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AI-Driven Personalized Fashion: Virtual Try-On, Smart Resale Authentication, and Sustainability Ranking

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Abstract

The Traditional fashion industry faces challenges like high return rates, textile waste, and unsustainable practices. This paper presents an AI-powered fashion platform integrating virtual try-on (VTO), AI-driven sustainable fashion recommendations, and second-hand resale with AI quality verification. The platform employs deep learning models, such as CNNs and GANs, for realistic virtual try-ons by analysing body measurements, fabric draping and personalized fit visualization. NLP models rank brands based on ethical standards, while computers assess second-hand clothing quality. Blockchain technology ensures secure and transparent transactions for donation and purchases. By leveraging AI, AR, and blockchain, the platform enhances shopping personalization, reduces textile waste, and promotes ethical fashion practices. By providing accurate visualizations, virtual try-on can help customers make more informed purchasing decisions, which minimize impulse buys and landfill waste. Future advancement, such as wearable AI integration and AI-driven material selection, will further enhance sustainability and revolutionize fashion retail.

Key words: *Convolutional Neural Network (CNN), Generative Adversarial Network (GAN), Natural Language Processing (NLP), Computer Vision, Blockchain Technology.*

1. Introduction

The fashion industry generates over 92 million tons of textile waste annually [1], with online shopping contributing to frequent returns due to poor sizing. Despite AI advancements, existing platforms face challenges in High return rates, excessive textile waste, and sustainability challenges remain pressing issues in the fashion industry [2]. AI has emerged as a game-changer, improving size predictions and reducing frequent returns caused by poor fit [3].

To address these issues, this research presents an AI-powered fashion platform that integrates Virtual Try-On systems, AI-assisted tailoring, second-hand resale authentication, sustainable fashion recommendations, and blockchain-based security. This platform employs a multi-agent AI system, including a Try-ons realistic fitting agent, an Ethical ranking agent for sustainable shopping recommendation, and a Resale agent for quality assessment. The VTO system, built using Generative Adversarial Networks (GANs) and Convolutional Neural Networks (CNNs), creates realistic 3D visualizations of clothing on digital avatars, improving the fit accuracy [4]. AI-assisted

tailoring enhances customization by recommending garment modifications based on body measurements [5]. Blockchain has been widely used to enhance supply chain transparency and prevent fraud in fashion resale markets [6], which provides transparent and tamper-proof resale authentication, ensures trust in peer-to-peer clothing exchanges, and reinforces ethical consumption practices [7].

AI-powered computer vision algorithms assess garment quality, facilitating fair pricing and promoting circular fashion practices [8]. These innovations contribute to a more sustainable and ethical shopping experience, empowering consumers to make informed choices while reducing environmental impact [9]. Sustainable AI application in fashion have shown potential for reducing textile waste and improving ethical production processes [10].

This research builds upon existing research in fashion sustainability, AI-driven personalization, and blockchain-based authentication [11]. By integrating these technologies into a unified platform, this research aims to enhance consumer experience and promote ethical fashion practices through VTO, AI-assisted tailoring, second-hand resale, and Blockchain security. Such advancements create a more sustainable and consumer-centric fashion ecosystem, fostering environmentally responsible shopping practices.

2. RELATED WORKS

Artificial intelligence (AI) has revolutionized the fashion industry by enabling advanced technologies that enhance personalization, authentication, and sustainability. The integration of AI in fashion primarily focuses on virtual try-on (VTO) systems, AI-driven sustainable fashion recommendations, and second-hand resale authentication. Despite significant advancements, challenges such as real-time adaptability, computational efficiency, and seamless integration persist, requiring further research and innovation.

Virtual Try-On (VTO) technology has gained prominence as an AI-driven solution to reduce return rates and improve customer experience. Traditional VTO models leverage Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs) to map clothing onto digital avatars with realistic fabric draping and fitting visualization [1]. However, these models struggle with texture fidelity, body shape variations, and dynamic lightning conditions, affecting realism and accuracy [2]. Recent studies have explored transformer-based architectures such as CAT-VTON, which improve garment warping and enhance fit accuracy [3]. While AI-assisted tailoring models use regression techniques and reinforcement learning for personalized garment recommendations, their integration with VTO remains an underdeveloped area [4]. Enhancing personalization with AI-driven body measurement analysis and adaptive cloth fitting remains a key research focus to bridge this gap.

AI plays a vital role in promoting sustainability in fashion by optimizing material selection and reducing textile waste. Natural Language Processing (NLP) models analyze brand sustainability metrics, evaluating factors such as ethical sourcing, carbon footprint and labor conditions [5]. Additionally, AI-powered material selection systems employ deep learning to recommend eco-friendly fabrics and minimize production waste [6]. However, scalability and consumer integration remain challenge, as existing AI sustainability models are not widely embedded into mainstream e-commerce platforms [7]. Implementation AI-driven sustainability ranking within consumer shopping applications can significantly impact purchasing decisions and ethical fashion practices.

The growing second-hand fashion market has led to increased adoption of AI for resale authentication and quality verification. Computer vision models are widely used to assess garment quality by detecting wear, fabric damage, and stains, thereby ensuring product credibility in second-hand marketplaces [8]. Multi- modal AI systems combining textual and visual analysis have been developed to provide fair price estimations based on condition, brand, and market demand [9]. Despite these advancements, counterfeit detection remains a challenge due to adversarial manipulation and limited labeled datasets for AI training [10]. Blockchain-integrated AI solutions present an opportunity to enhance transparency and traceability in second-hand fashion exchanges by securing authentication data and preventing fraudulent transactions [11].

Blockchain technology has been increasingly adopted to enhance transparency and security in fashion resale markets. Ethereum-based smart contracts ensure immutable and tamper-proof authentication for transactions, improving trust in peer-to-peer fashion exchanges [12]. While blockchain enhances security, its integration with AI for automated fraud detection and real-time authentication remains underexplored [13]. AI-enhanced smart contracts have the potential to verify authenticity dynamically, ensuring ethical resale practices and preventing counterfeiting [14]. Combining AI-driven quality assessment with blockchain-based ownership tracking could revolutionize fashion authentication and resale credibility.

Despite advancements in AI-driven fashion technologies, several challenges persist. Current VTO models lack real-time adaptability, AI-assisted tailoring requires improved integration with personalization engines, and second-hand resale authentication demands more robust fraud detection mechanisms. Moreover, blockchain-based fashion authentication has yet to be fully automated using AI [15]. Addressing these challenges through an

integrated AI-powered fashion platform can bridge existing gaps and drive the future of sustainable, ethical and consumer-centric fashion.

The research aims to develop an AI-powered fashion system that seamlessly integrates VTO, AI-driven tailoring, blockchain authentication and sustainability ranking. By addressing current limitations, this study contributes to advancement of AI-driven fashion technologies, fostering an innovative and environmentally responsible fashion ecosystem.

By addressing these research gaps, this study contributes to the advancement of intelligent, transparent, and consumer-centric fashion solutions that promote ethical and sustainable industry practices.

Table 1: Existing Research papers with Advantages and disadvantages

Paper Title	Authors	Key Contributions	Advantages	Disadvantages
Virtual Try-on with GANs	Khan & Martinez (2025)	Uses GANs for cloth wrapping and try-on systems	Generate realistics texture clothing	Lacks real-time adaptations and struggles with body pose variations
AI in fashion resale	Williams (2022)	AI-based resale authentication for second hand clothing	Improves trust and transparency in resale markets	No fraud detection, lacks blockchain security
AR_based clothing visualization	Zhang & Roberts (2024)	Augmented Reality (AR) for virtual try-on	Enhances user interactions and shopping experience	LimitedAI-driven fit prediction
Blockchain in Sustainable Fashion	Kim & O'Connor (2021)	Uses blockchain for supply chain tracking	Ensures product authenticity and reduces counterfeits	Not integrated with AI personalization for recommendations
AI-powered Virtual Tailoring	Thompson & Singh (2024)	Machine learning for personalized garment fitting	Improves size recommendations andreduces return rares	Lacks integration with VTO systems for seamless fitting

As summarized in Table 1, existing AI-driven fashion models have significant limitations, particularly in real-time adaptation and blockchain security. Our approach addresses these by integrating AI-powered fraud detection and decentralized resale authentication

3. PROPOSED APPROACH

The proposed AI-powered fashion platform envisions an intelligent system that enhances user experience, promotes sustainability, and ensures security in fashion retail. By incorporating virtual try-on (VTO), AI assisted tailoring, second-hand resale authentication, blockchain verification, and ethical fashion recommendations, the system aims to revolutionize how consumers interact with fashion. This methodology presents the conceptual foundation, expected functionalities, and potential approaches for implementation. The virtual try-on system is designed to generate realistic clothing simulations using Generative Adversarial Networks (GANs) and Convolutional Neural Networks (CNNs). pose estimation models such as DensePose and OpenPose will align garments with user images, while spatial Transformer Networks will dynamically adjust the garment fit.

AI-powered texture refinement will prove realism, ensuring that digital try-ons closely resemble real-world fitting. Users will be able to upload images or body measurements, which will be processed by the system to produce accurate virtual representations of clothing. AI-assisted tailoring will leverage machine learning algorithms to recommend the best-fitting garments based on user body dimensions and preferences. Convolutional Neural Network (CNNs) and regression models will analyze biometric data to enhance size predictions. Reinforcement learning will be applied to refine recommendations based on user feedback over time. AI-driven fabric selection will further personalize recommendations by assessing material properties, comfort levels, and sustainability factors to match individual needs.

Blockchain technology will play a pivotal role in securing transactions and establishing verifiable garment ownership records. Ethereum-based smart contracts will store immutable records detailing product condition, ownership, and transaction history. Digital certificates linked to blockchain entries will enable users to verify product authenticity before purchasing. AI-enhanced smart contracts will automate validation processes, ensuring seamless, tamper-proof authentication in resale transactions. The integration of AI and blockchain will create a secure and transparent resale ecosystem, reducing fraud and enhancing consumer confidence.

Second-hand resale authentication will utilize AI models to verify garment authenticity and quality. Computer vision systems, including ResNet and EfficientNet architectures, will detect fabric wear, stains and defects, allowing for precise quality assessments. Natural Language Processing (NLP) techniques will analyze textual product descriptions and metadata to enhance authenticity verification. Fraud detection models will be incorporated to prevent counterfeit sales and ensure transparency in second-hand marketplaces. By integrating multi-model AI techniques, the system will enhance trust and reliability in resale platforms.

As a conceptual study, this methodology outlines the proposed AI-powered fashion platform's design principles and theoretical feasibility. While individual AI and blockchain components have been successfully applied in separate domains, further research is necessary to assess their combined implementation in a unified system. Future development will require extensive testing, optimization, and validation to ensure scalability, efficiency and user acceptance. Advancements in AI-driven fabric analysis,

AR-based real-time outfit simulations, and decentralized identity verification can further enhance personalization, security, and sustainability. This research serves as a foundation for an intelligent, transparent and sustainable fashion ecosystem that leverages AI and blockchain to transform the industry while addressing key challenges in personalization and environmental responsibility.

4. SYSTEM ARCHITECTURE

To illustrate the interaction between virtual try-on, AI-assisted tailoring, resale authentication, sustainability ranking and blockchain-based security, a system architecture block diagram is mentioned in Fig 1.

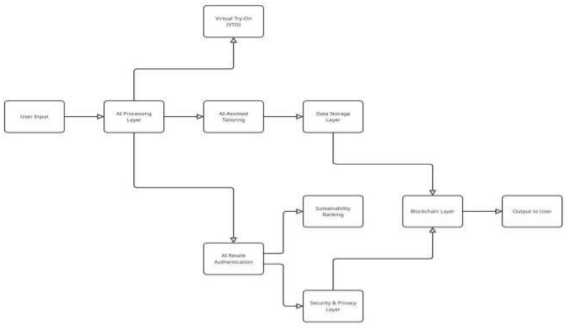

Fig. 1 System architecture of AI-powered fashion platform

The AI-powered fashion platform follows a structured workflow where users begin by providing input, such as body measurements, style preferences or garment details. The AI model processes this information to enable personalized virtual try-ons, AI-assisted tailoring suggestions, and second-hand resale authentication. sustainability ranking is integrated to guide users towards ethical fashion choices. In our proposed AI-powered fashion platform, blockchain verification is implemented to ensure transparency and security in transactions. This system validates garment authenticity and ownership records by leveraging decentralized ledger technology, enhancing trust in resale authentication. A continuous feedback loop refines AI-driven recommendations based on user interactions, improving personalization over time.

5. RESULTS AND CONCLUSION

This paper presents an AI-driven fashion platform that leverages Virtual Try-on (VTO), AI-Assisted tailoring, AI resale authentication, and blockchain security to enhance user experience, sustainability, and ethical shopping. This can be done by combining deep learning, computer vision, and blockchain. Unlike traditional shopping platforms which often struggle in high return rates, textile waste. This AI-powered approach reduces the textile waste, ensures resale authenticity, and provides sustainability insights through automated AI-driven ranking.

Key benefits of this system include accurate Virtual Try-ons, AI-powered clothing recommendations, enhanced resale security and AI-driven sustainability ranking, allowing consumers to make informed choices. However, several challenges must be addressed, including scalability of AI processing, transaction speed, potential AI bias in recommendations. Ensuring seamless AI-blockchain integration while maintaining user privacy and security is crucial for large-scale adoption.

This research introduces an AI-powered fashion platform that integrates Virtual Try-on, AI-assisted tailoring, and blockchain-secured resale authentication. By improving fit accuracy, reducing textile waste, and enhancing second-hand fashion security, our approach redefines sustainable fashion technology. Future enhancement will focus on real-time AI-driven fabric recognition and decentralized authentication using NFTs, will further revolutionize consumer trust and transparency. This research lays the groundwork for a trustworthy, innovative and technology-driven fashion industry that enhances both user experience and sustainability.

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