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Enhancing user Experience in Apparel Customization using Web Technologies

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***Abstract*— This paper illustrates an innovative web platform that transforms the experience of custom apparel by combining advanced technologies like 3D modeling, artificial intelligence and augmented reality. The platform enables customers to design customized clothing using an interactive 3D customization tool, get custom design suggestions based on AI-based insights and chatbot-created designs and get a perfect fit with full body measurements taken from a regular webcam seamlessly supported with real-time augmented reality try-on capabilities. This paper not only prevailing challenges in buying apparel online, sizing inconsistencies and generic style suggestions but also provide a dynamic, experiential and user-directed fashion designing process.**

***Index Terms*— 3D modelling, artificial intelligence, Natural Language Processing(NLP), augmented reality and computer vision.**

I. INTRODUCTION

The fashion business is in the middle of a dramatic transformation fueled by faster-than-ever development in digital technology and changing consumer demands. Classic apparel retailing—formerly focused on in-store experiences and mass-market fits—is progressively being replaced by pioneering online solutions with a focus on personalization [11, 13], interactivity, and analytics-driven intelligence. This paper is an innovative response to these trends—a complete, contemporary platform that changes the game for how consumers design, customize, and buy clothing online.

Fundamentally, this paper aims to empower users through a rich, engaging experience that integrates a 3D customization platform with advanced artificial intelligence and augmented reality features. The central aim of the platform is to close the gap between virtual and physical fitting experiences, hence avoiding regulatory obstacles like sizing differences and uninspiring design solutions. By allowing users to visualize their own unique designs in real-time, get smart suggestions, and virtually try on clothes with their own body measurements, the platform not only improves the shopping experience but also maximizes an engagement with fashion as a way of self-expression. This paper's creation is led by an intimate understanding of technical challenges and user-centered design principles. The use of pioneering technologies—ranging computer vision, body measurement algorithms to AR kits that place virtual garments [8] on top of live video streams—maximizes each feature to deliver against the requirements of today's consumers.

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This combined approach creates maximum consumer satisfaction while setting a new benchmark for digital fashion design, harmonizing artistic beauty with uncompromising performance. As the digital world continues to evolve, this paper spearheads the revolution with its power to transform the fashion universe through the creation of an unexampled blend of technology and art.

II. LITERATURE REVIEW

A. Interactive Clothing Design and Customized Virtual Display System [18]

The present work proposes an interactive fashion design and customized virtual display system developed with Unity3D and VR technology.
It allows users to customize clothing patterns, fabrics, and accessories, and view their designs on 3D avatars modeled based on individual facial structures. The system facilitates online shopping by giving a virtual try-on experience in a realistic manner and real-time manipulation of the design. It also enables mass customization through the incorporation of a flexible design DNA database. Although the system provides a very personalized and interactive shopping experience, it also incurs costs and difficulties concerning privacy protection and computational complexity.

Benefits

Hyper-Personalized Design: Provides complete customization of clothing types, materials, colours, and accessories, enabling users to design unique, tailor-made pieces that express their own tastes and preferences.
Realistic Virtual Try-On: Makes use of 3D avatars bearing users' facial characteristics to offer a realistic and interactive virtual fitting experience.
Improved User Experience: Real-time visualization and customization options enhance the satisfaction and trust in online shopping.

Drawbacks

Privacy and Security Concerns: The capture and processing of 3D facial information hold privacy risks and require strong security practices.
High Hardware Requirements: High-performance hardware is needed for real-time 3D rendering and detailed customization, which can restrict accessibility for certain users.
Complex User Interface:Advanced customization features of the system can be difficult to use by non-technical users, which highlights the importance of user-friendly UI design and user training [18].

B. Design of Customized Garments Toward Sustainable Fashion Using 3D Digital Simulation and Machine Learning-Supported Human–Product Interaction [21]

This study proposes a machine learning-driven approach for personalized garment design utilizing 3D digital simulation to enhance sustainability in fashion. The system employs RBF ANN, GA, PNN, and SVR algorithms to optimize garment fit, generate designs, predict fitness levels, and fine-tune parameters based on consumer feedback.
The approach represents an intelligent and eco-friendly fashion design process, though it still requires validation across various garment styles.

Advantages:

- Enhanced Customization: Enables highly personalized garment creation by accurately predicting body measurements and individual consumer preferences.
- Improved Efficiency and Accuracy: Machine learning models automate and refine design processes, making them faster, more precise, and cost-effective.
- Superior Consumer Experience: Promotes active human–product interaction, allowing consumers to participate directly in the design process for more satisfying outcomes.

Disadvantages:

- High Implementation Cost: Requires significant investment in advanced ML tools, specialized software, and technical expertise, which may challenge smaller enterprises.
- Dependence on Data Quality: The accuracy of predictions relies heavily on access to large, high-quality datasets, which may not always be available.
- Operational Complexity: Both consumers and designers may need training and guidance to use the system efficiently and interpret its outcomes correctly [21].

C. Design of a Customizable Preview Feature on Clothing Websites [22]

Soegoto et al. (2022) present the implementation of a user-tailored clothing preview functionality for e-commerce platforms selling fashion. The paper points out the unpredictable trends in fashion, the high competitiveness in the apparel sector, and the consumers' increasing need for customized clothing options as the main reasons for the proposal of such a system. This system is a customer-pleasing tool that gives customers the freedom of customization in their apparel choices — size, color, style, and accessories—as well as not worrying about stock availability. A descriptive analytical and qualitative approach was employed, and the system was created using Figma and Adobe Illustrator, while development was done using a prototype based methodology that allowed incremental improvements through user input. Among the essential characteristics are custom sizing, fabric selection, accessory customization, and body type recommendations, each of these features is intended to contribute to user engagement and satisfaction positively. The objective behind the introduction of this system is to outrun the competition in online shopping experience by giving the opportunity to consumers to view their personalized garments before payment. The research envisages as well the cutting down of inventory waste, the enhancement of business competition, and the satisfaction of increasing consumer and retailer demand for mass customization in the case of the fashion e-commerce sector all through the use of digital design tools.

Advantages:

Personalized Shopping Experience: Users will be able to design clothes according to their needs, which will lead to greater satisfaction and participation.

Reduced Inventory Waste: The practice of overproduction and having stock that does not sell are minimized, thereby ushering in a more eco-friendly retail process.

Technological Innovation: Utilizes cutting-edge digital design instruments for 3D representation and interaction, thus user experience being enhanced.

Improved Fit and Comfort: The use of size guides and body type recommendations to provide a better fit is the main application.

User-Friendly Interface: The design based on prototypes guarantees that the interface will be polished in line with the input from the users.

Disadvantages:

High Development Cost: Implementing advanced customization and visualization technologies requires significant financial investment.

Complex System Integration: Requires a robust backend to support dynamic customization and real-time updates.

Possibility of Design Misrepresentation: Users may have difficulty visualizing the final product accurately, which could lead to dissatisfaction if the delivered garment differs from expectations [22].

III. METHODOLOGY

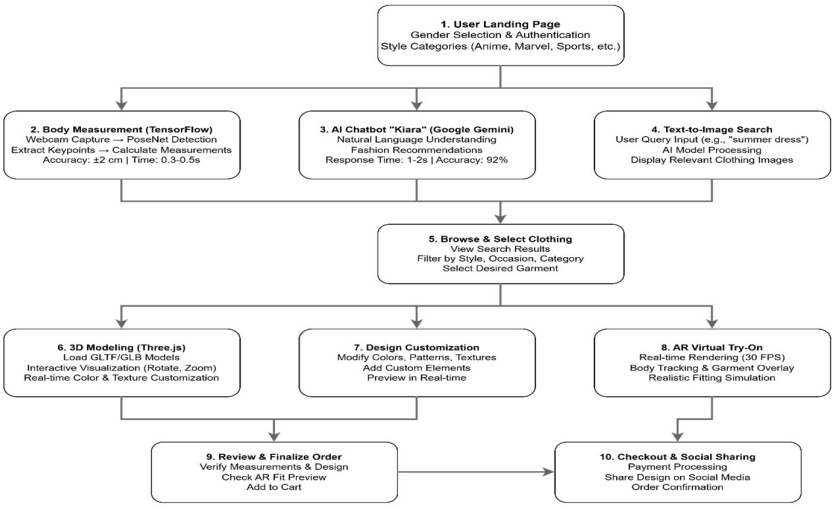

Fig 1

A. Body Measurement Using TensorFlow [18]

The body measurement module incorporated in the paper takes benefit of the outstanding deep learning capabilities of TensorFlow to accurately extract and assess the human body measurements from webcam images. The whole action is performed in stages with several aspects of the process being key.

Image Capture and Pre-processing: Users' webcams provide the source of live video streams that are captured as input frames for analysis.

Pose Estimation with TensorFlow: Model Selection: There is a very specific pose estimation model derived from the frameworks like PoseNet [5, 9] that is made to work with TensorFlow and thus employed very effectively to spot the primary anatomical landmarks (shoulders, elbows, hips, and knees, etc.).

Keypoint Extraction: The TensorFlow model processes every frame [4] in real-time, accurately selecting and pinpointing the body keypoints that will later on serve as the basis for measurement calculations.

Measurement Computation: Distance Calculation: The system accesses the critical landmarks (for instance, shoulder-to-hip and waist-to-hip) and calculates distances between them using the keypoints it has just extracted. The pixel-based measurements are then converted into metric units [10] with the help of calibration data.

Integration and User Feedback: Real-Time Adjustment: The measurements are shown and updated instantly in the user interface, which allows users to see the visual feedback and make the necessary corrections at the same time [18].

B. AI Chatbot for Fashion Recommendation Using Google Gemini [1]

The AI chatbot ”Kiara” is programmed to offer tailored fashion recommendations through the use of the powerful natural language processing (NLP) feature of the Google Gemini API. The methodology for the development and integration of Kiara into the paper’s platform is stated below:

Integration with Google Gemini API

API Setup and Configuration:

The Google Gemini API is the basis for Kiara, which offers top-notch NLP and machine learning features. The API handles user input and creates context-aware responses that are fitted to the user's fashion-related queries [1].

Authentication and Data Exchange:

The use of secure API keys and tokens is the method for verifying requests that allows safe and reliable data exchange between the paper’s platform and the Google Gemini API.

Natural Language Understanding (NLU) and Query Processing

Intent Recognition and Context Extraction: Advanced NLU techniques are used by Kiara to handle user queries and pinpoint main intents and contexts. For instance, when users inquire, “What should I wear to a beach party?” or “Does this jacket suit my style?”, Kiara finds related entities like clothing type, occasion, color, and style attributes. This extensive comprehension gives the system the power to provide precise and contextually relevant recommendations.

Fashion Recommendation Engine: Kiara, based on the user's input, presents customized clothing suggestions taking into account the aspects of current fashion trends, individual tastes, and event needs. As an illustration, if a user is looking for accessories that go along with a certain outfit, Kiara will recommend items that would be suitable as complementary.

Conversational Interface and Real-Time Response: Real-Time Response Generation: By means of the Google Gemini API processing user requests simultaneously, Kiara provides immediate, personalized responses that are in tune with the fashion needs of the users—either recommending dresses for particular events, offering styling choices, or giving tips on how to combine the items in the existing wardrobe in an efficient way.

C. 3D Modelling Using Three.js

The evolution of e-commerce is steadily upward, leading to the use of modern visualization technologies to improve the experience of the customer for online clothes shopping. This paper is proposing the inclusion of 3D interactive models on fashion designing websites, and the buyers will be able to customize, see, and play with their clothes all at once. By means of 3D visualization, virtual dressing, and digital size measurement, customers will be able to rotate, zoom in and out, and alter the clothes, thus, getting a more accurate knowledge of the body's fit, the texture of the fabric, and the style.

Models of clothing will not only be on the internet for viewing but also for interaction through the use of innovative technologies such as Three.js, Babylon.js and WebGL [2] that take care of the fast and smooth rendering of the models. For example, Three.js brings the ability to import GLTF/GLB models and use

Physically Based Rendering (PBR) for obtaining textures and lighting that are nearly real. Moreover, designers working with Blender, Marvelous Designer, and Clo3D can upload the high-quality 3D garment models [3, 12] they create straight into the website.

To keep the user involved in the process, among the main interactive features are, the change of colour, texture, and animation on the spot. Shopping can become even more personal and entertaining if one uses AI-powered suggestions and Augmented Reality (AR) [8, 11]. This approach would not only help in cutting down on the returns but also in boosting the consumers' trust and the companies' loyalty. The experiment has gone on to explain the technical aspects, difficulties, and future possibilities for the 3D interactive clothing design up for grabs on the internet fashion platforms.

E. Text-to-Image Search

The aim of this paper stands out with the unique feature of text-to-image clothing search among its various offerings. Users can enter descriptive fashion phrases like “casual streetwear” or “summer floral dress” into a search bar and after that, a gallery of clothing images that perfectly fit the description is displayed dynamically by the system. The use of the natural language search drastically improves the user experience, especially for people who do not know the exact name of a style or category because it is thus made easier and more natural for them.

The interface is very clean and user-friendly, with a simple input field and a single search button, allowing users to swiftly and effectively find out about styles that they are interested in. The functionality underneath uses JavaScript (implemented in `scriptt.js`) to get the fashion images that are relevant to the user's query. It probably connects to either an image API or a pre-trained AI model that processes the text input and selects visually similar clothing options. The images are presented in a responsive image grid layout, with a loading indicator that ensures interactivity and gives real-time feedback during the image fetch process.

This is an example of how modern web technologies can be combined effortlessly, and at the same time, it gives evidence of how AI-driven intelligent search can e-commerce platforms to personalize and simplify fashion discovery very effectively.

IV. Results and Discussions

In the early stages of prototyping, the developer designs the first page of the custom apparel application.

- Main page: The above figure shows the main page of our website. When the website loads, a well-designed animation plays. The navigation bar contains sections for men and women, along with buttons for logging in and signing up. HTML, CSS and Javascript and more tools used for this.
- Different pages for clothing ideas and styles: We have also added pages for different sections, such as anime, Marvel, DC, food, games, sports, and more.
- One click to access the AI chatbot and body measurement feature
- Body measurement webpage : The body measurement web pages access the user's webcam, mark key points on the body, and store the body measurements in the backend.
- AI chatbot using Google Gemini. This is the chatbot where users are asked fashion-related questions and personalized recommendations. This is the chatbot where users are asked fashion-related questions and receive personalized recommendations.
- Virtual try on: has a virtual try on feature includes – Three.js and BlazePoseNet [2, 9] to detect the GLB model and displays it over the webcam.

V. Future Scope

This paper is on the brink of development and thus plans to take advantage of emerging technologies to make its digital fashion ecosystem superior and broader. Among the areas of development that are going to be significant in the coming days are:

Enhanced Immersive Experiences: Future versions of the platform could introduce virtual reality (VR) environments [13] that would let users and their digital creations interact in a completely 3D immersive environment.

Advanced AI Personalization: The platform may even come to the point of offering users the most refined and personalized style recommendations through the evolution of machine learning technologies [15]. The system can better match individual tastes with its suggestions by sifting through vast amounts of data that not only include social media trends and live fashion metrics but also others.

Seamless Social Integration: The integration of social media and community characteristics will give users the opportunity to show off their personalized designs, get input, and take part in collective fashion trends. This will lead to a vibrant environment where new styles keep on being created through user-generated content.
Augmented Reality Evolution: The progress in AR technology [8] will not only enhance the realism and the responsiveness of the virtual try-ons but also improve their quality. Some features that could be developed in the future are gesture-based controls and superior body tracking, thereby eliminating the distinction between the virtual and the physical fit experiences.
Mobile and Cross-Platform Optimization: The extension of the platform fully supporting mobile devices and wearables will allow the users to be anywhere and still have access to all the functions thus, guaranteeing a continuous, top-notch experience regardless of device.

VI. Conclusion

This paper is a revolutionary model that demonstrates how technology can make the fashion industry by joining creative design and high-tech innovation to the fullest extent. The platform features an intuitive 3D customization interface, AI-driven design assistance, personalized fashion recommendations, precise full-body measurements, and interactive AR try-on features to give the shopper a comprehensive and immersive online shopping experience.
It solves problems with classical e-commerce, such as wrong sizing and generic design options, while creating a new standard for user engagement in digital fashion design. This paper can now take the technology of the future as the online environment keeps changing, and thus, remain a frontrunner in the online fashion market. The platform that prioritizes the user-centered design and technological excellence will be the one to provide a dynamic, personalized, and immersive fashion experience that is in line with the needs of the contemporary consumer.

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