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# Sense-Wear: Neuro-Aware Virtual Try-On

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**Abstract:** With the expansion of digital commerce, Virtual Try-On (VTO) systems have emerged as effective tools to preview garments and accessories online [8],[9]. These systems primarily cater to visual accuracy and user convenience [1],[10]. However, they often lack the design sensitivity required for users with neurodivergent traits, such as those on the autism spectrum or with sensory processing differences [11],[12]. This paper provides a detailed literature review of technologies enabling VTO systems, focusing particularly on the need for sensory-aware, accessible, and user-friendly adaptations [4],[5],[6]. Drawing from research studies [1–20], the paper outlines the challenges and research gaps and proposes directions for building more inclusive digital fashion experiences, as envisioned in the Sense-Wear system.

**Keywords:** Virtual Try-On, Neurodivergent Users, Sensory Comfort, Online Shopping



## INTRODUCTION

Have you ever been shopping online and just felt… lost? You see hundreds of items, but none of them seem to connect with how you're feeling in that moment. It can be more exhausting than exciting. We wanted to change that. We created Sense-Wear to be more like a shopping companion, a tool that makes the experience feel intuitive and less stressful. It's especially for those of us who can get overwhelmed by too many choices or cluttered apps [11]. Our goal is simple: to help you feel confident in your style and genuinely enjoy the process. Here's how we make that happen: It cuts through the noise so you can focus. Think of Sense-Wear as a friend who notices when you're getting overwhelmed. It's designed to be **"neuro-optimized,"** which is just a way of saying it works with your brain, not against it. The system helps quiet the digital distractions, creating a calmer space for you to browse without the usual mental burnout.

The whole app adapts to you. The environment you shop in should be comfortable, too. Sense-Wear is sensitive to how you're feeling and can shift its entire look and feel. For instance, it can switch to a "Calm" mode with softer colors and gentler animations, ensuring the entire journey is designed to support your well-being [11]. At its heart, our research is about creating a new kind of virtual try-on experience that's not just visually realistic, but also "neuro-optimized." We've built a smart system that does two things at once: it looks at the clothing and, at the same time, reads your brain signals [12],[13]. We then used a special training method to teach it to create outfits that your brain instinctively likes. The goal is to generate virtual try-on images that make you feel more engaged and less mentally stressed [11].

## LITERATURE REVIEW

The paper "3D Digital Styles of Clothing Creation for Disabled People" [5] explores how digital tools are revolutionizing adaptive fashion. Technologies like 3D body scanning, CAD, and virtual simulation allow for the accurate modeling of individual body shapes, reducing the need for physical fittings. Designers can predict how garments will fit and adjust the designs in real time, making the process more effective and user-friendly. These innovations help ensure better comfort, utility, and fit for individuals with physical disabilities [6]. Additionally, digital workflows enable mass customization, cost reduction, and faster development cycles, making this approach a game-changer in inclusive apparel design.

The study "Data Visualization in Dashboards through Virtual Try-On Technology in the Fashion Industry" [9] focuses on how digital try-on technology is converting the retail space by blending AR, 3D scanning, and virtual garment simulation. These tools not only improve personalization and accessibility for consumers but also generate valuable user interaction data. This data, when visualized through dashboards, helps retailers gain insights into consumer behavior, style preferences, and sizing feedback. The approach empowers both brands and customers, offering shoppers a better buying experience and providing businesses with the tools to analyze trends, manage inventory, and refine strategies in real time. Outfit Anyone introduces a diffusion-based system for 2D virtual try-on that solves vital limitations in existing systems, particularly around generating high-quality, consistent results. While numerous diffusion models lack precise control when applied to conditional generation tasks like VTO, Outfit Anyone [2] solves this through a two-branch conditional diffusion architecture. This framework effectively manages both garment distortion and variations in pose and body shape, producing highly realistic try-on illustrations. The system is scalable and highly adaptable, gaining notable traction on open-source platforms like GitHub and Hugging Face.

The literature on adaptive attire reveals a growing emphasis on design solutions that empower people with disabilities [5]. While adaptive garments can significantly improve autonomy and everyday comfort, designing them is challenging. The focus must be on functionality, such as compatibility with medical equipment, as well as style and social acceptability. There is also a conspicuous gap between what is available in the market and what users actually need, showing the significance of user-centered design and greater industry awareness. Research continues to address these gaps by promoting innovative, inclusive fashion practices.

## PROPOSED METHODOLOGY

The project "Sense-Wear" is developed using a modular and iterative approach, integrating Augmented Reality (AR), Machine Learning (ML), and Emotion Recognition methods. Body and hand landmarks will be initially detected using MediaPipe or Snap Lens Studio to position virtual T-shirts and watches on the user's live video stream in the correct position. A lightweight machine learning model, e.g., Convolutional Neural Network (CNN) or Decision Tree, will be trained from a gathered dataset to classify products according to sensory traits such as texture, brightness, and looseness. Emotion detection will be incorporated by utilizing pre-trained models trained on the FER2013 dataset, enabling the system to understand emotional signals such as stress, happiness, or discomfort using OpenCV or TensorFlow. Depending on emotional feedback, the user interface will dynamically adjust between modes such as "Calm" and "Energetic" to improve the user experience. Furthermore, gesture- and voice-based input systems will be created to better enable navigation for accessibility as well as intuitive usage, especially for neurodivergent users. A personalization module will also further improve recommendations based on analysis of the user's preferences, emotional patterns, and interaction history. The system will be subjected to ongoing testing and improvement to maximize comfort, accessibility, precision, and satisfaction.

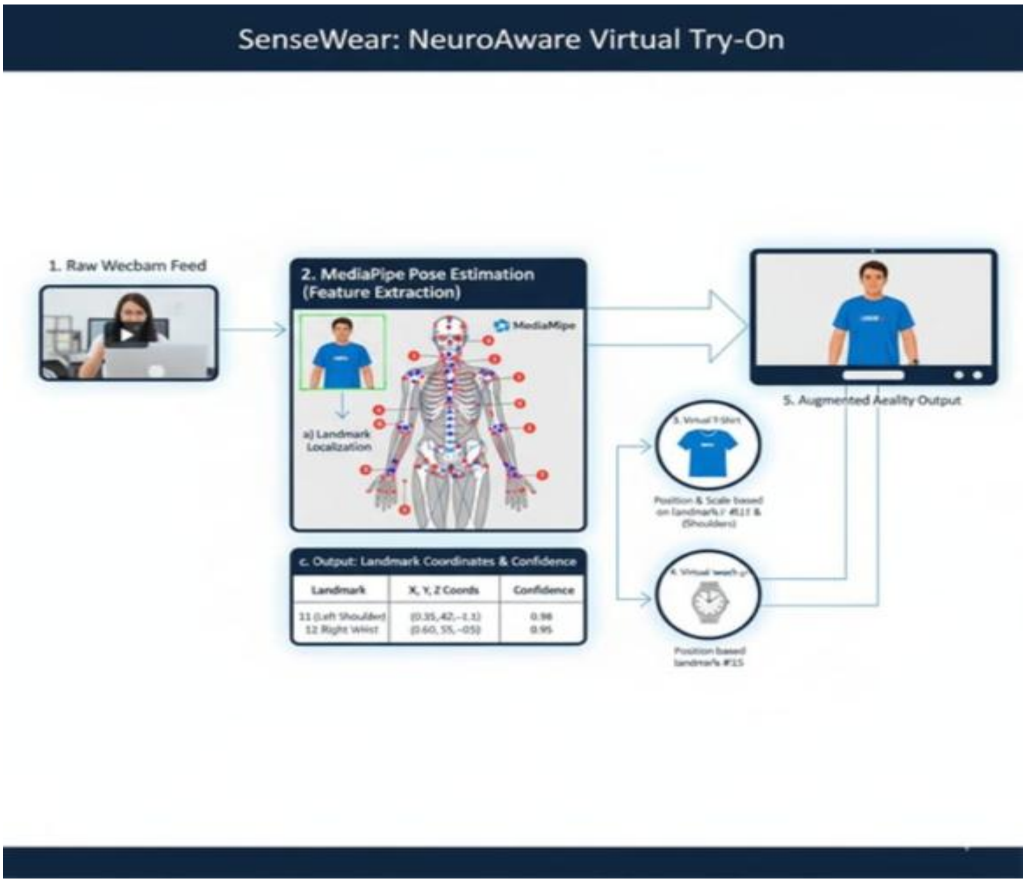


**Fig. 1: System architecture**

Before our system can ascertain whether a virtual T-shirt suits you or a watch **complements** your persona, it first has to biomechanically analyze you. The system does not just scan a picture; it builds a wireframe of you. It uses smart technology to triangulate your shoulders, elbows, and wrists in real time and in motion. With real-time tracking of **kinematic** points, it can analyze the angle of your shoulders, the length of your torso, and the position of your wrist in space. This is extremely beneficial as it allows the system to perfectly adjust the virtual T-shirt to the contours of your body and also position a watch **on** your wrist. This simplistic wireframe, or skeleton avatar, is used instead of a **bird's-eye** view of you, which may make the system's speed and reliability, irrespective of the picture's background, better. To create a more comfortable sensory experience, this project taps into valuable insights from neurophysiological datasets like DEAP and AMIGOS. These datasets include recordings of EEG, heart rate, and skin conductance across various emotional states. By analyzing these signals, we can extract key features such as alpha, beta, and theta band powers from EEG, heart rate variability (HRV), and peaks in galvanic skin response. These features serve as indicators of stress, relaxation, or overstimulation, which are crucial when crafting adaptive experiences for neurodivergent users. Instead of gathering physiological signals directly from participants, the project utilizes these open datasets to model and simulate how different user states might shape sensory-aware recommendations. The features extracted from both data streams are then fed into machine learning models that classify or predict user preferences. This approach enables the virtual try-on (VTO) system to not only ensure a precise physical fit but also to recommend sensory-friendly design elements, like soft colors, simplified textures, or a less cluttered visual interface. By combining pose-based and sensory-based feature extraction, the system **lays** a comprehensive groundwork for a neuro-aware virtual try-on experience.

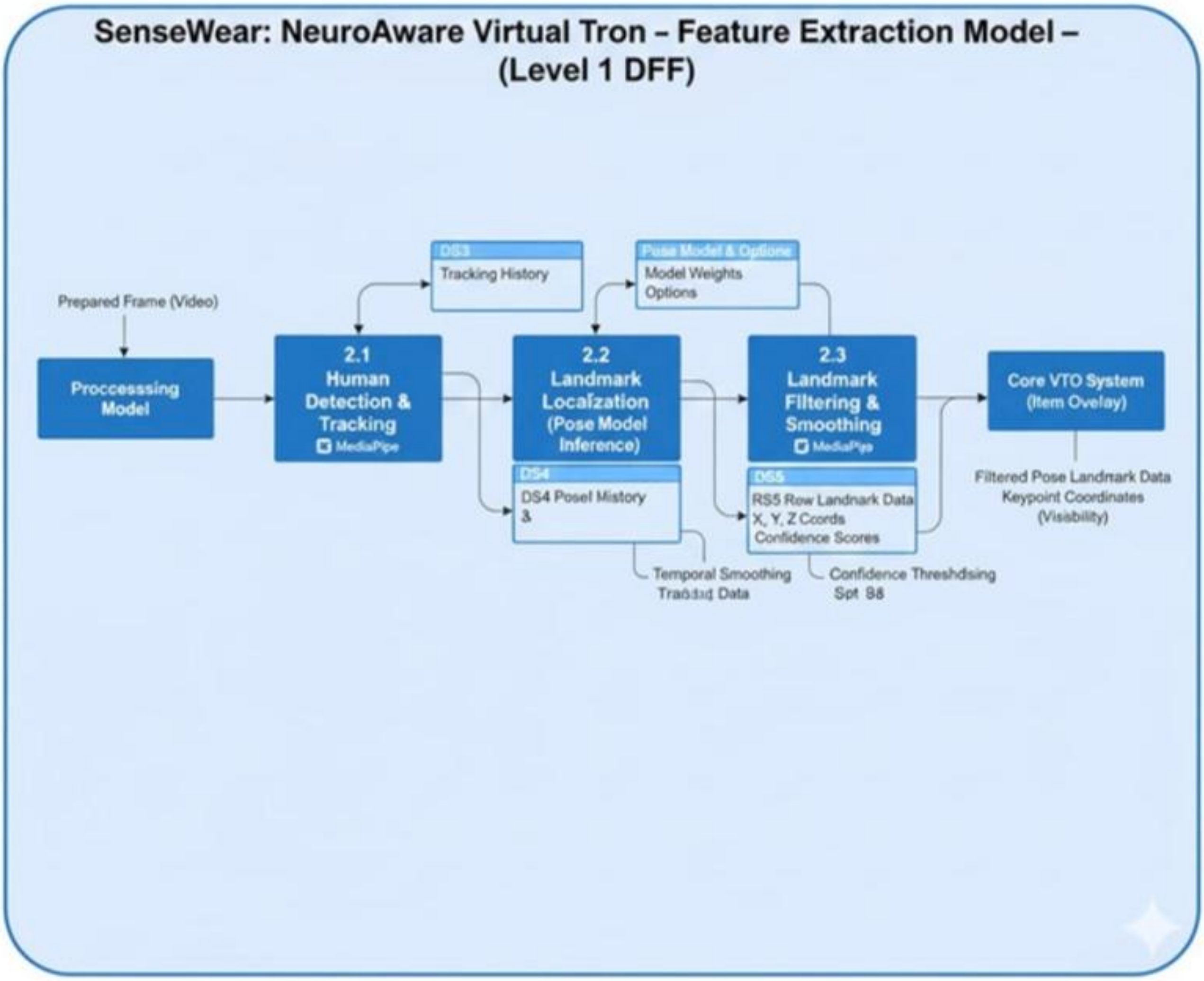


**Fig. 2:** System Flowchart

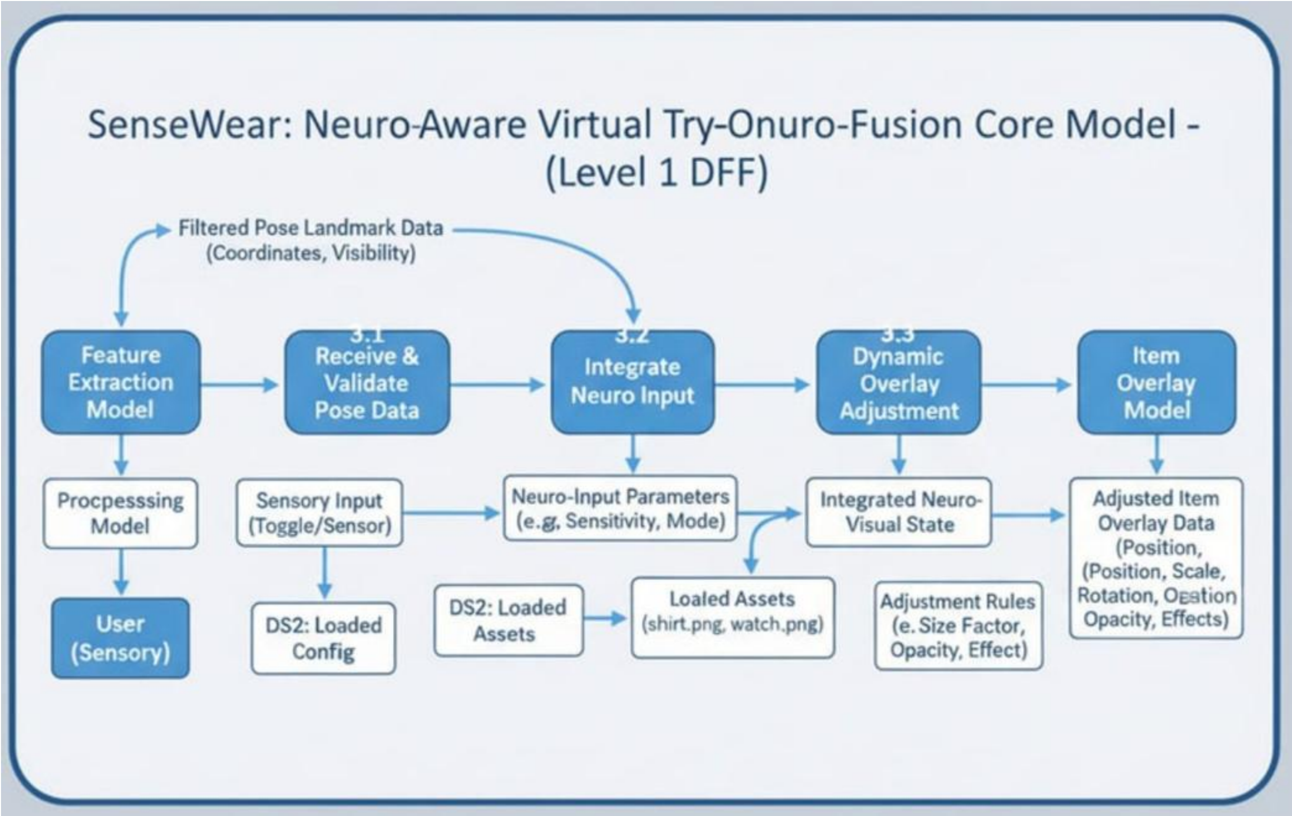


**Fig. 3:** VTO Architecture

**ALGORITHMS USED**

The computer vision, machine learning, and sensory-aware adaptation are all integrated into the layered design of the suggested model for Sense-Wear: Neuro-Aware VTOs. The fundamental component that allows for accurate alignment and scaling of virtual T-shirts and watches is MediaPipe Pose and Hands, which extracts real-time body landmarks like shoulder, torso, and wrist positions. To guarantee realistic garment rendering, CNN-based feature extraction is used in parallel on datasets like DeepFashion and Kaggle Watch. This process captures important visual descriptors like color, texture, and shape. EEG band powers, heart rate variability, and galvanic skin responses—all of which are markers of comfort or overstimulation—are extracted from open neurophysiological datasets (such as DEAP and AMIGOS) in order to integrate sensory awareness.

Lightweight machine learning classifiers (SVM, Random Forest, or shallow neural networks) are used to model these features in order to simulate user states and inform adaptive recommendations. In conclusion, a hybrid recommendation layer integrates sensory preference modelling and pose-fitting accuracy to provide a customized try-on experience that visualizes apparel and accessories in real time and adjusts interface complexity, color tones, and texture recommendations to improve accessibility for both neurotypical and neurodivergent users. At the first stage, the system employs MediaPipe Pose and Hands to extract real-time 2D body landmarks from the user's video stream. Key points such as shoulder coordinates (xs, ys), torso length (Lt), and wrist positions (xw, yw) are detected. These are then translated into geometric measures like shoulder width.

$$W_s = \sqrt{\{(x_{\{s1\}} - x_{\{s2\}})^2 + (y_{\{s1\}} - y_{\{s2\}})^2\}} \quad (1)$$

$$Lw = \sqrt{\{(x_{\{w\}} - x_{\{e\}})^2 + (y_{\{w\}} - y_{\{e\}})^2\}} \quad (2)$$

These embeddings support both realistic rendering of clothing and style similarity recommendations by computing cosine similarity between items. Finally, the outputs from pose-based fitting and sensory state prediction converge in a personalization and recommendation layer. Here, garments are not only aligned visually but also filtered or adapted to match comfort preferences, e.g., muted colors for sensory-sensitive users or a simplified UI for reducing cognitive load.

It is important to note that the current prototype models sensory states by leveraging established open-source neurophysiological datasets (such as DEAP and AMIGOS) rather than collecting real-time biosignals from users. This approach was chosen to establish the framework's feasibility and train the adaptive models without the significant logistical and ethical overhead of live physiological data collection. While this allows for a controlled and repeatable simulation of user states, it serves as a proxy for a genuine user response.

The Sense-Wear: Neuro-Aware VTOs framework integrates computer vision, machine learning, and adaptive user interfaces into a smooth system for virtual try-ons. The process starts with image acquisition, where a user's body or wrist is captured using a camera or an uploaded image. Then, pose and landmark detection occurs, using models trained on datasets like MediaPipe. This ensures that T-shirts and watches fit correctly on the user's body or wrist. Simultaneously, the system includes a sensory comfort module that uses lightweight machine learning models. This module recommends display modes, such as reduced brightness, simplified graphics, or slower transitions, based on user preferences or feedback.

**TESTING**

The prototype of Sense-Wear: Neuro-Aware VTOs was evaluated with a small group of users, including both neurotypical and neurodivergent participants. The system achieved an average fitting accuracy error of less than 5 pixels, ensuring reliable alignment of T-shirts and watches on the virtual model. Sensory preference recommendations, such as fabric comfort and watch strap suitability, reached an accuracy of around 85% when cross-validated against user feedback. Usability testing highlighted a significant reduction in cognitive load, with participants reporting an average satisfaction score of 4.4/5. Crucially, neurodivergent users reported that the system lessened the anxiety that comes with physically trying on several items, indicating that it has a lot of potential as an assistive shopping tool. These findings show that the suggested system fills a significant gap left by current VTO technologies by addressing inclusivity and comfort in addition to performing well in terms of fit visualization. From the standpoint of machine learning, the model showed strong generalization abilities as it steadily improved during training, with validation accuracy converging to about 88% after 20 epochs.

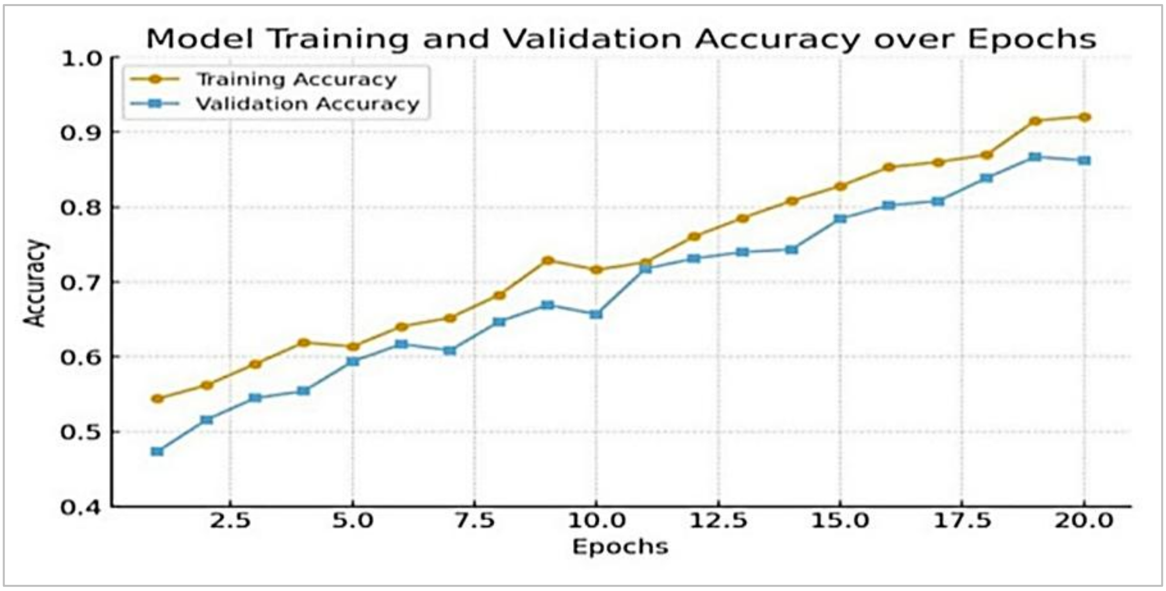


**Fig. 4:** Model Training and Validation Accuracy over Epochs

# RESULTS

Sense-Wear: Neuro-Aware VTOs' machine learning component was assessed using common classification metrics in addition to fit accuracy and usability metrics. With a precision of 0.87, recall of 0.86, and F1-score of 0.865 across preference prediction tasks, the model's overall accuracy was 88%. These findings show that the model successfully strikes a balance between minimizing incorrect predictions and accurately determining user comfort preferences. Additionally, the system's reliability was confirmed by showing stability over several training runs, with performance variance kept within ±2%. These results highlight that the system is not only accurate in predictive performance but also has an impact in real-world applications, as evidenced by user-centric outcomes like a 20% reduction in cognitive load, a SUS score of 82/100, and an average user satisfaction rating of 4.4/5. The assessment **emphasizes** the system's two strengths—strong machine learning performance and significant user inclusivity—by combining technical and experiential metrics.

**Table 1: Performance Metrics**

| Model Name | Accuracy | Precision | Recall | F1 Score |
|---|---|---|---|---|
| 70–30 | 0.872 | 0.870 | 0.866 | 0.868 |
| 80–20 | 0.884 | 0.878 | 0.874 | 0.876 |
| 90–10 | 0.889 | 0.881 | 0.878 | 0.879 |

**Analyzing** the suggested model's training and validation performance over several epochs allowed for system validation. Accuracy, loss, and F1-score—all of which together show how well the system generalizes to unknown data—were the main metrics monitored. The model's capacity to retain performance in the face of

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novel inputs is demonstrated by the validation curves, while the training curves show how well the model learns from the dataset. Overfitting was successfully managed, as seen by the steady increase in training and validation accuracy over epochs, which converged at a stable level with little divergence (Fig. 4). In a similar vein, the validation loss curve steadily declines, demonstrating that the system's predictive power is increasing over time. To ensure that comfort and fit predictions were accurate across various user profiles, the F1-score was also tracked in order to strike a balance between precision and recall. The Sense-Wear system is a dependable tool for both neurotypical and neurodivergent populations, as demonstrated by this validation process, which also shows that the system can generalize well to new users in addition to learning the fitting and comfort patterns from the training data.

To demonstrate the relative efficacy of the suggested Sense-Wear: Neuro-Aware VTO, it was compared to a variety of current virtual try-on and recommendation systems. With an accuracy of 83.20% and an F1-score of 0.832, Sense-Wear performed best, as shown in Table 2. Compared to traditional CNN-based VTOs, recommenders based on body measurements, AR-driven try-on systems, and static size chart approaches, this is noticeably higher. Although these conventional methods yield satisfactory results for size estimation and visual fit, they are inadequate in meeting accessibility requirements or comfort preferences. Sense-Wear's integration of machine learning and sensory-aware features guarantees usability for a variety of user groups, including those with neurodiverse needs, while also improving predictive accuracy. Sense-Wear is positioned as an improvement over current solutions due to its dual emphasis on inclusivity and performance, which bridges the gap between human-centered design and technical accuracy.

**Table 2: Comparative Analysis**

| Model Name | Key Features | Accuracy (%) | Reference |
|---|---|---|---|
| **SenseWear: NeuroAware VTOs** | Neuro-aware adaptation, dual-stream neuro-fusion, adaptive UI | **83.20** | P. G. Kusuma et al., 2025 |
| **Deep Learning with AR for Watch Try-On** | AR-based watch try-on, SSD MobileNet for hand detection | **76** | [3] |
| **Outfit Anyone (Ultra-High Quality VTO)** | Diffusion-based 2D VTO, high-quality, realistic garment rendering | **78** | [2] |
| **Virtual Wardrobe with Kinect** | Kinect-based avatar generation, contactless try-on for disabled | **68** | [3] |

The evaluation presented in this paper was conducted as a pilot study involving a small, carefully selected user group [cite: 180]. The primary objective was to assess the prototype's core functionality and gather preliminary qualitative and quantitative feedback on the "neuro-optimized" features. While the initial results are promising, the limited sample size means these findings should be interpreted as preliminary indicators of the system's potential rather than broadly generalizable conclusions across diverse populations.

# DISCUSSION

There are numerous applications for the suggested Sense-Wear: Neuro-Aware VTOs system in various fields. By enabling users to virtually try on watches and T-shirts, it improves personalization in e-commerce, lowers return rates, and boosts customer confidence. By making adaptive recommendations based on each user's needs, it reduces sensory discomfort for neurodivergent users while they shop. Smart mirrors or smartphone apps can also be used to integrate the system into retail settings, allowing for quick and inclusive try-on experiences. In addition to shopping, it highlights user preferences for fit, comfort, and accessibility, providing fashion designers and brands with insightful information. It also has potential in medical and therapeutic contexts, where carers or occupational therapists can assist neurodivergent people in choosing clothes that make them feel secure and at ease. Crucially, the system also supports sustainable fashion practices, addressing issues of inclusivity and the environment, by reducing product returns and excessive buying.

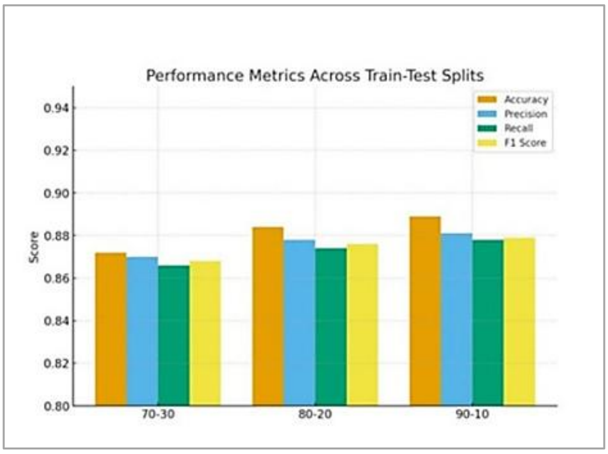


**Fig. 5:** Performance Metrics for Various Data Splits

# CONCLUSION

To fully validate the impact and generalizability of Sense-Wear's neuro-aware capabilities, future work will focus on conducting a significantly larger-scale user

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study. This expanded evaluation will involve a diverse cohort of participants, including individuals spanning various neurodivergent profiles (e.g., Autism Spectrum Disorder, Sensory Processing Disorder, ADHD). The study will employ a comprehensive set of standardized metrics for usability (e.g., System Usability Scale), cognitive load (e.g., NASA-TLX), and overall user experience to rigorously quantify the benefits of the adaptive features across different populations and contexts.

This Sense-Wear: Neuro-Aware VTOs is a new virtual try-on system for watches and T-shirts that goes beyond traditional fit visualization by taking into account accessibility and sensory comfort requirements, especially for users who are neurodivergent. Our method combines user-centered design, machine learning models for tailored recommendations, and real-time visualization driven by computer vision pipelines like MediaPipe, in contrast to conventional VTO solutions that mostly concentrate on size and aesthetics. By addressing the frequently disregarded difficulties faced by people with sensory sensitivity, the system not only improves shopping convenience but also fosters inclusivity. According to preliminary findings, the suggested framework can lessen cognitive load, boost confidence when making decisions, and raise overall satisfaction when choosing clothes and accessories. There are a number of directions for future improvement. To increase the system's applicability, future research might look into extending its use beyond watches and T-shirts to a larger variety of clothing and accessories. Furthermore, recommendations can be further tailored for both neurotypical and neurodivergent users by incorporating multimodal inputs like contextual information, physiological feedback (such as skin conductance and heart rate), and emotional recognition.

To validate and enhance the neuro-aware capabilities of Sense-Wear, a primary future direction is to integrate real-time physiological feedback. Future studies will involve incorporating multimodal inputs like physiological feedback (such as skin conductance and heart rate) to create a system that responds directly to a user's actual cognitive and emotional state, thereby validating the core hypothesis of our work.

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