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A Comprehensive Survey on AI-Driven Fashion Technologies: Clothing Detection, Recommendation Systems, and Virtual Try-On Solutions

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ABSTRACT—The rapid development of AI, deep learning, and computer vision redefined the fashion industry landscape, with the fast development of advanced systems for managing clothing, recommending styles, and providing a virtual fitting experience. This survey paper discusses recent attempts made in the fields, and for that reason, it analyzes ten different studies that were centered on various aspects-from deep CNNs that have been applied for clothing detection to AR applications that have been used for virtual trials of fittings and intelligent wardrobe management systems. Analyzing methodologies, data sources, and the results of such investigations, the present paper provides an extensive summary of conditions existing with regard to technology within fashion-oriented AI systems. The survey shines a light on enormous challenges, trend changes, and future avenues, through which understanding is well deepened about the impact of AI and computer vision in the alteration of experiences into fashionable customized individuality.

Index Terms—Smart Wardrobe Systems, Fashion Recommen- dation Systems, Virtual Try-On Technology, Clothing Detection Models, Deep Learning Architectures, Augmented Reality (AR) in Fashion, Computer Vision Applications

I. INTRODUCTION

The rapid growth of digital content, electronic communication, and multimedia applications has created a significant demand for the integration of high technologies that allow for greater access, interactivity, and comprehension. In today's hypernetworked world, where unprecedented levels of information are being generated, processing and converting between different forms—image, text, and video—are necessary in different segments, including apparel and e- commerce, education, and entertainment. The growing desire of consumers for special experiences experienced significant changes in the fashion industry, marked by the development of intelligent systems to assist people in their wardrobe organization and in making knowledgeable choices when buying clothes.

Advanced wardrobe systems, virtual fitting rooms, and AI-based fashion recommendation engines are representative examples of the growing need for sophisticated instruments that can analyze intricate visual and textual information. These systems, which apply advanced techniques like computer vision, deep learning, or even augmented reality, provide customized fashion suggestions as well as interactive shopping interfaces to the users. The ability of these systems to accurately identify clothing items, recommend coordinating outfits, and facilitate virtual try-ons improves user satisfaction and encourages an even more interactive engagement with the brands in the fashion industry.

The integration of these technologies in the fashion landscape addresses various challenges that consumers experience today. For example, the proliferation of online retail has generated a plethora of choices, complicating the process for consumers as they attempt to maneuver through extensive inventories and identify appropriate apparel that aligns with their specific tastes. Through the implementation of image recognition technologies and machine learning frameworks, advanced fashion systems have the capacity to optimize this procedure, enabling users to effectively organize their closets and obtain customized outfit suggestions tailored to their

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distinct styles, body shapes, and preferences.Moreover, inclusivity is of great importance. New style technologies are developed to support users within a very wide spectrum, encompassing both people with disabilities, non-native speakers, and seekers after customized versions of their appearance. These systems make it easier and more immersive for all users to be involved in the process of interaction with fashion using technologies such as augmented reality and the virtual fitting environment. For instance, individuals with visual impairments can take advantage of technologies such as text-to-speech, which transform clothing descriptions into audible formats, thereby guaranteeing them equitable access to information regarding fashion.

Notwithstanding the encouraging developments in smart wardrobe systems and associated technologies, numerous challenges remain. Ensuring precise clothing identification across diverse lighting environments, achieving real-time performance for interactive applications, and preserving the quality of user experience represent persistent issues that researchers and developers are consistently working to resolve. In addition, the incorporation of these technologies within current retail settings necessitates thorough deliberation of user interfaces and the overall usability of the system.

This survey paper aims to investigate the technologies that are considered the foundation of contemporary advancements in smart wardrobe systems and related fashion technologies. The review paper will involve findings from recent scholarly research and developments in diverse studies, offering insights on the methodologies used, obstacles faced, and prospective pathways for improving personalization and accessibility regarding fashion-related experiences. This in-depth analysis seeks to build on one's knowledge of the impact of AI and computer vision technologies on the fashion industry's development process, while also perfecting the way consumers interact with clothing and beauty.

II. LITERATURE REVIEW

Chaitanya Paresh Vaidya et al.(2023) [1] proposed the "Smart Wardrobe" model which uses deep learning to make daily wardrobe recommendations based on user preferences, current fashion trends, and local weather. The system makes use of a CNN model that was trained using 40,000 photos from Kaggle. Users browse or upload photographs online, which are then processed by a model that makes use of TensorFlow's pre-trained ResNet50 architecture. From the input photos, the model extracts 2048 features, compares them with the avail- able data, and recommends the top five matching ensembles. The system is evaluated in the study using a test set, and it achieves an accuracy of 94% in outfit recommendation and 89.7% in garment recognition. The idea behind the smart wardrobe is to incorporate current trends into outfit choosing, save time, and make dressing easier. Including functions like wardrobe mapping and body size detection is another way to improve the system. The findings point to a promising future for deep learning technologies to help with personal style.

Sakshi Shete et al. (2024) [2] proposed the AI-powered Fashion Stylist Recommendation System that uses augmented reality, machine learning, and artificial intelligence to provide tailored fashion advise in an effort to improve the user ex- perience. Convolutional neural networks (CNNs) are used for image categorization, user profiles are constructed, and fashion data is gathered and preprocessed. Users can see virtual try- ons through augmented reality, and outfit recommendations are provided through collaborative and content-based filtering processes. The system is intended to increase its accuracy in response to user feedback and incorporates real-time trend analysis. CNNs were utilized during the deployment phase to categorize apparel into groups such as footwear and top wear. Ongoing optimization attempts were necessitated by the categorization accuracy issues early models encountered. There are plans to enhance augmented reality elements to offer virtual try-ons for female clothing in addition to male clothing. Although the recommendation system produced positive out-comes, it is still being improved with regard to content-based filtering and user profiling for further customization.

Using deep learning and computer vision techniques, the FashionAI project proposed by Disha Jain et al. (2024) [3] focuses on image-based garment recognition and purchase recommendations. Users of the system can input photographs of clothing items to be evaluated using CNN for feature extraction and models like YOLOv5 for bounding box detec- tion. The project employs web scraping techniques to extract product information from e-commerce websites and datasets such as DeepFashion2 for model training. To adapt pre-trained models to the particular use case of garment recognition and categorization, transfer learning was used. The finished system recognizes dominating colors, derives patterns (such as stripes or flowers), and distinguishes different types of apparel. With the

ability to filter by price, size, and other characteristics, these results are used to suggest related products from internet retailers. With 96% accuracy on the DeepFashion2 dataset, the YOLOv5 model was able to detect apparel items and produce bounding boxes. Based on Inception v3, the CNN model was able to recognize patterns and color schemes that would help with additional classification.

B Suvarna et al. (2022) [4] proposed a deep convolutional neural network (CNN) model-based effective fashion sugges- tion system. The algorithm categorizes goods according to user preferences in order to deliver precise suggestions for fashion products. Lower precision was the outcome of using traditional recommendation techniques like closest neighbor or clustering. The authors suggest a deep CNN model that has excellent accuracy in classifying fashion products as a solution to this problem. A dataset with 44,000 photos and 143 classifications was used to test the model; 12 categories were chosen for classification and suggestion. The procedure comprised pre-processing the dataset, using a trained model to extract features, and dividing it into training and testing sets. Three sets of Conv2d, max-pooling, and dropout were among the numerous layers used in the construction of the CNN model. The model was trained for 150 epochs with a batch size of 256, and cosine similarity was applied to compare features of classified images for making recommendations. The model achieved 89.02% accuracy, outperforming prior models by 23%. Metrics such as precision, recall, and F1-score validated the model's effectiveness, with some categories showing up to 100% accuracy. Future work aims to integrate gender and color attributes to enhance recommendation quality.The CNN model was created utilizing three sets of Conv2d, max-pooling, and dropout, among other layers.

Smart Bezzie is an intelligent wardrobe system proposed by Kahatapitiya G.S.A et al. (2023) [5] that includes a virtual try-on feature and is intended to manage, detect, and propose apparel. Deep learning algorithms for virtual fitting, IoT sensors for wardrobe condition monitoring, and CNN-based classification models for apparel categorization make up the system's main parts. The CNN models use the InceptionRes- NetV2 architecture to identify clothing according to events and weather. The results demonstrated a high degree of classifica- tion accuracy, with particularity in the types and patterns of apparel that were classified. Computer vision algorithms were used in virtual try-on to provide realistic fitting experiences by estimating users' body posture and aligning garments to their body shapes. Notwithstanding the intricacy of virtual fit- on, the technology was able to produce precise and visually appealing outcomes. Enhancing garment preservation, the IoT integration made real-time wardrobe monitoring possible. All things considered, Smart Bezzie provides a complete mod- ern wardrobe management solution, including individualized dressing advice and a realistic virtual experience all while preserving garment quality with Internet of Things monitoring.

Liang et al. (2021) [6] advanced a cell software that lever- ages augmented truth (AR) to decorate the web purchasing enjoy via enabling customers to measure their toes, strive on footwear definitely, and visualize 3-d fashions of products in their actual environment. The technique worried a user as- sessment method in which individuals familiarized themselves with the app and completed 4 unique tasks, with their task final touch instances recorded. Usability was assessed the usage of the system Usability Scale (SUS), which provided insights into consumer satisfaction and ease of use. The results indicated that the software turned into well-obtained, with all users locating it easy to navigate and 80mission of entirety instances averaged among 1 to three mins, demonstrating performance in person interplay. standard, the findings advise that the AR util- ity considerably improves the net shopping revel in, presenting users with extra self belief in their purchases and enhancing their engagement with the shopping technique. This modern approach now not handiest enables virtual becoming however also addresses common demanding situations confronted in online retail, making it a treasured device for clients.

Ying Wu et al (2022) [7] conducted an innovative study aimed at enhancing user engagement and improving accuracy in digital apparel applications. The research introduced a virtual solution that utilizes a kinect motion sensor to de- tect movements and adjust clothing algorithms by collecting detailed skeletal data and analyzing traditional body mea- surements. This system more accurately represents clothing which not only improves the precision of virtual fitting but also reduces the costs associated with traditional fitting meth- ods.Wu's findings demonstrated that real-time digital appli- cations significantly enhanced user experience by enabling people to visualize apparel on their avatars in a highly realistic way. The integration of motion-sensing technology provides a deeper understanding of users body dynamics allowing for a better fit in virtual clothing. These advancements

address key challenges in the digital fashion industry such as delivering a seamless user experience and overcoming barriers to adoption. Overall Wu's research highlights the potential of combining advanced motion-sensing technology with traditional measure- ment techniques to transform how consumers interact with fashion in a digital context ultimately paving the way for more personalized and interactive virtual shopping experiences.

The research paper enhancing clothing 360 a great op- portunity by Anjana Sundari et al (2023) [8] proposed a new method for a virtual fitting room using marker-based augmented reality. This method leverages vuforia and unity 3d to instantly project 3d clothing onto the users body. Users can scan qr codes to search for different clothing and accessories customize colors and sizes and view products from a full 360- degree view. The app aims to enhance purchasing by con- necting online and offline stores. However for some photog- raphy purposes, accuracy may be compromised. Instructions collected from a live test with 20 participants demonstrated the quality of the softwares usability and accuracy. The authors conclude that apparel 360 has a positive impact on purchasing and suggest future improvements such as combining smart glasses with ai to make recommendations to the person. This new approach could change the way consumers interact when purchasing clothes making shopping more efficient and powerful.

Szegedy et al (2021) [9] presented an enhanced version of the inception architecture called inception-v3 which sig- nificantly improves classification performance on the ilsvrc 2012 benchmark . Their methodology includes the factoriza- tion of convolutions rigorous measurement reduction and the implementation of batch normalization along with auxiliary classifiers all aimed at achieving superior results while re- ducing computational costs. The authors provide a detailed examination of the networks structure which integrates multi- ple inception modules and grid reduction strategies allowing for efficient image processing across various resolutions. Their experimental findings demonstrate that effective results can be obtained despite reduced receptive field resolutions making the architecture particularly effective for identifying small objects. The results indicate that inception-v3 outperforms previous models achieving a top-1 error rate of 448 and a top-five error rate of 1947 on the ilsvrc 2012 dataset showcasing significant improvements in both accuracy and efficiency compared to earlier architectures such as googlenet and VGG.

Kaijan Khan (2023) [10] outlines a comprehensive method for picture detection that consists of installing the OpenCV library, importing necessary modules, loading images with the "imread" function, and making use of preprocessing tech- niques which include resizing and converting to grayscale (T4). The look at emphasizes the effectiveness of Python and its libraries, mainly OpenCV, TensorFlow, and PyTorch, in training device studying fashions like SVM and CNNs for correct object detection (T2). The consequences imply a hit implementation of these strategies, demonstrating the capability to visualise and annotate images with detection outcomes, thereby improving understanding of the OpenCV Python library's talents (T6). This research highlights the flexibility of Python in photograph detection packages, ranging from autonomous automobiles to medical imaging, making it a treasured tool for both beginners and experts in the subject (T1, T3). Khan's paintings contributes notably to the understanding of computer imaginative and prescient and machine studying, showcasing the capacity of those technologies in numerous modern-day applications.

III. DISCUSSION

The ten papers reviewed highlighted tremendous progresses made in AI-based fashion technologies, particularly in areas on clothing detection, virtual tryon applications, and personalized recommendation systems. Intelligent wardrobe systems and the fashion recommendation engines have prospects of becoming quite viable for improving the experience of digital fashion users characterized by high involvement and real-time responsiveness. Integration of deep learning models-including CNN and YOLOv5-shows remarkable efficiency for the purpose of accurate detection and classification of clothing items, hence enabling users to manage their wardrobes skillfully and inform their fashion choices accordingly. Personalized fashion advice has now become an essential feature for enhancing the user experience. These systems use user data-such as past purchases and preferences-to provide users with outfit suggestions that cater to their individual styles. Therefore, with the combination of both collaborative filtering and content-based filtering methods, the recommendations are not very off from being accurate and tend to meet different user needs.

Additionally, augmented reality technologies used in virtual fitting rooms transformed the way users interact with clothes. This process minimizes uncertainty synonymous

with online shopping to increase confidence in purchases, as it enables a user to see how clothes fit an avatar or even through the camera on their phone. However, much more work needs to be done to achieve noise robustness for image recognition systems. Such differences in illumination, view angles, and background might affect the accuracy of clothing detection that requires more and more research for real-time application model optimiza- tion.The AR technology is surely opening newer avenues of more enriched user experience. Its usability, however, would depend on the rendering quality and effectively designed user interfaces while keeping a balance between immersive experiences and practical usability to encourage user adoption of such novel technologies. Therefore, future research will be directed to developing of hybrid systems that not only line up the visual information with user-generated content but also connect social media trends in enriching insights and enhancing personalization. Inclusivity and, in particular, adaptation technologies to a range of body types and cultural contexts will reap most benefits from fashion AI by reaching far greater demographics.

IV. CONCLUSION

Artificial Intelligence and Computer Vision are moving at a rapid pace, significantly influencing the fashion industry in domains like intelligent wardrobe systems and virtual fitting applications with recommendations based on individual tastes. The growing demand for a more vibrant and accessible fashion experience drastically improves the way consumers interact with clothing. While good promises and significant improvements have been achieved in detecting and classi- fying garments accurately, the advent of augmented reality applications in online shopping allows a user to experience what he or she intends to purchase. So, at least some issues persist, namely: achieving accuracy under different conditions, optimizing performance in real time, and introducing people- friendly solutions taking all sorts of body types and cultural contexts into consideration. Further research and innovation in AI and ML are thus necessary. Improvement in accuracy, efficiency, and inclusivity of fashion technologies results in improved user experience and access to broader market niches, opening up the possibility of potentially redefining consumer interaction with clothes and style in an increasingly digital landscape.

REFERENCES

[1] Vaidya CP, Kulkarni N, Kulkarni R, Singh P, Singh AP. Smart Wardrobe: A Deep Learning Model. In2023 1st International Conference on Cogni- tive Computing and Engineering Education (ICCCEE) 2023 Apr 27 (pp. 1-4). IEEE.

[2] Shete S, Darshan H, Thakare M, Dhuri K. AI based Fashion Stylist Recommendation System. In2024 11th International Conference on Com- puting for Sustainable Global Development (INDIACom) 2024 Feb 28 (pp. 697-701). IEEE.

[3] Jain D, Thazhathu EM, Adiraju I, Bhattacharya J, Singh D. FashionAI: Image-Based Clothing Detection and Shopping Recommendation. In2024 3rd International Conference for Innovation in Technology (INOCON) 2024 Mar 1 (pp. 1-6). IEEE.

[4] Suvarna B, Balakrishna S. An efficient fashion recommendation system using a deep cnn model. In2022 International Conference on Automation, Computing and Renewable Systems (ICACRS) 2022 Dec 13 (pp. 1179- 1183). IEEE.

[5] Kahatapitiya G.S.A., Kiriella K.T.R.A.S., Maduwantha R.M.A., Wellalage S., Nirmal H.I.D., and Abeygunawardhana P.K.W. Smart Bezzie - Intelligent Wardrobe for Cloth Management, Detection and Recommendation. In 2023 International Journal of Research Publication and Reviews (IJRPR), vol. 4, no. 6, pp. 3868-3876, June 2023. DOI: 10.55248/gengpi.4.623.38683876.

[6] Karkour M, Liang D, AlAghbar A, Melaab R, Doush IA. Mobile Application for Augmented Shopping: Virtual Shoe Try-on and Virtual Equipment Placement. In2022 8th International HCI and UX Conference in Indonesia (CHIuXiD) 2022 Nov 19 (Vol. 1, pp. 59-64). IEEE.

[7] Wu Y, Liu H, Lu P, Zhang L, Yuan F. Design and implementation of virtual fitting system based on gesture recognition and clothing transfer algorithm. Scientific Reports. 2022 Nov 1;12(1):18356.

[8] Sundari AA, Pareriya ND, Karna V. Development of Apparel 360°-An AR based Virtual Trial Room. In2023 International Conference on Digital Applications, Transformation Economy (ICDATE) 2023 Jul 14 (pp. 1-5). IEEE.

[9] Szegedy C, Vanhoucke V, Ioffe S, Shlens J, Wojna Z. Rethinking the inception architecture for computer vision. In Proceedings of the IEEE conference on computer vision and pattern recognition

2021 (pp. 2818- 2826).

[10] K. Khan. Image Detection Using OpenCV Python. In2023 International Research Journal of Modernization in Engineering Technology and Sci- ence (IRJMETS), vol. 5, no. 10, pp. 2111-2116, Oct. 2023.