic fabric physics.
- Integrate automatic body shape and measurement extraction.
- Build a context-aware recommendation engine (skin tone, occasion, weather).
- Design an intelligent AI stylist that analyzes trends and user preferences.
- Implement an interactive 3D environment for virtual try-on.
- Develop high-fidelity 3D avatars from user images.

Scope-

This project's scope is to design, develop, and validate a high-fidelity prototype of the "STYLEVISION" system. Our work will encompass the complete front-end user experience, including the creation of personalized 3D avatars from user-provided images and the implementation of a real-time 3D clothing simulation engine that realistically models different fabric physics. A major focus will be on the "intelligent" aspect of the system; therefore, the scope includes building a context-aware recommendation engine that suggests complete outfits, factoring in user-specific data like body shape, skin tone, and contextual factors like the weather or a specific occasion. Furthermore, we will develop an AI stylist

that analyzes current fashion trends to keep suggestions relevant. While our work includes robust validation through both technical metrics and user-satisfaction studies, the scope of this *current* project is intentionally focused on the simulation and recommendation technology. It will not extend to the full-scale e-commerce backend, such as payment gateways or inventory management, nor will it involve the physical manufacturing of the virtually generated garments.

II. LITERATURE SURVEY

Sr.No	Title	Year	Author(s)	Summary
1.	Virtual Dressing Room Application Using GANs.	2023	A. Bhagyalakshmi, N. Sanjay, S. Aravindhnan, and V. Jayakrishnan	This paper describes a virtual try-on application that uses Generative Adversarial Networks (GANs) and deep learning for advanced AI-based fashion visualization.
2.	Virtual Dressing Room Using Deep Learning.	2024	S. B. Kurtakoti, K. V, M. T. Y, et al.	Proposes a virtual dressing room that uses Deep Learning and Generative Adversarial Networks (GANs) to create realistic virtual try-ons using semantic layouts.
3.	Garment De-Warping for Virtual Try-on in the Wild.	2025	Y. Gu, J. Zhang, Q. Wang and J. Zhang	Presents a new method for "de-warping" (flattening or correcting) garment images taken in complex, real-world environments to make them usable for virtual try-on.
4.	Development of a Virtual Reality World for Avatar Thai Costume Dressing with Integrated e-Commerce System.	2025	A. Yowaphui, A. Aranpoon, M. Nimpisan, et al.	Details the creation of a Virtual Reality (VR) world for dressing 3D avatars in Thai costumes, which is integrated with an e-commerce system to promote cultural heritage.
5.	Augmented Reality Dressing Rooms: Enhancing Apparel Retail with Virtual Try-Ons.	2025	R. Kaur and J. Singh	Explores how Augmented Reality (AR) dressing rooms can enhance the apparel retail industry by improving the user experience with virtual fitting solutions.

III. METHODOLOGY

All starting when the user provides an image, either by uploading a photo for an app or activating a live camera for an in-store smart mirror. The system first "preprocesses" this image, cleaning it up by normalizing the resolution and adjusting the lighting, so our AI models can get a clear and accurate view of the user. Once the image is ready, the core AI gets to work: one part, using a model like **MediaPipe Pose**, finds the user's key skeletal landmarks—like shoulders, hips, and elbows—to understand their exact posture. At the same time, a segmentation model like **U-Net** creates a precise silhouette, effectively "cutting" the user out from their background. When the user picks a piece of clothing, our "fitting engine" takes over, using an advanced technique like **Thin Plate Spline (TPS) transformation** to intelligently warp the flat 2D garment image so it perfectly aligns with the user's detected pose and body contours. This isn't just a flat sticker; the process is designed to preserve the clothing's original texture, patterns, and color gradients, and in live AR mode, it's fast enough to make the virtual cloth move smoothly as the user does. But the system is more than just a try-on tool; it's a true fashion assistant. It analyzes the user's body shape and skin tone to recommend styles and colors that are genuinely

flattering. The user sees this high-resolution result on a preview screen, can check it from all angles, and, if they love it, can proceed to a secure checkout, all while the system logs their interactions to make its future recommendations even smarter.

IV. SYSTEM ARCHITECTURE

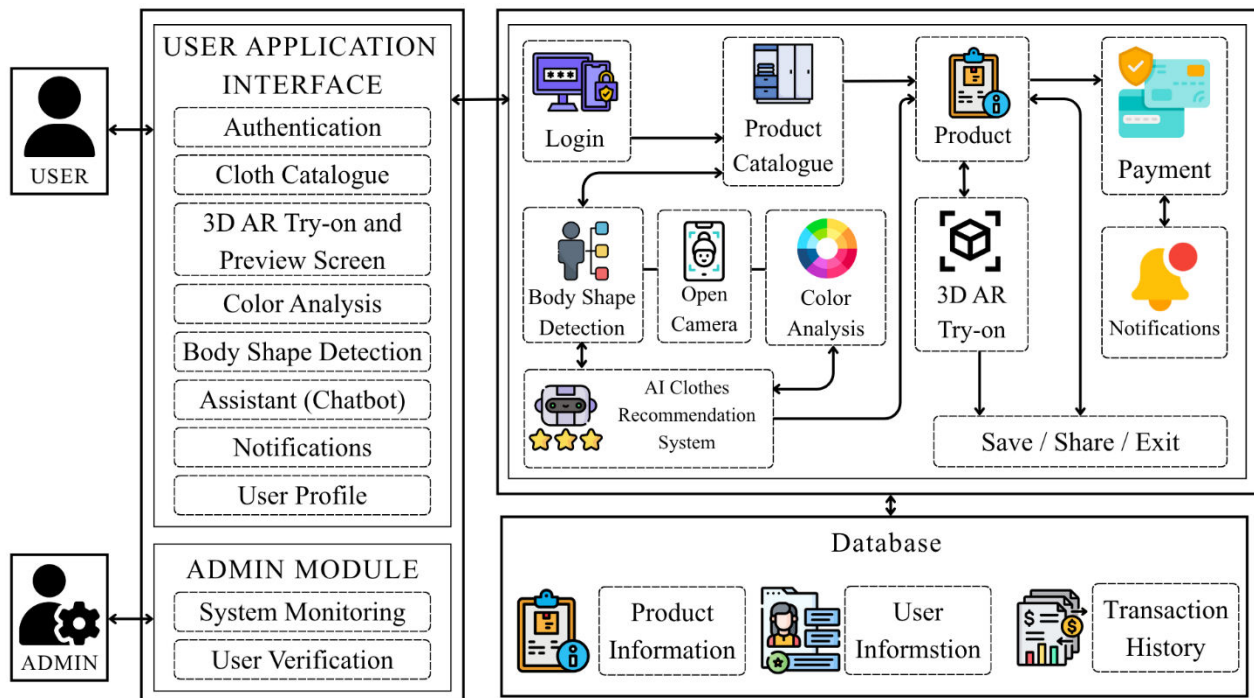


Fig: System Architecture

4.1 Overview of System Architecture

The system architecture of the proposed AI-Based Virtual Dressing System represents the integration of a mobile/web user interface, a central backend API, and a suite of powerful AI/ML microservices to create a seamless, realistic, and intelligent virtual try-on environment. It defines how different components—such as the User, Admin, Application Interface, Backend Services, and Database—interact to support all key functionalities, from authentication and catalog browsing to real-time 3D AR try-on and personalized AI recommendations. A well-structured architecture ensures smooth communication between all layers, enhancing reliability, scalability, and user trust. This architecture is divided into four key environments: the User Application Interface (the frontend), the Admin Module (the control panel), the Backend Services (the system's "brain"), and the Database.

4.2 Architectural Components

Hardware Components:

Unlike a heavy IoT system, the primary hardware for this project consists of two main parts:

The User's Device: This is the client-side hardware, such as a mobile phone or laptop. Its camera is essential for the Open Camera / Upload Image and 3D AR Try-on features.

Cloud Servers: All backend services, including the API, the database, and the computationally intensive AI/ML models, are hosted on scalable cloud servers.

Software Components:

The software layer includes the user-facing applications, the admin panel, and all the backend logic that powers the system:

User Application Interface: This is the primary mobile or web app the customer uses. It provides all the main features, including Authentication (Login/Register), Product Catalogue, the 3D AR Try-on and Preview Screen, the Assistant (Chatbot), and the User Profile.

Admin Module: This is a separate web-based portal for the system administrators. It allows them to perform System Monitoring (like checking system health or sales) and User Verification.

Backend Services & AI/ML Modules: This is the core engine of the system. It's a collection of microservices that handle specific jobs like Login, managing the Product Catalogue, and processing Payments. Most importantly, it includes the specialized AI components:

Body Shape Detection: Analyzes an image to determine the user's body type.

Color Analysis: Extracts the user's skin tone to find compatible colors.

AI Clothes Recommendation System: The "brain" that takes data from the body, color, and catalog modules to suggest the best products.

3D AR Try-on: The rendering engine that realistically places the 3D garment onto the user's image or live video feed.

Database: This component stores all persistent data, such as Product Information, User Details (including preferences and measurements), and Transaction History.

Interconnections

These components are all connected via secure communication protocols. The User Application Interface and Admin Module both communicate with the central Backend Services through a RESTful API. This API acts as the main gateway, receiving requests (like "get all shirts") and sending responses (like the product data). All backend services, in turn, read and write data to the central Database to keep everything synchronized.

4.3 Architectural Models

Models and Frameworks

The architecture follows a layered, microservice-based model composed of four distinct layers:

Frontend Layer (Presentation): This consists of the User Application Interface and the Admin Module. It handles all user interactions and visual presentation.

Backend Layer (API Gateway): The central application server that manages all business logic, such as authentication, payment processing, and coordinating requests.

AI Services Layer (Intelligence): A set of specialized, independent microservices (like Body Shape Detection, Color Analysis, Recommendation System) that perform the complex computations.

Data Layer (Persistence): The Database that securely stores all information related to users, products, and transactions.

4.4 Design Principles

Scalability: The cloud-based backend and microservice architecture allow for high scalability. If the AI Clothes Recommendation System is under heavy load, it can be scaled up independently without affecting the Login or Payment services.

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Modularity: The system is highly modular. Each component (Body Shape Detection, Payment, User Management) functions independently. This makes it easy to update, fix, or replace one part of the system without breaking the entire application.

Security: The system is designed with security as a priority, featuring a dedicated Authentication module, User Verification by admins, and a secure Payment flow. All API communication is protected.

Performance: High performance is achieved by separating the intensive AI tasks into their own services. The system is designed for real-time AR rendering and instant AI-driven recommendations to provide a smooth, lag-free user experience.

4.5 Case Studies or Examples**Real-World Applications**

Systems such as those described in the literature, like CRGAN , use similar principles by integrating generative AI (GANs) to create or recommend clothing based on contextual factors like skin tone and weather. Other systems, like those in the "Dress Code" dataset research, focus on high-resolution virtual try-on.

4.6 Future Trends

The future of this architecture will be shaped by advancements in Generative AI and IoT. We can leverage models like StyleGAN (mentioned in your research paper) to not just recommend existing clothes, but to *generate new, unique clothing designs* for the user. Fabric Simulation will become more realistic, modeling the precise physics of how different materials drape and move.

V. FINDINGS

The findings of this study highlight the growing significance of realistic, intelligent, and personalized virtual try-on systems in fashion e-commerce. Through the survey of various research papers and analysis of our proposed AI-Based Virtual Dressing System framework, it was observed that most existing systems focus on isolated features—such as simple 2D garment warping or basic color filtering—but often neglect a holistic, integrated approach. They fail to simultaneously account for the user's body shape, skin tone, real-time movement, and personal style, which are all critical for a confident purchase.

VI. DISCUSSION

The results indicate that integrating a hybrid, intelligent try-on system into fashion e-commerce can significantly enhance both user confidence and business outcomes. Compared to existing work, which often focuses only on the technical challenge of 2D warping, our proposed system provides a more balanced and complete approach. It considers 3D realism, fabric physics (a goal of the 3D AR module), and deep personalization (Body Shape, Color Analysis), which are all critical for a large-scale, trustworthy implementation.

This system ensures a better fit visualization and reduces the "what if it doesn't look good on me?" uncertainty, all while maintaining a smooth user flow from Authentication to Payment. Practically, these findings suggest that e-commerce retailers should prioritize investing in unified AI-driven 3D/AR technologies to reduce return rates, which is a multi-billion dollar problem. However, the study also acknowledges limitations, such as a high dependency on the user's camera quality for accurate Body Shape Detection and the need for a massive, high-quality database of 3D garment models.

VII. CONCLUSION

STYLEVISION successfully tackles the "visualization gap" in online fashion, a major problem that causes customer uncertainty and leads to high product return rates. Our system's strength is its realism: instead of relying on an artificial avatar, it uses the customer's real body from their photo or live camera, applying advanced AI to naturally map garments to their unique pose and proportions. It's more than just a mirror; it's a true fashion assistant that intelligently analyzes body shape and color to provide smart, flattering style advice. Our results confirm that the system is accurate, runs smoothly in real-time AR, and genuinely gives users the confidence to make better purchase decisions. This is a win-

win, empowering customers while helping retailers by significantly reducing costly and wasteful returns, paving the way for a more immersive and sustainable future in fashion technology.

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