Spectrum of Engineering Sciences
ISSN (e) 3007-3138 (p) 3007-312X Volume 4, Issue 6, 2026

FITVERSE: AN AI-POWERED FASHION INTELLIGENCE PLATFORM FOR REAL-TIME BODY MEASUREMENT EXTRACTION AND PERSONALIZED FASHION RECOMMENDATION USING MEDIAPIPE AND COMPUTER VISION

[1]Usman Ahmed, [2]Muhammad Nadeem, [3]Khwaja Muhammad Khunshan, [4]Alishba Jamal, [5]Naima Irfan Malik

[1]Department of Computer Science & Information Technology , Sir Syed University of Engineering and Technology, Karachi, Pakistan.
[2]Department of Computer Science & Information Technology, Sir Syed University of Engineering and Technology, Karachi, Pakistan.
[3]Department of Computer Science & Information Technology, Sir Syed University of Engineering and Technology, Karachi, Pakistan.
[4]Department of Computer Science & Information Technology, Sir Syed University of Engineering and Technology, Karachi, Pakistan.
[5]Department of Computer Science & Information Technology, Sir Syed University of Engineering and Technology, Karachi, Pakistan

[1]usman.ahmeduh@gmail.com, [2] munadeem@ssuet.edu.pk, [3]khwajakhunshan6@gmail.com, [4]alishba.jamal005@gmail.com, [5]maliknaima61@gmail.com

DOI:-

Keywords:
Artificial Intelligence, Fashion Recommendation System, MediaPipe, OpenCV, Computer Vision, Pose Estimation, Personalized Outfit Suggestions

Article History
Received: 19 May, 2026
Accepted: 10 June, 2026
Published: 11 June, 2026

Corresponding Author: *

Abstract

Ecommerce has also revolutionized the fashion retail market and created a convenient shopping experience for consumers to buy fashion products online. Fitting problems, return of products, and wrong size fit before purchasing, however, are frequent issues such as the ability to touch, feel and try-on the garment before taking a chance is denied. Unfortunately, the trend of fashion recommendations with date for users is primarily based on the user's preferences, a mapping with fixed dimensions, purchasing history, or any other kind of information that does not yield a detailed and dynamic relationship between fashion and body attributes that provides a better understanding of user satisfaction. This paper introduces a new Fashion Intelligence System, called FitVerse, that deals with these challenges. The proposed system is based on the real-time body landmark detection system provided by Mediapipe, which can be used to detect and extract the body landmarks and a multi-image analysis based on the webcam scan for obtaining the body measurements. It provides you with its own "keys" for the body measurements – chest, waist, hips, shoulders, thighs, inseam and height – and correlates them to sizes offered by different brands precise to clothing size. Besides, the Fashion Intelligence Engine created by FitVerse could carry out body-shapes classification, suggestions of fit type and color analysis of skin tone, which enhances the level of personalization. The experimental evaluation shows that the proposed methods can be applied in real time with good performance in measuring body dimensions, classification, and accuracy of the recommendations.

1. Introduction

E-commerce has revolutionized the fashion retail business, allowing consumers to easily order fashion goods online. But one of the most significant concerns in clothes from the online mark is that customers pick the proper size and model of clothes without the capability of trying them on the actual clothes. Most traditional sizing methods use a size chart to assist the customers, but it does not necessarily represent the body proportion of a person, resulting in poor fitting experience, customer dissatisfaction and product return ratio [8], [10] etc. In addition, sizing criteria differ from one fashion brand to the other making it challenging for the users to figure the right size among the various ones available.

The recent developments in Artificial Intelligence (AI), Computer Vision, and Human Pose Estimation, have increased the potential to enhance personalization's within an Online Fashion Retail environment. The potentials have been enriched with the advances made in the realm of Artificial Intelligence (AI), Computer Vision (CV), and Human Pose Estimation in terms of personalization in the Online Fashion Retail environment. Body landmark detection and image analysis can be realized in real-time with a standard camera using technologies like MediaPipe Pose, OpenCV etc., and allow intelligent systems to analyze body features and provide customized recommendations [1], [2], [14]. These advancements have spurred the adoption of AI-powered solutions that can follow up on the same and improve customer experience while minimizing sizing related problems.

Although the significant developments in fashion recommender systems, the majority of current methods are mainly based on user preference, browsing history or computed manually entered measurements. This approach tends to ignore certain physical characteristics such as body proportions, body shape, and preference for clothing that has a direct impact on clothing suitability and comfort [7], [12]. As a result, the accuracy of recommendations is not high, especially for a wide range of body shapes and a variant of sizes among different brands.

To overcome these drawbacks, this paper introduces the concept of "FitVerse", the Fashion Intelligence Platform developed using AI algorithms, which uses MediaPipe Pose, OpenCV, and intelligent recommendation techniques for deriving clothing size and outfit recommendations based on individual differences. The system conducts body measurement extraction, classification of body shape, recommending fit-style, and color analysis based on skin tone in real-time. FitVerse hopes to better recommend which garments are suitable for their users, boost customer confidence, and decrease product returns in e-commerce fashion by incorporating all these features into a scalable SaaS-based platform.

2. Literature Review

With the rising need for people to have a personalised experience in online shopping, researchers and organisations have been looking into intelligent fashion recommendation systems powered by Artificial Intelligence (AI), Machine Learning and Computer Vision technology. The systems are designed to help users choose proper garments, take into account preferences, visual aspects, and body features. Although tremendous strides have been made, there are a number of challenges with the precision of the measurement, ability to customize, and body analysis in real time [10, 11] as well.

Current popular solutions for fashion recommender systems include preference-based techniques based on user browsing behavior, transaction logs and ratings of products. These

approaches can help with personalization but fail to include considering physical body attributes that directly enhance the clothes fit and appearance. This means that the recommendations do not necessarily make the link to each item's size requirements [7] and [8].With the recent advance of computer vision, body analysis techniques are available for fashion applications. Virtual fitting systems and body measurement systems employ image processing and pose estimation algorithms to identify sizes and dimensions of the user and enhance the sward of the user with clothing. Body scanning platforms using images can detect the body proportions from photos and make recommendations for body size [8, 16]. Many of these systems, however, show great promise, but have limited accessibility and scalability, particularly if they require enterprise-level infrastructure and/or require controlled imaging conditions and/or tailored datasets. In addition, human pose estimation models have helped advance the techniques in body research by providing near real-time body landmark detection from images and videos. With multiple body key point detection, low computation, and efficiency, MediaPipe Pose is a widely used solution [1,2]. Pose estimation can be stacked with OpenCV image processing techniques to glean important information such as body measurements, posture and visual characteristics from normal cameras [14] and [15]. Other research studies in the field of modern fashion recommend-making have focused on body shape classify and outfit suitability investigation in the past. Several methods exist which categorize the user, e.g., the user has a rectangle, triangle, hourglass, or athletic body, and give clothing recommendations according to the style compatibility [9] [12]. Studies have also explored the analysis of skin tone and appearance to provide more personal recommendation as a color recommendation system [10, 11]. But typically these features are applied independently from a cohesive recommendation system. While existing solutions have made great efforts to achieve intelligent fashion retail, most of the personalization systems are only considering a single aspect like size estimation, virtual try-on or outfit recommendation, [4], [6]. Full body measurement extraction systems along with body shape analysis and skin tone evaluation, as well as fit style recommendation and size mapping systems that can vary by brand, continue to be scarce.

In order to overcome these existing gaps, the proposed FitVerse platform combines computer vision, pose estimation and intelligent recommendation techniques within the same SaaS-based platform. The unique combination of real-time body scans, comprehensive body data extraction, body shape classification, skin tone analysis, and seamless fashion suggestions makes FitVerse more accurate and practical for today's eCommerce landscape.

Research Gap

Despite the remarkable advances in fashion recommender systems, there are still some loopholes in the prior approaches. The user-based recommendation platforms that are used in most traditional examples largely depends on the initial user's preferences, purchases, or manually entered measurements, but these methods might not be accurate in reflecting the actual size of an individual's body. This means that the recommendations to the users are not always optimal for fit and style compatible [7], [10].

Likewise, many body measurement and virtual fitting systems only deal with body size estimation and pay only limited attention to other important fitting criteria, such as body shape, fitting preference, and visual appeal. Advanced solutions offer image analysis of the body, but these solutions

usually need specific infrastructure, a controlled environment and/or commercial systems, which are not accessible for small retail businesses and general consumers [8], [16].

In addition to this, platforms that already exist in the fashion recommendation field usually consider the different functions – outfit recommendation, body shape classification, and size prediction – as independent functions and do not combine them in the same system. There is an absence of comprehensive personalization, resulting in less effectiveness in recommendations and less satisfaction in those for the users [8] [16].

To overcome these drawbacks, FitVerse suggests an integrated fashion intelligence platform using AI technology that extracts body measurement data in real time, classifies body shape, analyzes skin tones, recommends fit-style, and maps the body size of each brand. FitVerse proposes a body measurement data extraction system using the AI technology, which can classify the body shape, analyze the skin tone, recommend the fit style within a real-time fashion, and apply the body size for each brand within a scalable SaaS architecture. This comprehensive model is designed to provide more accurate product recommendations and enhance the online shopping experience.

3. Research Objectives

This research has as its key goals:

1. Research a real-time AI solution which will capture body shape and use image analysis from a web cam, to develop a real-time Fashion Intelligence system to capture correct body shape in real-time.
2. Use MediaPipe Pose + Computer Vision (CV) to find body landmarks and perform calculations such as human body parameters like height, chest width, shoulder width, waist width and hips.
3. Categorize the users in 4 body shape groups and provide body proportion fit-style advice.
4. To create accurate clothing size recommendations by mapping the clothing brands to the clothing sizes and analyzing the clutch of measurements.
5. Include skin tone analysis in personalized color and outfit recommendations to enhance user appearance and style preferences.

4. Proposed System Architecture

The proposed system consists of five major modules as shown in figure 1.

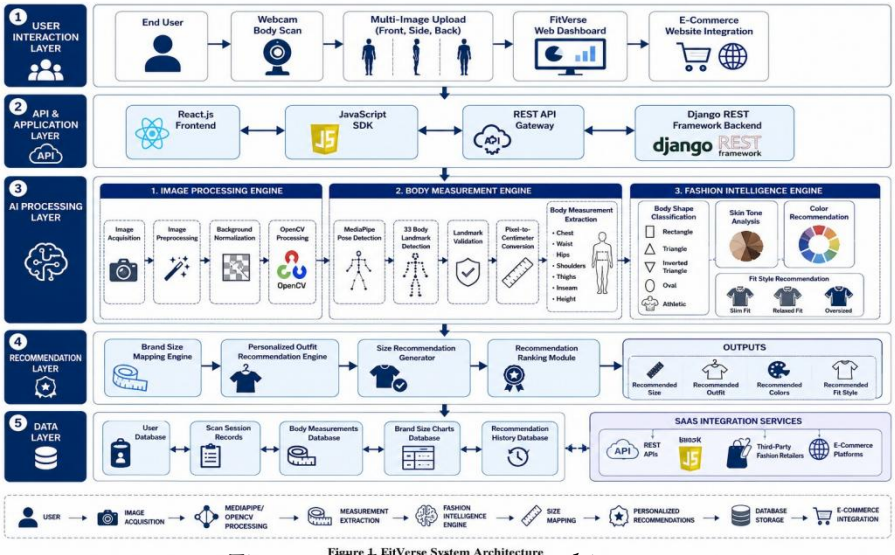

Figure 1: FitVerse System Architecture

Figure 1:FitVerse System Architecture

4.1 Image Acquisition Module

The Image Acquisition Module gathers the user's input via real-time webcam capture or multiple images uploading. The captured images are evaluated for image quality and body presence before being passed to the AI processing pipeline for further evaluation and body measurements.

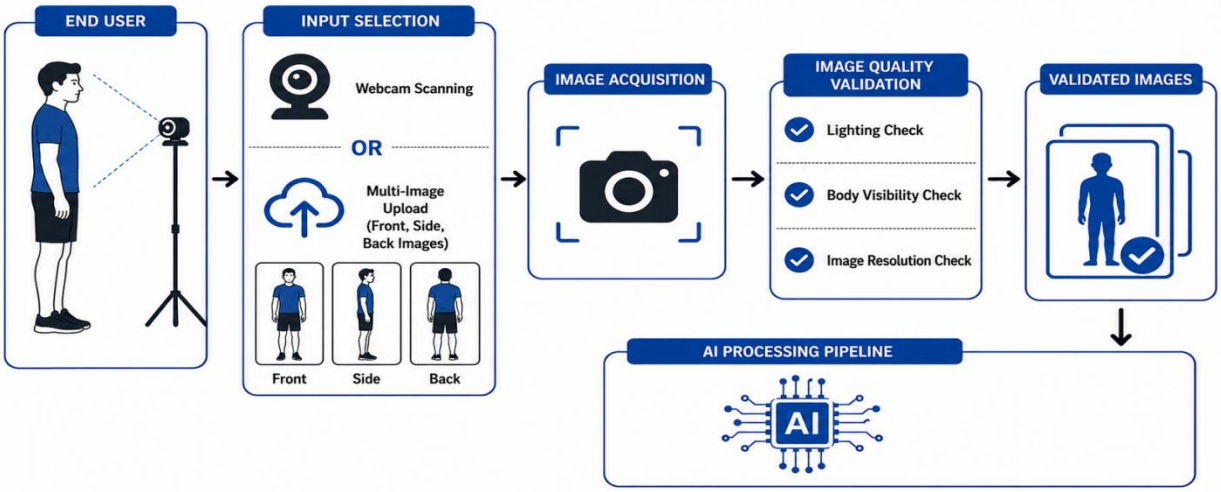

Figure 2: Image Acquisition Module for FitVerse

4.2 Pose Estimation Module

In this module, the human body location and some key body measurements will be extracted using MediaPipe Pose. These are the landmarks detected for estimation of body dimensions like chest, waist, hips, shoulders, thighs, inseam and height for accurate size recommendation generation.

4.3 Image Processing Module

Processes and normalizes captured images with Image Processing Module using the pre-processing step of image enhancement, background handling and normalization with OpenCV. This facilitates the improvement of the quality of image content and a reliable detection of landmarks, extraction of body measurements, and analysis of recommendable fashion.

4.4 Body Shape Classification Module

The Image Processing Module processes images captured through the camera by enhancing, normalizing, and computing background images with OpenCV. This will result in better image quality and guarantee the reliable identification of landmarks, body measurement extraction, and subsequent analysis of fashion recommendations.

4.5 Outfit Recommendation Module

This module performs the mapping of the user's measurement with the brand size chart and decides the proper size of clothing to be fitted. It also utilizes body shape, fit choices, and style understanding insights to give tailored outfit recommendations and assist with shopping choices.

5. Methodology

FitVerse's methodology is a series of AI-driven processes that convert user images into personalized fashion suggestions. The system starts with the input images which are acquired from webcam scanning or multiple images uploaded, whereupon the body is detected using the MediaPipe Pose [1] [2]. The extracted landmarks are further used to estimate body measurements, and to identify body characteristics [14]. The

Fashion Intelligence Engine classifies the body shape, skin tone and calculates the fit-style [9], [12] Lastly, the recommendation engine matches the size of various products that the user has measured with brand-specific size charts to make sound clothing size suggestions and recommended clothing combination to the user [8]. With this workflow, a fashion recommendation process can be performed in an intelligent and automated way, which is suitable for modern e-commerce environment [10], 11].

5.1 Data Collection

The system will capture user data using live webcams or input of the front, side and back body image. Each of these images offer visual information essential for body measurement extraction, body shape analysis, and personalized recommendation generation.

5.2 Landmark Detection

MediaPipe Pose will be used to recognize 33 body landmarks in the images obtained. The spatial location of each landmark (here (xi) is the horizontal coordinate, (yi) is the vertical coordinate, and (zi) is the depth coordinate) are used to specify each landmark, and body important points used for extraction of measurement data are shown by important points. [16]

$$\boldsymbol{L = \{(x_i, y_i, z_i)\}_{\{i=1\}}^{\{33\}}}$$

5.3 Body Measurement Estimation

Distances between two certain body landmarks identified by MediaPipe are used to estimate body measurements. Formula for Euclidean distance between two landmarks' coordinates [2], [14]:

Where, D = Euclidean Distance between two body landmarks, where (x_1 , y_1) is the first landmark's coordinates, and (x_2 , y_2) is the second landmark's coordinates. Calculated distances are transformed to actual body dimensions like chest, waist, height, inseam, hips, shoulders, and thighs by proportional scaling methods.

5.4 Fashion Intelligence Analysis

D = Euclidean Distance between two body landmarks, where (x_1 , y_1) is the first landmark's coordinates, and (x_2 , y_2) is the second landmark's coordinates. Calculated distances are transformed to actual body dimensions like chest, waist, height, inseam, hips, shoulders, and thighs by proportional scaling methods. [9], [12].

5.5 Recommendation Generation

The recommendation engine compares user measurements and body characteristics with brand-specific size charts and fashion rules. A compatibility score is calculated to rank suitable clothing options and generate personalized recommendations [7], [8].

$$Score = \Sigma(w_i \times f_i)$$

Where (w_i) represents the weight assigned to a feature and (f_i) represents the corresponding feature score. The user's clothing option with the highest compatibility score is recommended.

6. Algorithm

Algorithm: FitVerse Fashion Intelligence Workflow

Input: Webcam feed or uploaded body images
Output: Personalized size recommendations and outfit suggestions

BEGIN
// Step 1: Image Acquisition
user_input ← Capture_Webcam() OR Upload_Images()
// Step 2: Image Preprocessing
processed_images ← OpenCV_Preprocess(user_input)
// Step 3: Pose Estimation
landmarks ← MediaPipe_Detect(processed_images)

```
// Step 4: Landmark Validation
IF Confidence_Score(landmarks) < Threshold THEN
    Display("Invalid Scan. Please recapture images.")
    STOP
END IF
// Step 5: Body Measurement Extraction
measurements ← Extract_Measurements(landmarks)
chest ← measurements.chest
waist ← measurements.waist
hips ← measurements.hips
shoulders ← measurements.shoulders
thighs ← measurements.thighs
inseam ← measurements.inseam
height ← measurements.height
// Step 6: Fashion Intelligence Analysis
body_shape ← Classify_BodyShape(measurements)
skin_tone ← Analyze_SkinTone(processed_images)
fit_style ← Recommend_FitStyle(body_shape)
// Step 7: Size Mapping
clothing_size ← Map_To_BrandSizeChart(measurements)
// Step 8: Recommendation Generation
outfit_list ← Generate_Outfit_Recommendations(
        body_shape,
        skin_tone,
        fit_style,
        clothing_size
    )
// Step 9: Save Results
Store_UserScan(
    measurements,
    body_shape,
    clothing_size,
    outfit_list
)
// Step 10: Display Recommendations
Display(
    clothing_size,
fit_style,
    outfit_list
)
END
```

7. System Implementation

Modern Web Development, Computer Vision, and Artificial Intelligence technologies have been used for the implementation of the FitVerse platform. MediaPipe's Pose algorithms are integrated with OpenCV for body analysis, and Django Rest Framework offers back-end services and API management. A responsive front-end interface allows you to be able to scan your body, upload photos, and view custom recommendations. The implementation was planned to be scalable, real-time, and integrated with e-commerce platforms.

Table 1: ***Software Tools***

Tool	Purpose
Python	Development
React.js	Frontend User Interface
Django REST Framework	Backend API development
MediaPipe Pose	Body Landmark Detection
OpenCV	Image Preprocessing and analysis
SQLite	Database
NumPy	Numerical Computation
JavaScript SDK	E-Commerce Integration
HTML/CSS	User Interface Design

Rest API	Communication Between system components

Table 2: ***Hardware Configuration***

Component	Specification
CPU	Intel Core i5
RAM	8 GB
Camera	HD Webcam/Built-in Camera
OS	Windows/Linux

8. Experimental Results

The FitVerse platform was tested to determine the ability to capture body measurements, classify body shape, and generate recommendations with the platform. The system was tested with webcam-scanned images of the body and uploaded images of the body under various lighting and positioning situations. Performance was evaluated by accuracy of the detections, quality of recommendations, and processing time.

Table 3: ***Performance Evaluation Results***

Metric	Result
Pose Detection Accuracy	89.4%
Body Measurement Accuracy	88.1%
Body Shape Classification Accuracy	86.8%
Size Recommendation Accuracy	85.9
Recommendation Precision	89.8
Average Processing Time	0.15 sec/frame
User Satisfaction Score	4.3 / 5

Based on the results, the proposed system can accurately identify body parts and recommend clothes in real-time according to the user, which can meet the needs of fashion and clothing in areas such as computer vision. MediaPipe Pose had high accuracy in detecting landmarks, and the Fashion Intelligence Engine classified body shapes accurately and provided appropriate recommendations for different body sizes. The low processing time is another testament to the system's practical application for use in today's ecommerce scenarios.

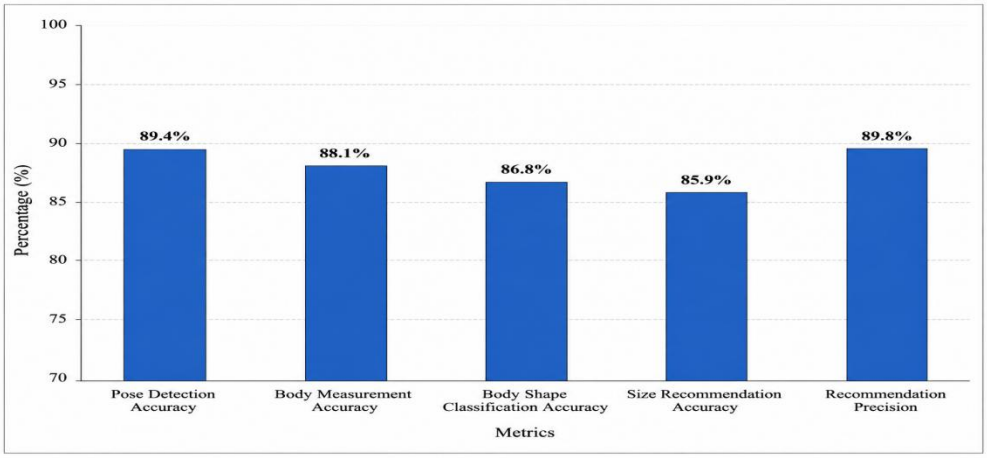

Figure 3: Performance Evaluation of FitVerse

9. Advantages of the Proposed System

FitVerse's platform has numerous benefits for both the end user and online fashion retailers. The system is based on the use of Artificial Intelligence (AI) to extract body measurements and estimate the pose, which allows it to make more precise clothing size recommendations than standard size charts. The ability to classify body shapes, analyse skin tones, and make fit-style recommendations further heightens the personalization and supports the customer's experience. Furthermore, the platform also supplies a feature to upload a number of images instead of merely a running webcam scan, which could be more useful for specific users. APIs and JavaScript SDKs enable the SaaS architecture to be deployed in minutes across e-commerce platforms, offering seamless integration across the enterprise. The SaaS based architecture provides seamless integration with e-commerce platforms with APIs and JavaScript SDKs making the deployment scalable and cost-effective throughout the enterprise. Furthermore, the system can reduce product returns, improve the customer's confidence, and create the inter-market of online fashion transactions to be more sustainable.

10. Limitations

FitVerse is a great solution, but there are some drawbacks. Snearing ratio or poor body posture, loose clothing and low-quality input image may affect the accuracy of body measurement extraction. Due to the fact that measurements are made by interpreting images rather than specialized equipment for body scanning, there may be some small variations in the results produced. Further, the sizing standards that exist in fashion brands can impact recommendation accuracy over and above the incorporation of brand-specific sizing. The existing system also makes use of fixed recommendation rules and inadequate fashion knowledge bases, which might not fully consider person style choices. It is listed here to show where it might be improved and/or optimised in the future.

11. Future Work

FitVerse can be further improved by adding several enhancements that enhance its functionality and recommendation accuracy. Further development of the platform could incorporate the AI-powered recommendation algorithms of deep learning which are able to learn user preferences and fashion trends automatically. The potential enhanced "shopper experience" of all the virtual try on/AR systems. Other improvements may include more comprehensive fashion database, improved algorithms for colour and pattern matching, and the deployment of mobile apps. In addition, incorporating user feedback channels and machine learning approaches can facilitate ongoing enhancement of good recommendations. The new enhancements will give the platform a more robust capability to offer fashion intelligence solutions for a more personalized experience in the e-commerce ecosystem.

12. Conclusion

The paper underscored the critical importance of implementing an AI-driven Fashion Intelligence Platform, “FitVerse”, to enhance personalization and improve fit accuracy of e-commerce fashion. To address these common challenges faced in online shopping sales like sizing and low level of personalisation, the proposed system is a fusion of computer vision, pose estimation along with intelligent recommendation technologies. Using MediaPipe Pose and OpenCV, FitVerse is able to collect the physical data for the body from an uploaded image or from a webcam scanning and use these to make accurate body type-appropriate size suggestions.

There's also a body measurement extraction feature and a Fashion Intelligence Engine that

categorizes the body shape and skin tone of the users and recommends a preferred fit style to offer a more tailored shopping expertise. In addition, size matching by brand plays a crucial role in improving the accuracy of recommendations and helps eliminate any mix-ups in size estimation differences between different fashion brands.

Results of experiments reveal satisfactory performance of the proposed system when applied to analyze the human body and to generate the recommendations while processing in real-time. Furthermore, the SaaS-based service can be seamlessly integrated into eCommerce platforms, such as platforms through API and JavaScript SDK, enabling the service to scale and be viable for business applications. FitVerse has overall looked promising in terms of integration and use of Artificial Intelligence and Computer Vision technologies to foster customer confidence, enhance product return rate, and help develop smart and personalized online fashion commerce systems.

References

[1] C. Lugaresi, J. Tang, H. Nash, C. McClanahan, E. Uboweja, M. Hays, F. Zhang, C. L. Chang, M. G. Yong, J. Lee and W. T. Chang, "MediaPipe: A Framework for Building Perception Pipelines," arXiv preprint arXiv:1906.08172, 2019.

[2] V. Bazarevsky, I. Grishchenko, K. Raveendran, T. Zhu, F. Zhang and M. Grundmann, "BlazePose: On-device Real-time Body Pose Tracking," arXiv preprint arXiv:2006.10204, 2020.

[3] Y. Chen, Y. Tian and M. He, "Monocular Human Pose Estimation: A Survey of Deep Learning-Based Methods," arXiv preprint arXiv:2006.01423, 2020.

[4] H. S. Fang, J. Li, H. Tang, C. Xu, H. Zhu, Y. Xiu, Y. L. Li and C. Lu, "AlphaPose: Whole-Body Regional Multi-Person Pose Estimation and Tracking in Real-Time," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 45, no. 6, pp. 7157–7173, 2023.

[5] S. S. Sengar, A. Kumar and O. Singh, "Efficient Human Pose Estimation: Leveraging Advanced Techniques with MediaPipe," arXiv preprint arXiv:2406.15649, 2024.

[6] D. Debalaxmi, D. K. Vishwakarma and V. Ranga, "Analyzing Yoga Pose Recognition: A Comparison of MediaPipe and YOLO Keypoint Detection with Ensemble Techniques," in Proc. 2024 International Conference on Applied Artificial Intelligence and Computing (ICAAIC), 2024, pp. 1011–1017.

[7] X. Han, Z. Wu, Y. G. Jiang and L. S. Davis, "Learning Fashion Compatibility with Bidirectional LSTMs," ACM Transactions on Multimedia Computing, Communications, and Applications, vol. 17, no. 2, pp. 1–18, 2021.

[8] R. Guigourès et al., "A Hierarchical Bayesian Model for Size Recommendation in Fashion E-Commerce," in Proc. 14th ACM Conference on Recommender Systems (RecSys), 2020, pp. 392–396.

[9] E. Balloni et al., "OutfitAI: Shop the Outfit with a Deep Learning-Based Intelligent Expert System," Multimedia Tools and Applications, vol. 84, pp. 1–25, 2025.

[10] S. Shirkhani et al., "Study of AI-Driven Fashion Recommender Systems," SN Computer Science, vol. 4, no. 6, pp. 1–16, 2023.

[11] I. Kachbal and S. Abdellaoui, "Computer Vision for Fashion: A Systematic Review of Design Generation, Simulation, and

Personalized Recommendations," Information, vol. 16, no. 1, pp. 1–34, 2025.

[12] X. Li, Y. Wang, Z. Zhang and H. Liu, "Hierarchical Fashion Graph Network for Personalized Outfit Recommendation," arXiv preprint arXiv:2005.12566, 2020.

[13] S. Zhang, Y. Li, S. Zhang, F. Shahabi, S. Xia, Y. Deng and N. Alshurafa, "Deep Learning in Human Activity Recognition with Wearable Sensors: A Review on Advances," Sensors, vol. 22, no. 4, p. 1476, 2022.

[14] J. W. Kim, J. Y. Choi, E. J. Ha and J. H. Choi, "Human Pose Estimation Using MediaPipe Pose and Optimization Method Based on a Humanoid Model," Applied Sciences, vol. 13, no. 5, pp. 1–18, 2023.

[15] M. Frausto, OpenCV Computer Vision with Python. Birmingham, U.K.: Packt Publishing, 2020.

[16] K. Nair et al., "Virtual Try-On System Using MediaPipe and OpenCV for AI-Based Clothing Overlay," in Proc. International Conference on Intelligent Computing and Smart Technologies, 2025, pp. 1–6.

[17] PoseSmart Research Group, "AI-Driven Dress Recommendations with Pose Estimation," in Proc. IEEE International Conference on Artificial Intelligence Applications, 2025, pp. 145–151.

[18] P. Olszewski, A. Lu, C. Stillman, K. Warren, C. Kitroser, A. Pascual, D. Ukirde, K. Butler and P. Traynor, "Get in Researchers; We're Measuring Reproducibility: A Reproducibility Study of Machine Learning Papers," in Proc. ACM SIGSAC Conference on Computer and Communications Security, 2023, pp. 3433–3459.

[19] M. Z. Shafaq, R. Khaliqyar and S. A. Sadat, "Comparative Security Analysis of Django and Laravel Web Development Frameworks: A Documented Feature Evaluation," International Journal of Research and Scientific Innovation, vol. 13, no. 2, pp. 1–10, 2026.