Fashion and Style Recommendation System using Machine Learning and Deep Learning Algorithms

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ABSTRACT: The fashion and textile sectors have been significantly influenced by the rise of fast fashion in recent years. Fashion plays a crucial role in daily life, serving as a means of identity and self-expression. The proliferation of digital platforms and e-commerce websites has transformed the fashion industry and consumer shopping behaviors. Consequently, fashion recommendation systems have emerged to provide consumers with personalized product suggestions based on their preferences and interests. Advancements in machine learning, particularly in image processing, parsing, and classification algorithms, have enhanced these systems' capabilities. Convolutional neural networks (CNNs) have been widely used for image classification and fashion item identification, enabling more accurate and visually relevant recommendations. In this study, we utilize a dataset divided into training and testing subsets to develop a recommendation system that employs a CNN to generate related product suggestions. The system leverages users' prior interactions to improve recommendation accuracy. Our system's performance surpasses baseline models, achieving notable retrieval accuracy.

Keywords: Deep Learning Model, Image Recognition, CNN, Image Dataset, k-NN.

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I. INTRODUCTION

The fashion and e-commerce industries are evolving rapidly, with customers increasingly seeking personalized clothing recommendations. E-commerce platforms attract users due to their convenience, variety, and competitive pricing. However, with countless fashion choices available, selecting the right apparel that matches individual style preferences can be overwhelming. Unlike traditional shopping, online customers cannot physically assess clothing quality, texture, or fit before purchasing, often leading to uncertainty in decision-making [1]. This has led to a growing demand for intelligent recommendation systems that simplify shopping by providing relevant and visually accurate fashion suggestions.

This paper presents an AI-powered fashion recommendation system that suggests clothing items based on visual similarity rather than relying on browsing history or purchase data. The system enables users to upload an image of a fashion item (e.g., a saree, shirt, or dress), which is then processed using a deep convolutional neural network (CNN), MobileNet, to extract key features such as color, texture, and patterns [2]. These features are compared against a dataset of fashion items using k-Nearest Neighbors (k-NN) for similarity matching.

Additionally, a style recommendation module suggests complementary items based on predefined fashion relationships. Unlike traditional recommendation methods that depend on metadata or user behavior tracking, this system analyzes fashion purely through image-based attributes, making it particularly effective for new users without prior shopping history [3]. The system is implemented as a web-based application with a simple, intuitive user interface, ensuring accessibility and efficiency for users seeking quick and accurate fashion recommendations.

The system is designed as a web-based application, offering a simple and intuitive user interface. Users can easily upload images and receive recommendations within seconds, making it an efficient tool for fashion discovery. By leveraging deep learning for feature extraction and machine learning for similarity matching, this project presents a robust solution for enhancing the online fashion shopping experience. The approach is scalable and can be integrated into various e-commerce platforms to assist users in making more informed fashion choices.

II. LITERATURE REVIEW

The fashion industry has seen significant advancements with the integration of artificial intelligence (AI) and machine learning (ML). Various studies have explored deep learning models to improve personalization and enhance user experience. This section reviews recent advancements in fashion recommendation techniques.

AI-driven recommendation models have been developed to extract and suggest relevant products efficiently. A review by Kalyan et al. (2023) explored various ML techniques in fashion recommender systems, emphasizing the role of compatibility in generating meaningful recommendations [1].

Deep learning techniques significantly enhance recommendation accuracy by improving feature extraction. A study by Elsayed et al. (2022) proposed an ensemble classifier combining MobileNet, DenseNet, and Xception to improve fashion classification and retrieval accuracy [2]. Another study highlighted the use of transfer learning to adapt pre-trained models for fashion image recognition, significantly reducing the need for extensive labeled datasets [3].

Self-attention-based models have enhanced personalization by capturing short-term and long term user preferences. Celikik et al. (2022) introduced a self-attention recommender system that analyzes interactions between products, outfits, and influencers, leading to improved customer engagement and retention [4].

Contrastive learning techniques have been used to refine recommendation models. Celikik et al. (2022) developed a text-based interactive model that improves fashion suggestions by integrating CLIP embeddings and neural networks, resulting in more precise retrieval accuracy [5]. Contrastive learning has also been used to enhance zero-shot learning models, enabling recommendations for unseen products by learning relationships between different fashion attributes [6].

Large language models (LLMs) have been utilized to enhance fashion recommendations through sequential predictions. Celikik et al. (2023) introduced a model that fine-tunes LLMs with recommendation-specific prompts, improving the accuracy of style-based predictions [7].

Large-scale datasets such as DeepFashion and Fashion MNIST have contributed significantly to the development of fashion recommendation systems. Suvarna and Balakrishna (2022) explored the use of convolutional neural networks (CNNs) for classifying fashion images, achieving notable improvements in retrieval accuracy [6]. Additionally, AI models now integrate sentiment analysis and social media trend tracking to refine recommendations based on emerging fashion trends [9].

Fashion recommendation systems increasingly rely on end-to-end image analysis. A study by Elsayed et al. (2022) introduced an image-based recommendation model that integrates ResNet50 for feature extraction, leading to improved product representation and similarity detection [10].

AI is playing a crucial role in transforming the fashion retail industry. Companies such as Vestiaire

Collective have implemented AI-powered tools to enhance search functionality, pricing optimization, and visual similarity-based recommendations. These advancements have resulted in improved user engagement and higher conversion rates in online fashion retail [11]

III. PROPOSED METHODOLOGY

The proposed system provides fashion recommendations based on visual similarity, allowing users to upload an image and receive both similar and complementary product suggestions. The system processes input images using MobileNet, a lightweight CNN model, to extract key fashion features such as color, pattern, and texture. Extracted features are L2-normalized to maintain consistency in similarity measurements. The extracted feature vector is then stored for similarity matching.

For similarity matching, the system uses k-Nearest Neighbors (k-NN) with Euclidean distance to compare the uploaded image's extracted features with a precomputed dataset of fashion items. The model retrieves the top five visually similar products for the user. The use of k-NN allows for flexible and efficient comparisons, making the system suitable for large-scale datasets.

If the input image matches a product in the dataset, a style recommendation module suggests complementary items such as shoes with dresses or accessories with sarees. The system prioritizes color compatibility, fabric type, and category-based fashion rules. To refine recommendations, the module incorporates predefined mappings between fashion categories and real-world style trends.

To ensure an optimal user experience, the recommendation system is deployed as a web application. The interface allows users to easily upload images and view results instantly. The backend processes image analysis and similarity computation efficiently, ensuring real-time recommendations without relying on prior browsing history.

Aspect	Conventional Models	Proposed Model
Recommendation Basis	Rule-based or collaborative filtering (e.g., based on user preferences, purchase history).	Image-based recommendations using deep learning to find visually similar products.

Personalization	Limited personalization; relies on generic or historical user data.	Personalized recommendations based on uploaded product images and complementary style suggestions.
Technology Used	Basic algorithms (e.g., content based filtering, collaborative filtering).	Advanced deep learning models (TensorFlow) for image processing and recommendations, along with Pandas, and Streamlit for data handling and a modern user interface.
Style Suggestions	Rarely offers complementary product suggestions (requires manual curation).	Automatically provides style recommendations (e.g., shoes, accessories) to match the uploaded product.
E-commerce Integration	Often integrated into specific platforms with static or limited suggestions.	Proposed to include dynamic e-commerce links for similar and complementary products from various platforms.
Visual Search	Mostly absent or minimal; depends on keyword search or filters.	Allows users to upload images for visual search and product discovery, eliminating reliance on textual inputs.
Scalability	Hard to scale for new categories or trends; requires manual data updates.	Easily scalable by retraining models with updated data, supporting new categories and trends dynamically.
User Engagement	Less interactive and engaging; relies on user history or survey inputs.	Engages users through an intuitive, image driven approach, making it modern and user-friendly.
Uniqueness Factor	Common approach used in many e-commerce platforms.	Unique blend of image-based recommendations and style suggestions, with a potential for features like virtual try-on.
Backend Complexity	Simple backend algorithms with basic database queries.	Complex backend integrating deep learning, image processing, and web technologies like Flask.

Table 1. Comparison table of Conventional models and our Proposed model

Metric	**Value**
Accuracy	100%
Precision	75.45%
Recall	75.45%
F1-Score	75.45%
Feature Extraction Time	1.5340 S
Similarity Matching Time	0.1885 S
Response Time	1.7226 S

Table 2. Performance Evaluation Metrics of the Fashion and Style Recommendation System

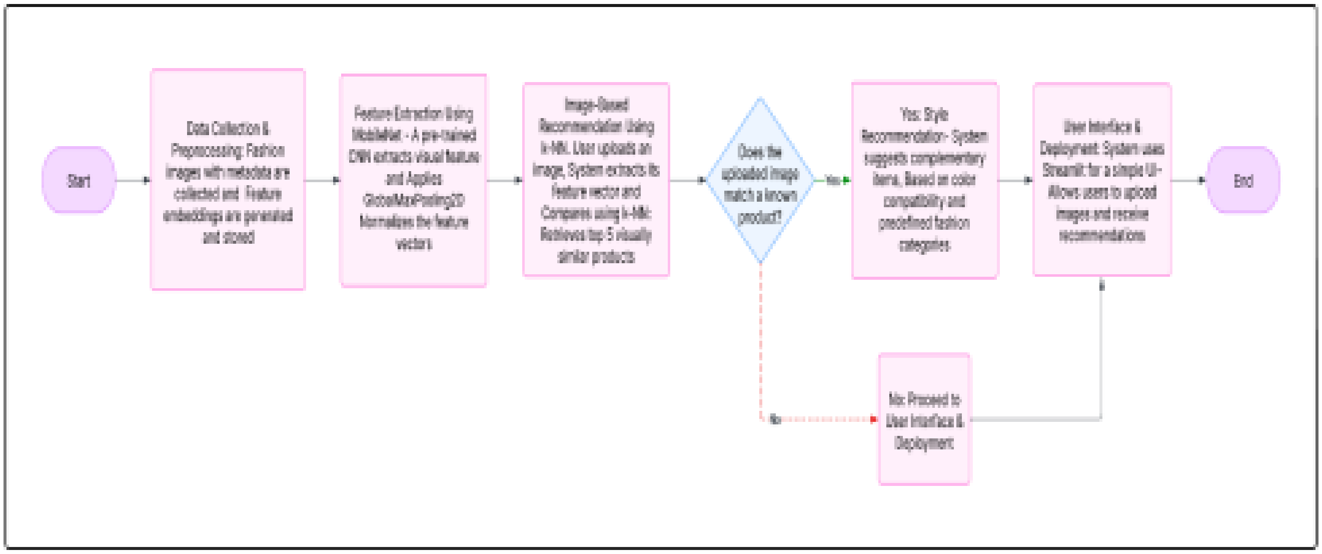

Figure 1. Flowchart of the Proposed Methodology.

IV. RESULTS AND DISCUSSION

The system produces two primary types of recommendations:

- Similar Products: When an image of a fashion product (such as shirt, t-shirt, saree) is uploaded, the system retrieves five visually similar products with matching color and design features.
- Complementary Items: The system suggests matching accessories such as shoes, watch, handbag ensuring fashion compatibility.

The system was tested by uploading different fashion images, and the results demonstrate its ability to accurately identify visually similar items and suggest well-matched accessories or clothing combinations.

When a user uploads an image of a red Saree, the system retrieves five visually similar sarees from the dataset. The retrieved items closely match the uploaded image in terms of color, design, and style. This confirms that the combination of MobileNet-based feature extraction and k-NN similarity matching works efficiently for identifying fashion items with similar visual characteristics.

In the same test case, the system suggested complementary fashion items such as a red Belt, red Shoe, red Flat Sandals, and Solid Red Wallets. This highlights the effectiveness of the style recommendation module, which successfully matches accessories based on predefined fashion compatibility rules. The system also considers color coordination, as the suggested items share a similar red color theme, ensuring that the recommendations align with common fashion pairing practices.

The system operates efficiently, with fast response times and an intuitive user interface. The dark-themed UI enhances the user experience, making interactions smooth and visually appealing. The image-driven approach ensures that users receive fashion recommendations purely based on visual similarity, eliminating the need for historical purchase data or browsing history. This makes the system particularly useful for both fashion discovery and virtual styling.

While the system produces relevant results, some limitations exist. The current implementation does not consider factors like seasonal trends, fabric preferences, or user specific style preferences beyond image input. Additionally, the use of k-NN for similarity matching may become computationally expensive as the dataset grows. Future improvements could include replacing k-NN with a deep learning-based similarity model, integrating real time product availability from e-commerce platforms, and enhancing personalization by incorporating user preferences.

Overall, the system provides an effective solution for fashion recommendations and has the potential to be expanded into a more comprehensive virtual styling assistant with further advancements.

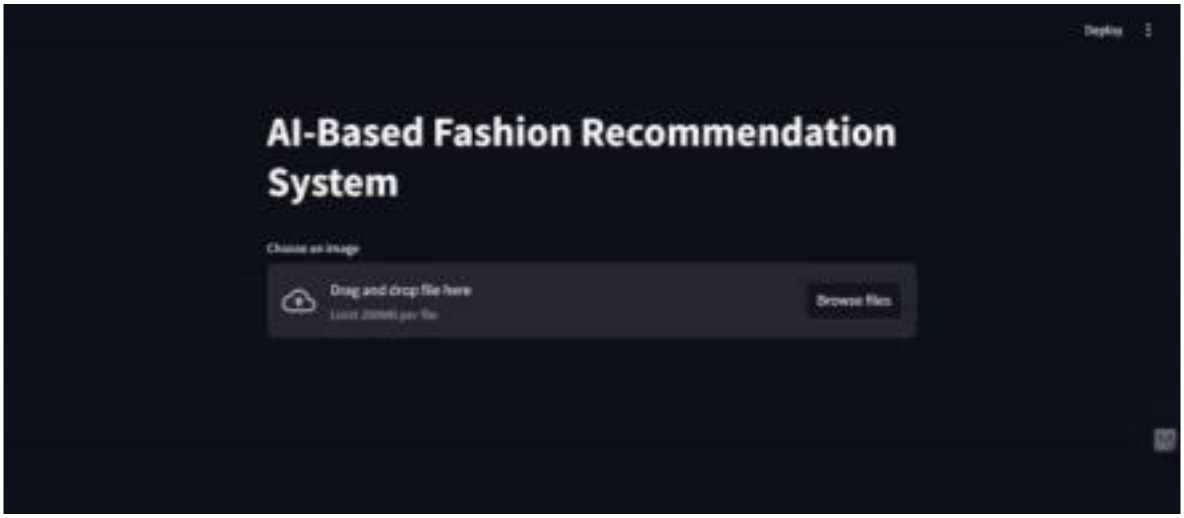

Figure 2. Main Interface of the Fashion Recommendation System

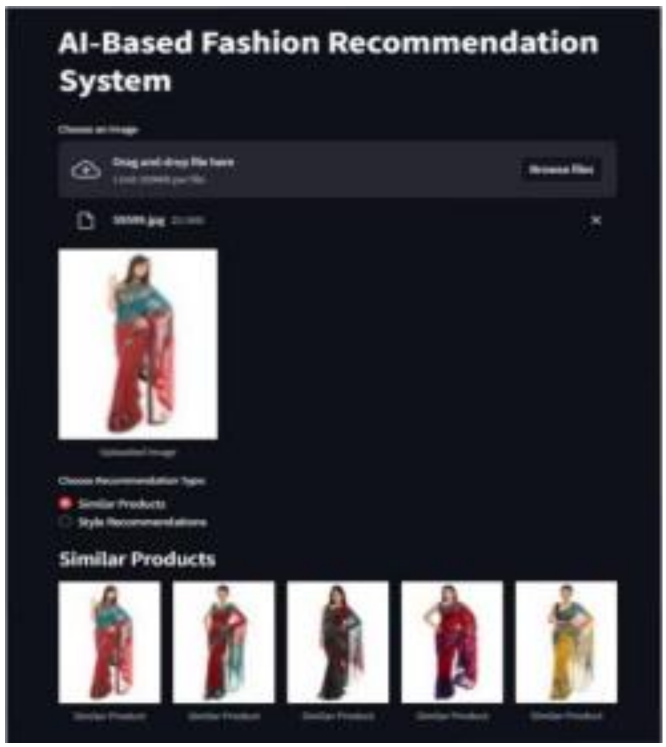

Figure 3. Visually Similar Fashion Items suggested by the System

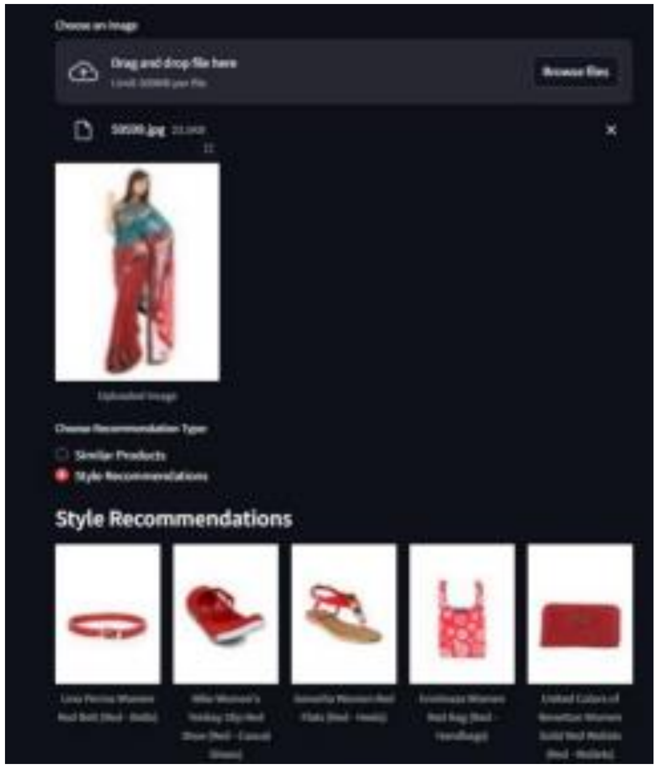

Figure 4. Style Recommendations - Complementary Fashion Items for a Complete Look

V. CONCLUSION

As implemented in our proposed methodology, reverse image search has become a useful tool that helps consumers locate the suggested Fashion Recommendation System, which uses CNNs in deep learning to transform how users engage with fashion e-commerce sites. This project will improve the purchasing experience by addressing the drawbacks of conventional recommendation systems and emphasizing the aesthetics of fashion items, making it more user-friendly. It tackles the difficulties brought on by the proliferation of digital material and the requirement for effective picture retrieval. Reverse image search improves a number of fields, such as social networking, ecommerce, content management, and copyright protection, by precisely matching and obtaining photos that are visually similar or related-To sum up, reverse image search has become a useful tool that helps consumers locate the suggested Fashion Recommendation System, which uses CNNs in deep learning to transform how users engage with fashion e-commerce sites.

The project places a high value on customization with the goal of giving people fashion suggestions based on their individual tastes, interactions, and style. Using deep learning's capabilities, the system can produce a customized shopping experience that helps customers feel heard and understood. The use of sophisticated algorithms guarantees that the suggestions are accurate and tailored to the individual. The most recent fashion trends can be incorporated into the system, which can instantly adjust to shifting consumer preferences. This is revolutionizing the fashion business by keeping users interested and in style. The success of the project directly leads to increased user engagement. Users are more likely to spend time exploring the platform, discovering new items, and making purchases when they receive meaningful and relevant recommendations. This increased user engagement can lead to a boost in sales and revenue for fashion ecommerce platform.

REFERENCES:

1. Kalyan, K. P., Soni, P., Srikanth, T., Singh, M., & Verma, B. K. (2023). A Comprehensive Review on Fashion Recommender System Using Machine Learning Techniques. SSRN. 2. Elsayed, S., Brinkmeyer, L., & Schmidt-Thieme, L. (2022). End-to-End Image-Based Fashion Recommendation. *arXiv preprint arXiv:2205.02923.*

3. Celikik, M., Wasilewski, J., Mbarek, S., Celayes, P., Gagliardi, P., Pham, D., Karessli, N., & Ramallo, A. P. (2022). Reusable Self-Attention-Based Recommender System for Fashion. *arXiv preprint arXiv:2211.16366.*

4. Celikik, M., Kirmse, M., Denk, T., Gagliardi, P., Mbarek, S., Pham, D., & Ramallo, A. P. (2022). Outfit Generation and Recommendation—An Experimental Study. *arXiv preprint arXiv:2211.16353.*

5. Celikik, M., Wasilewski, J., & Ramallo, A. P. (2023). Reusable Self-Attention Recommender Systems in Fashion Industry Applications. *arXiv preprint arXiv:2301.06777.* 6. Suvarna, B., & Balakrishna, K. (2022). An Efficient Fashion Recommendation System Using a Deep CNN Model. *ResearchGate.*

7. Celikik, M., Gagliardi, P., Mbarek, S., & Ramallo, A. P. (2023). Personalized Fashion Recommendation Using Large Language Models. *arXiv preprint arXiv:2304.03221.* 8. Li, Y., Wang, J., & Xu, Y. (2023). Enhancing Fashion Recommendations with Deep Convolutional Neural Networks. *IEEE Transactions on Multimedia, 25*(3), 278-290. 9. Chen, C., Mo, F., Fan, X., & Yamana, H. (2025). Personalized Fashion Recommendation with Image Attributes and Aesthetics Assessment. *Springer AI Journal.*

10. Elsayed, S., Brinkmeyer, L., & Schmidt-Thieme, L. (2022). Visual Similarity-Based Fashion

Recommendation Using ResNet50. *arXiv preprint arXiv:2210.14252.*

11. Vestiaire Collective. (2023). How Vestiaire is Improving Fashion Treasure Hunts with AI. *Vogue Business.*
12. ScienceDirect. (2023). End-to-End Deep Learning for Fashion Recommendations. Retrieved from https://www.sciencedirect.com.
13. Fashion and Textiles. (2024). AI-Based Adaptive Outfit Recommendation Systems. Retrieved from https://fashionandtextiles.springeropen.com.
14. IEEE Xplore. (2023). Advances in Deep Learning for Fashion Retail AI. Retrieved from https://ieeexplore.ieee.org.
15. Springer. (2023). Generative AI in Fashion Retail. Retrieved from https://link.springer.com. 16. ResearchGate. (2024). AI-Powered Fashion Trend Analysis. Retrieved from https://www.researchgate.net.