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Customize Your Clothing Through 3D Models: A New Trend in the Fashion Industry

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Abstract:-The fashion industry at present mostly provides clothing items that are created by designers and distributed through retail and online stores. The issue with the current system in place is that the customers do not get an opinion on the design of the garments they purchase and are usually limited to a handful of clothes they prefer given the availability. This limitation of choice is somewhat minimized by online stores, but the issue of being unable to buy clothes just as your preference persists. This application is intended to let the customer customize a clothing item in a virtual studio and view the customized clothing item as a 3D model which they can then view in their personal spaces. This ensures that they can purchase a personalized garment that fully matches their expectations. The application uses a 3D model so that the customer can customize clothes and view the clothes they customize and view them through Augmented Reality before they purchase.

Keywords: *virtual dressing room, 3D model, augmented reality.*

1. Introduction

Clothing has been one of the main needs of man that has been widely commercialized, and the fashion industry is one of the most prominent industries in the past, present and future since the clothing needs of humans will always persist. When humanity advances technologically, it is important that an industry such as the fashion industry, given its significance and longevity, evolves with technology. This can be seen in the past when clothing evolved from wearing animal skin, plant fibres and leaves which were assembled by themselves to online shopping stores which can be seen today. The application proposes the next step of evolution in the fashion industry.

In the present, the commercial fashion industry does its business in two main methods. Physical retail stores and online stores. Physical retail stores have been around in the industry for some time now and they vary from small textile shops found in markets to huge textile stores. Physical stores have their pros and cons to the businessman and the customer. The Advantages of physical stores are, that customers can try out the product they purchase and make sure they are satisfied with the design, material and fit. Customers can also easily return or exchange the products in case of dissatisfaction in a given period if they shop from physical stores. Businessmen also can be seen benefiting from physical stores in the case of customers engaging in 'impulse buy' after seeing products in stores. Although, physical stores have their downsides as well. With the development of technology, most of the services which required humans to go outside in the past, have now been enabled to do at home with smart devices, and with this, the amount of people that are eager to physically visit a store is reducing. This has resulted in people viewing visiting physical stores as a burden. As businessmen, this is a downside of physical stores as well since these drive down sales. Products in stores not being sold is another issue businessmen face when maintaining physical retail stores.

With the issues that arose from physical stores, and especially after the quarantine era, online stores have been the new trend in the fashion retail industry. Online stores can be seen varying from small stores which sell a handful of clothing items to huge clothing brands maintaining their online stores. These online stores respond to one of the main problems with physical stores, which is enabling the customer to purchase clothing items at their fingertips without having to travel. Online stores usually let the customer view clothing items through

websites and apps and let them order the said items which will be delivered to the customer's doorsteps. The payment would be made when the item is delivered or more commonly through online payment methods. Allowing customers to easily purchase items from home. These online stores are advantageous to businessmen as well, since the costs such as building costs can be cut down.

The main downside of online stores is customers not being able to get a clear idea of the clothing items they purchase from online stores. Since usually the store website only provides several photos of the product, the customer has to wait till delivery to see the actual product, this results in customer dissatisfaction, especially since it's also hard to do returns or exchanges in online stores. As a solution to this problem in online stores, the application is proposed where a 3D Model function is proposed so that the customer can have an idea of how the clothes look from any angle before they purchase the clothing items.

However, one of the main problems that can be seen in the clothing industry at present, in both physical and online stores is that the customer is forced to purchase clothing items that are pre-designed and are unable to purchase the exact clothingitem they have in mind. Customers purchase items that are somewhat like the designs they have in mind and are usually limited to clothing options because of this matter. The businessman also has to rely on the designer's knowledge of current trends and has to make a gamble on the likeability of customers to the products they design. Because of this issue clothing items being put on sale or discarding these items can be seen.

As a solution for this issue, the application proposes a feature where the customer can customize personalized clothing items where they can customize the clothing items as they like and the store can then design the item according to the necessities of the customer. Given this option, the wastage of clothing and customer dissatisfaction can be decreased greatly and would be beneficial for both the businessman and the customer.

Using the application, the customer would visit the online store, choose the apparel they wish to purchase, specify sizes, customize them through the user interface, and try the customized clothing in the virtual dressing room to get an idea of how the clothing would look like and then place the order, the store can then customize the clothing item and deliver it so that the customer would receive a clothing item that was personally produced for them guaranteeing an increased customer satisfaction compared to the system in place at present in the clothing industry.

The rest of the paper is organized as follows: Section II demonstrates the literature review on this research area. Section III defines the methodology of the study. Section IV discusses the achieved results. Finally, Section V concludes the paper by presenting key findings and suggesting future areas related to the research.

2. Litereture Review

A survey was conducted to investigate the challenges that customers encounter when shopping for clothing items online. The initial findings of the survey revealed the common issues associated with purchasing clothing items through online platforms. Due to the absence of fitting rooms, customers often struggle with selecting the correct size of the clothing they intend to buy. Additionally, purchased clothes cannot be exchanged if the item is not good enough. Another noteworthy concern is that even when the size is accurate, customers sometimes find that the appearance and quality of the clothing are not up to their expectations.

At the time of the survey, most of the participants, more than half, were utilizing online platforms for their clothing purchases. These challenges are particularly pronounced in the online shopping environment because, unlike physical clothing stores, online platforms lack certain facilities. In a brick-and-mortar store, customers have the opportunity to try on clothes in fitting rooms, seek assistance from sales personnel, or seek opinions and advice from friends or partners. In contrast, online platforms offer fewer services compared to the traditional shopping experience.

Many studies have been conducted in the past decade to enhance the online clothing shopping experience. A prevalent focus in these studies involved the integration of 3D models and Augmented Reality (AR) technology. The development of Virtual Fitting Rooms has been a key theme, offering web-based solutions that enable users

to try on clothes virtually. These innovative systems encompass real-time 2D image-based approaches and 2D/3D mannequin-based systems, each contributing to more interactive and engaging online apparel shopping experiences.

One notable study by Hu Peng et al. in 2020 explored the combination of face identification technology and mobile augmented reality to create interactive mobile augmented reality applications. They developed AR Facebook, an Android-based application that used face identification to enhance the augmented reality experience [1]. While this study primarily focused on face identification, it underscores the potential of combining technology to improve the online shopping experience.

In 2018, Gaurav Raturi and others proposed "Virtual Mirror: The Future of Interaction." The virtual mirror concept involved users placing clothing in front of a virtual mirror, which would then scan the garment and superimpose it onto the user's body, creating a realistic virtual try-on experience. This technology allowed users to visualize how clothing would look on them without physically trying it on [2].

Furthermore, "Tendency to Use the Virtual Fitting Room in Generation Y - Results of Qualitative Study" by Miroslaw Moroz and his team in 2019 investigated the propensity of Generation Y individuals to use virtual fitting rooms (VFRs). The study compared 2D and 3D VFRs and found that 2D VFRs, particularly those based on augmented reality, had a greater market impact. These VFRs acted as "virtual mirrors," aiding consumers in making more informed purchasing decisions and reducing the rate of returns [3].

In 2020, Rushikesh Kore and colleagues proposed "Virtual Clothes Fitting Application Based On Augmented Reality for Online Retailers." Their research employed marker-based AR technology to track user motions using markers like QR codes. AR markers replaced markers with garment models, and 3D cloth models were superimposed over users' bodies. This implementation was done using Unity and AR Core's motion tracking and light estimation features [4].

Yael Vizel, CEO of Zeekit, launched a virtual fitting room software in 2013. Zeekit allowed online consumers to visualize themselves in any clothing available on the internet by mapping their images into thousands of segments with real-time image processing. This technology provided a unique and interactive buying experience, reducing returns due to non-fitting or non-flattering items. However, the technology was primarily static and could not view garments from various perspectives [5].

Additionally, C. Garcia Martin et al. in 2012 presented "Human-Friendly Interface Design for Virtual Fitting Room Applications on Android-Based Mobile Devices." This research focused on implementing a human-friendly virtual fitting room application for Android using image processing. It involved body detection, reference point recognition based on facial recognition, augmented reality indicators, and clothes superimposition over the user's image [6].

In the study by Priyadharsun et al. [7], they tackle the multifaceted nature of fashion interests, which vary based on factors such as culture, age, and personal preferences. Their innovative "Parade in the Virtual Dressing Room" application utilizes social networks, allowing users to create virtual models based on their body measurements and even upload photos for comprehensive models. This unique fusion of entertainment and business value aligns with the evolving landscape of social networking, highlighting the potential of integrating virtual models and social platforms to enhance the fashion experience.

Li et al. [8] delve into the pressing need for an Online 3D Virtual Garment Try-on System with improved accuracy, effectiveness, and user experience, which is gaining momentum in the fashion industry. Their paper outlines pivotal design considerations, beginning with the system architecture. They introduce a straightforward yet potent approach to model 3D body prototypes, leveraging Poser software models segmented into layers and subjected to triangularization for triangular surfaces. Furthermore, their garment modelling method, based on the Spring-Mass model and physical try-on simulation, introduces a novel collision detection method utilizing a uniform grid. This innovation results in swift detection and real-time responses, contributing to a more

satisfying and interactive virtual fitting room experience for users and providing potential solutions for the complex challenges of online clothing try-on.

Amid rapid advances in computer network technology, virtual reality (VR) is emerging as a transformative force in instant messaging and communication networks. Li and colleagues [9] investigate VR's myriad advantages, including resource optimization, device redundancy, immersion, interactivity, conceptualization, and holography. Their study introduces a semi-supervised spatio-temporal feature model rooted in the Restricted Boltzmann Machine principles to tackle animation data style recognition. This innovative approach streamlines feature perception through unsupervised bottom-layer pretraining and subsequent supervised model training. Crucially, their layer-by-layer training enhances model parallelism, enabling swift adaptations. Simulation experiments demonstrated a ten-minute reduction in animation design assistance time compared to baseline methods, emphasizing VR and machine learning's pivotal roles in streamlining animation design processes for efficiency and enhanced user experiences.

Additionally, Weerasinghe et al.'s research [10] addresses the clothing industry's evolving landscape, a vital contributor to global economies. As physical and online clothing stores proliferated, traditional shopping practices were disrupted, notably by the pandemic. Their study introduces an innovative application, offering an alternative shopping experience for customers constrained by mobility or pandemic-related concerns. This solution tackles challenges such as time inefficiency, sizing issues, and customer satisfaction in physical stores. With personalized 3D models for virtual fittings and AI chatbots for interactive assistance, the application enhances the clothing selection process. Furthermore, it employs a predictive sales algorithm using K-Nearest Neighbors, aiding clothing businesses in decision-making. Weerasinghe and the team's work underscores technology's transformative potential in reshaping clothing retail and meeting evolving consumer needs.

In summary, the literature review highlights the growing interest in using augmented reality and virtual fitting rooms to address challenges in online clothing shopping, such as sizing, fit, and user satisfaction. These studies provide valuable insights into the development and application of AR technology in the fashion industry, laying the foundation for the proposed AR virtual fitting room system described in this paper.

3. Methodology

This section presents a comprehensive overview of the methodology employed in the development of the proposed application, which integrates the three.js library for the 3D dressing room, React.js for the e-commerce front, and Express.js, MongoDB, and Node.js for the backend.

The “Dress mo” application was developed to optimize the garment selection process of customers and to solve the issue of excess inventory of unsold clothing in stores. The” Dress-mo” application had Three main objectives to accomplish. Those objectives are as follows:

- Display item catalogue with 3D Models
- Display Items in personal space through VR technology
- Enable the User to customize the 3D Model

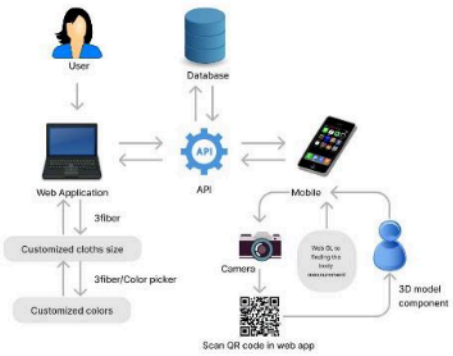
The project commenced with an in-depth Requirement Analysis phase, aimed at establishing a profound understanding of the application's objectives. This included identifying the essential functionalities such as clothing customization, real-time 3D visualization, and user interaction within the virtual fitting room. These insights were vital for shaping subsequent design and development efforts. The overview of the system is shown in Fig 1.

The UI/UX Design stage followed, during which the visual and experiential aspects of the application were meticulously planned. This entailed crafting wireframes and mockups that portrayed the layout, navigation flow, and user journey. The emphasis was on creating an intuitive user interface that seamlessly amalgamated the three. js-powered virtual dressing room and the React. js-based e-commerce interface.

The Integration Architecture was defined to ensure cohesive integration, mapping out the interactions between three.js, React.js, Express.js, MongoDB, and Node.js components. This architecture facilitated robust communication and synchronization between frontend and backend elements.

Frontend development focused on implementing React. js-driven e-commerce platform. This encompassed the realization of user interfaces enabling clothing selection, dynamic customization, and interaction with the 3D virtual Model components. The three.js library was seamlessly incorporated to empower users with real-time clothing visualization and modification capabilities.

Figure 1:System OverviewFigure 2:Dressmo application



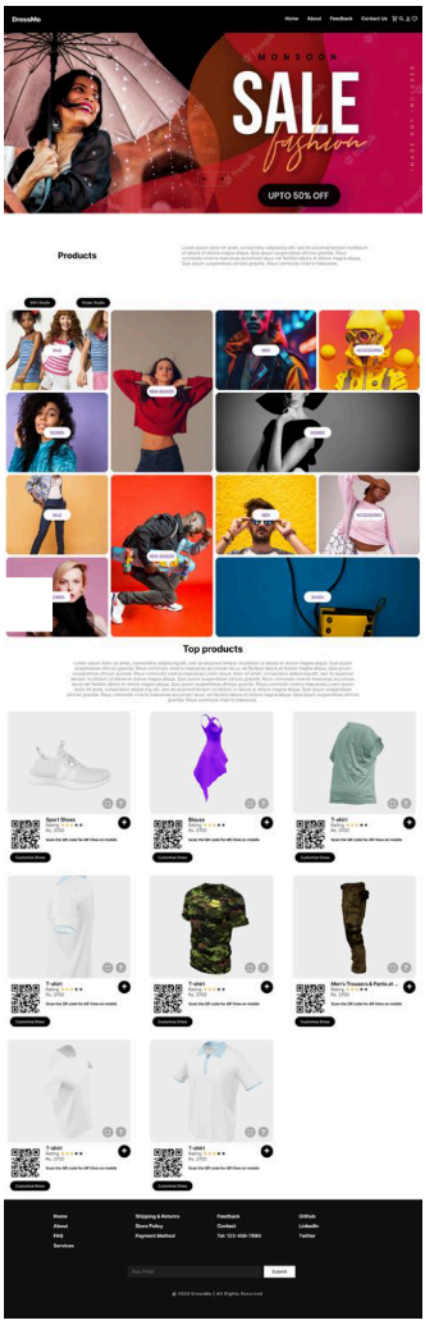


Figure 3:AR

As shown in Fig 2, the application displays a catalogue of clothing items which was made responsive for both web and mobile view. These items are rendered 3D models so that the customer can use pointing devices or touch screens to rotate, resize and view clothing items at any angle they prefer. This was done by creating the 3D models from the clothing items using Blender – which is an open-source platform used to create 3D models, these 3D model files were imported into the react Web application and rendered to the catalogue through a model viewer.

Customers are given the option of viewing the 3D models through the mobile camera in their personal space as shown in Fig 3. The web application users can scan a QR code through their mobile devices and be redirected to the mobile web platform where they can see the items in their personal space. Mobile users can access this function seamlessly with the "View in your space" option. This was done by using an open-source API called "WebXR Device". This API is called with the 3D model file, and the API serves as a bridge between your web application and the user's AR-capable device. It provides a set of functionalities and tools to create immersive AR experiences by accessing the camera feed, rendering 3D content, handling interactions, and managing the overall AR session.

The application allows the customer to customize the rendered 3D models in a personalized studio which we named "Dress-mo Studio". Customers can change the appearance of the clothing items they wish to purchase to design them according to their preferences as shown in Fig 4. This is done by creating the 3D models in multiple layers, which would then be incorporated into the ThreeJS framework using the node package "react-three-fiber". ThreeJS, which is an open-source JavaScript library designed for creating 3D computer graphics and visualizations in web browsers, is used to render the different layers of the 3D model. React packages like "colour-picker" and "drei" were employed to ensure the smooth functionality of the feature.

Figure 5:Customized shoe

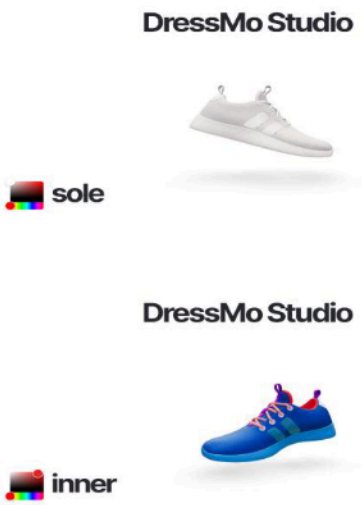
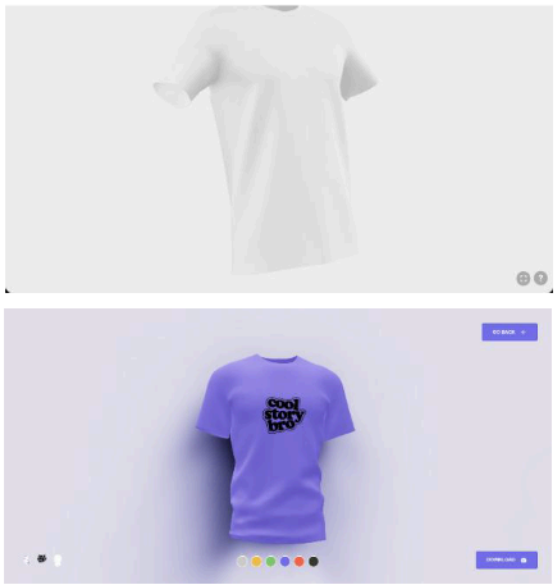


Figure 4:T-shirt customization



The backend was constructed through Express.js and Node.js, where APIs were designed to handle user authentication, product management, customization choices, and order processing. Data persistence was managed by integrating MongoDB, ensuring efficient storage and retrieval of user data, product details, and customization preferences.

To deliver the immersive virtual fitting room experience, the 3D Model Integration phase involved seamlessly merging the three.js library into the front end. Customizable 3D models of clothing items were meticulously developed, with parameters established to facilitate dynamic changes such as colours, styles, and sizes. This

tight integration assured a seamless user experience transitioning between garment selection and lifelike visualization.

To guarantee system integrity, Unit Testing was conducted on all application components. This entailed a rigorous assessment of React components, Express.js routes, API endpoints, and the rendering of 3D models through three.js. Ensuring the smooth interaction of frontend and backend was paramount; Integration Testing was performed, meticulously scrutinizing data flows, communication, and synchronization.

In the User Acceptance Testing phase, a diverse group of users participated to evaluate the application's usability and effectiveness. The focus was on assessing the accuracy of clothing customization, the realism of the 3D Models, and overall user satisfaction. Valuable feedback from users played a pivotal role in refining the application's design and functionality.

Data collection was integral to evaluating the application's performance. Usage Data Collection encompassed tracking user interactions, such as clothing customization choices, 3D model views, cart contents, and successful orders. These data Utilizing the feedback gathered during testing, the User Feedback Analysis provided crucial insights. Qualitative feedback shed light on user satisfaction levels, the effectiveness of customization features, and the perceived realism of the virtual fitting room experience. This qualitative analysis drove continuous refinement and enhancement of the application's features

Ethical considerations played a significant role throughout the development process. Stringent Privacy and Security Measures were implemented in the backend to ensure user data remained confidential and secure. Encryption and authentication mechanisms were diligently integrated to safeguard user information and financial transactions.

To ensure that the "Dress-mo" application delivers a seamless and responsive user experience, performance optimization was a key focus during development. This involved various techniques such as code minification, and server-side caching. The web frontend was made to be responsive for various screen sizes as well. Additionally, the application utilized content delivery networks to reduce latency and accelerate the loading of 3D models and other assets. By implementing these optimizations, we aimed to minimize loading times and provide users with a fluid interaction with the virtual dressing room.

Ensuring that the "Dress mo" application is accessible to a wide range of users was a core consideration. We adhered to web accessibility standards to make the application usable by individuals with disabilities. Features such as screen reader compatibility, keyboard navigation, and alt-text for 3D models were integrated to provide an inclusive experience. This commitment to accessibility reflects our dedication to creating a virtual dressing room that caters to diverse user needs.

To facilitate a smooth user onboarding process, user training materials and documentation were developed. These resources aimed to guide users through the clothing customization process, 3D model interactions, and the use of augmented reality features.

Recognizing the potential for scalability and future growth, the application architecture was designed with extensibility in mind. The use of a microservices architecture allowed for modular development, enabling us to add new features and scale the application's capacity seamlessly. As the fashion industry evolves, the "Dress mo" application can adapt and incorporate emerging technologies and trends, ensuring its relevance and longevity.

Throughout the development process, a user-centered design approach was embraced. User feedback and preferences played a pivotal role in shaping the application's features and functionalities. Regular usability testing sessions were conducted to gather insights from potential end-users. This iterative design process allowed us to refine the user interface, enhance customization options, and improve overall user satisfaction.

Furthermore, the principle of Informed Consent was upheld during user testing. Participants were transparently informed about the nature of data collection and how their interactions would be utilized within the application. Obtaining consent was pivotal to adhering to ethical guidelines and maintaining user trust.

The outlined methodology offers a comprehensive insight into the systematic approach undertaken to develop the proposed application. Leveraging the strengths of three.js, React.js, Express.js, MongoDB, and Node.js, this methodology ensured the successful integration of an interactive 3D dressing room experience within an e-commerce platform. The subsequent section presents the outcomes of this implementation and critically evaluates the application's efficacy in meeting its intended objectives.

4. Results And Discussions

web application 'Dress mo has been developed so that the customers can shop for the clothing type they need and view them as a 3D model so that they can have an extended idea of how the clothes look like and give them the ability to customize them. The application has been developed in a way that is responsive for both mobile and desktop users so that the users would have different user experiences which would vary according to the devices they use.

The application was made using React JS as the front-end framework while the Three JS framework has been used to render the 3D Model aspects of the application. Node JS was used with the Express JS framework for the backend and Mongo DB was used as the database. The research used 3D Models and augmented Reality concepts in its implementation.

Each clothing item has its Multi-layered 3D model rendered in the web application. The customer can view the model from any angle they want on the catalogue page and view the model in full screen if needed. Web users can use their mouse, or touchpad to view different angles of the clothing model, and an added option is given so that they can scan a QR from their mobile devices and view them in mobile as well.

Each 3D model can be rendered into real-life space using Augmented Reality, where the 3D model would be projected into the user space through the camera of the device and users could view the items in their personal space, the customer could then interact with the Model resizing, rotating and placing the said clothing item to get a complete idea of the item, and even take photographs for future references.

The Added function of Customizing Clothes allows the users to Customize the clothing items, in a studio page we named 'Dress mo studio'. Users can customize the 3D Model in a way to their liking. Each layer of the cloth can be customized according to the user's liking so that the final product can be purchased through the application.

5. Consclusion

In the current fashion industry, clothing items are mainly created by designers and distributed through retail and online stores. Most of the clothing items used by customers are designed by fashion designers. Customers usually do not get a say in the designing process, At present the main distribution methods are Physical stores that vary from small boutiques to large textile chains, and online stores which can be found in many sizes to small startup online stores that distribute clothes from various designers or Large online stores that designs and distributes their products

However, a notable issue with this existing system is that customers lack the opportunity to express their opinions regarding the design of the clothing items they purchase. They are typically restricted to choosing from a limited selection of clothes available to them. For instance, the customers tend to find garments with preferable quality and design but with colors they dislike While online stores do provide a somewhat broader range of choices, the fundamental problem of not being able to buy clothes that precisely match one's preferences persists.

This application serves the primary purpose of empowering customers by granting them the ability to customize clothing items according to their specific preferences, ultimately enabling the purchase of personalized garments that align perfectly with their expectations. At its core, this innovative application harnesses the power of technology to revolutionize the way consumers engage with fashion.

The key feature of this application lies in its utilization of a sophisticated 3D model, which serves as the canvas for customers to customize their chosen clothing items. This 3D model provides an immersive and interactive platform for users to experiment with various design elements, from colors and patterns to styles and fits. Through this dynamic interface, customers have the freedom to express their unique tastes and fashion sensibilities with unparalleled precision.

What truly sets this application apart is its Augmented Reality (AR) technology integration. Customers can not only customize their garments but also visualize the final product in real-time through the lens of AR. This groundbreaking feature allows users to see how their customizations translate into the physical world, providing a heightened sense of confidence in their choices before making a purchase decision.

In essence, this application represents a pivotal shift in the fashion industry, putting the power of design and personalization directly into the hands of consumers. By seamlessly merging 3D modelling and AR technology, it fosters a more inclusive and customer-centric approach to fashion, where individuals can actively shape their clothing choices, resulting in a wardrobe that truly reflects their unique style and preferences.

Refrences

[1] Hu Peng et al., "Application Research on Face Detection Technology based on Open Source Computer Vision (Open-CV) in Mobile Augmented Reality," 2020.
[2] Gaurav Raturi et al., "Virtual Mirror: The future of Interaction," 2018.
[3] Miroslaw Moroz et al., "Tendency to Use the Virtual Fitting Room in Generation Y - Results of Qualitative Study," 2019.
[4] Rushikesh Kore et al., "Virtual Clothes Fitting Application Based On Augmented Reality for Online Retailers," 2020.
[5] Yael Vizel et al., Zeekit.
[6] C. Garcia Martin et al., "Human-Friendly Interface Design for Virtual Fitting Room Applications on Android-Based Mobile Devices," 2012.
[7] S.Priyadharsun, S.Lakshigan, S.S Baheerathan, S.Rajasooriyar, U.U.S.K. Rajapaksha and S.M.BuddikaHarshanath, "Parade in the Virtual Dressing Room," in International Conference on Computer Science & Education (ICCSE 2018), Colombo, Sri Lanka, 2018.
[8] Rong Li, Kun Zou, Xiang Xu, Yueqiao Li and Zan Li, “Research of Interactive 3D Virtual Fitting Room on Web Environment” in Fourth International Symposium on Computational Intelligence and Design, P.R.China, 2011.
[9] R. Li, K. Zou, X. Xu, Y. Li, and Z. Li, “Research of Interactive 3D Virtual Fitting Room on Web Environment,” 2011 Fourth International Symposium on Computational Intelligence and Design, Oct. 2011.
[10] Weerasinghe S.W.P.N.M., Rajapaksha R.M.D.D., Sathsara L.G.I., Gunasekara H.S.D.N, Dinuka R. Wijendra, Dilshan I. De Silva, "Virtual Dressing Room: Smart Approach to Select and Buy Clothes" in 2021 3rd International Conference on Advancements in Computing (ICAC).