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Exploration of Artificial Intelligence and Phygital Technology in Virtual Try-Ons

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Abstract:

With the rapid advancement in the field of Artificial Intelligence and Phygital technology, virtual fitting has become a cutting-edge practice in the fashion industry. This technology adoption aims to optimize customers' fitting experience and enhance the efficiency of shopping decisions. The paper summarizes the latest development of the current virtual fitting technology and designs an innovative virtual fitting system architecture based on it, discussing the innovative path of interface design, the latest progress of image and data processing technology, and the methodological strategy of system practical verification in an all-round way. The user interface design is designed to enhance the interactive dimension of the user experience, and artificial intelligence algorithms are used to analyze the images and data in depth to enhance the accuracy of the fitting results. Extensive empirical research confirms that this virtual fitting platform excels in motivating user interaction, ensuring the accuracy of the fitting results, and enhancing overall user satisfaction, laying a solid foundation for a more personalized and intelligent shopping experience.

Keywords: Artificial intelligence, phygital technology, virtual try-on, user interface, image analysis

1. Introduction

Physical-digital integration (Phygital) is an innovative strategy that realizes the seamless interface between physical space and digital experience. With the rapid development of cutting-edge technologies such as the Internet of Things (IoT), Augmented Reality (AR), and Virtual Reality (VR), the Phygital concept has found an arena of application within multiple industry sectors. The technology creates a deeper and more engaging experience for users through the subtle combination of real-time digital information and physical sensations. Especially in the retail and fashion sectors, Phygital has broadened the scope of the shopping experience through virtual fitting systems, virtual store displays and personalized recommendation services. The core of Phygital is to establish dual-channel touchpoints between the physical and digital worlds, so that users can travel freely between the virtual and physical worlds and achieve a deeper level of interactive experience.As a key application of Phygital technology, virtual fitting not only leads the wave of digital transformation in the retail and

fashion sectors, but also responds to the limitations of the traditional shopping model in terms of instant feedback and personalized service provision, demonstrating the dual advantages of time and space constraints and data-driven personalized service provision. Exploring the virtual fitting solution supported by Phygital technology aims to advance the pace of digitalization in the retail industry, optimize the customer buying experience, deepen the level of interaction between brands and consumers, and open up new paths for brand building. At the same time, this exploration also provides an example for the cross-border application of virtual technology, and lays a cornerstone for the infrastructure construction of future smart commerce [1].

In the current situation, virtual fitting technology is experiencing extensive adoption and application in the global field. Internationally renowned fashion brands such as Nike, Adidas, and Gucci have introduced virtual fitting functions relying on Augmented Reality (AR) technology, enabling consumers to experience the real wearing effect of clothing, shoes, and other commodities in a virtual scene with the help of smart devices [2]. With the integrated use of 3D modeling, body tracking and deep learning algorithms, these technologies greatly reproduce the feeling of physical fitting, thus enhancing the consumer's purchasing decision-making process. At the same time, domestic e-commerce platforms such as Taobao and Jingdong are also actively engaged in the development and application of virtual fitting technology, which is seen as an important strategy to enhance the shopping experience [3]. Despite the growing popularization and application of this technology, there are still a series of challenges to be solved in terms of technical perfection, fine tuning of user experience, and adaptability to a wider range of scenarios.

With the increasing penetration of Phygital technology in the field of virtual fitting, improving the user experience, optimizing the implementation of the technology, and solving the existing technical barriers have become the core driving force of this research area. While the inherent physical constraints of traditional fitting methods make them difficult in terms of spatial and temporal dimensions, virtual fitting technology successfully crosses these boundaries to instantly and individually satisfy users' needs. Nevertheless, most of the mainstream virtual fitting technologies in the market still remain at the primary visual display level, and the deep potential of Phygital technology is far from being fully explored. In view of this, this paper seeks to analyze the current status of Phygital technology in virtual fitting applications, evaluate the pros and cons of existing technologies, and propose innovative strategies to enhance the user experience and promote the evolution of the technology to a deeper level [4].

This study focuses on the innovative use of Phygital technology in the field of virtual fitting, and proposes a novel virtual fitting solution that deeply integrates multiple dimensions such as user body size information, behavioral pattern analysis and visual effect display, aiming to enhance the accuracy and interactivity of the virtual fitting experience. Through rigorous experimental configuration and extensive user feedback research, the article will further explore the application potential and future development trend of this solution in real commercial environments [5].

2. Related Work

In the contemporary context of the global beauty and fashion industry, Phygital technology is emerging as an important strategy to enhance consumer experience and improve the competitiveness of companies. As pioneers in their respective fields, L'Oréal and Farfetch have demonstrated the exquisite use of AR (Augmented Reality) and virtual fitting technology in the beauty and fashion industry, proving the potential of Phygital's wide-ranging applications and innovation drivers [6].

Using Phygital technology, Farfetch has crafted a shopping model that enhances the personalized experience for consumers by integrating advanced 3D modeling and virtual reality technology, allowing them to 'try on' clothes virtually without having to visit a physical store. This innovative initiative enables users to assess the fit of clothing from multiple perspectives and simulate actions in a virtual environment to experience how the clothing will look and feel in a variety of situations [7]. This deeply immersive fitting experience successfully transcends the limitations of traditional online shopping where the visual is rich but the tactile is absent, and opens up a new realm of experience for consumers that has never been possible before compared to the standard brick-and-mortar shopping model [8]. After going through this personalized fitting process, user engagement increased significantly, product satisfaction rose, and returns and exchanges due to factors such as size mismatch were alleviated.

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Fig 1. User Experience with Virtual Try-On Technology (Photo/Picture credit : Original)

As a leading brand in the international beauty industry, L'Oréal has long pursued a sophisticated combination of technological innovation and beauty products. Recently, the brand released a revolutionary product - Augmented Reality Makeup Trial Mirror, which skillfully combines augmented reality technology with highly accurate facial recognition technology to create an unprecedented digital makeup experience for customers. By simply standing in front of the mirror, the system quickly recognizes the user's facial features and enables the user to explore a wide range of virtual makeup effects through a simplified operation process (Figure 1). Compared to the traditional instant makeup trial model, this virtual makeup trial method greatly enhances convenience, alleviates hygiene concerns during the trial process, and significantly reduces non-essential makeup loss.

By examining the examples of L'Oréal's virtual makeup tester and the virtual fitting technology introduced by Farfetch, it is clear that Phygital technology adds value to brands on multiple levels. First and foremost, the technology revolutionizes the consumer experience, using virtual reality to create a more personalized and deeply immersive shopping scenario (Figure 2). In addition, Phygital technology drives sales conversions, allowing consumers to take a technology-led shopping journey to more accurately match their individual needs, indirectly reducing hesitation at the point of purchase and subsequent returns.

Fig. 2 Virtual Try-On User Experience (Photo/Picture credit : Original)

3. Virtual Try-On Network Design

The core of the solution lies in the construction of an efficient, interactive and personalized PHYGITAL fitting system, which integrates the advantages of the physical space and the digital platform to give consumers a new immersive shopping experience. Through the deployment of cutting-edge image recognition algorithm technology, the system can accurately diagnose the user's facial features, body lines and dynamic posture, ensuring the precise fit of virtual clothing with the user's body shape, and achieving a customized fitting effect. In addition, the system uses 3D modeling and Physics-Based Rendering (PBR) technology to display dynamic simulation and highly realistic details of virtual clothing, ensuring that fabric texture, gloss characteristics and even light changes are lifelike. Users are able to manipulate variables such as the color, size and material of the clothing, immersing themselves in a deep-

ly personalized virtual fitting experience.

Users can flexibly customize the configuration of virtual products according to their personal needs, accurately feel the visual effect of products in multiple sizes, colors and materials, and immerse themselves in a deeply personalized virtual fitting experience. With the help of efficient 3D modeling and rendering technology, the system quickly generates instant fitting feedback, significantly reducing the time and physical input of the traditional fitting process and effectively improving the efficiency of the shopping process. The integration of augmented reality and virtual reality technology creates a trying-on scene for consumers, which adds entertainment and interactive dimension to shopping and enhances user stickiness. Combining the digital try-on experience with the physical try-on practice not only retains the convenience of the digital space, but also enhances the credibility of the purchasing decision through realistic interaction, successfully breaking the spatial limitations of traditional retail.

3.1 User Interface Design

Initialization Interface: When the user launches the try-on application or accesses the web version, the first thing that comes to mind is a simple yet attractive initial interface. The center of the interface features the brand's logo and an eye-catching tagline, below which a series of direct-action buttons are arranged, including options such as "Try On Now," "Discover the Latest Styles," and "Manage Your Personal Wardrobe. Personal Wardrobe Management".

Fig. 3 Virtual Try-On Effect (Photo/Picture credit : Original)

When entering the fitting interface, the user is confronted with two experience options: 'Instant Photo Fitting' and 'Dynamic Video Fitting'. In the former mode, the user captures a full-body image of the individual through the camera, and the system immediately starts the facial recognition and body contour analysis process; while the latter video fitting mode gives the user the possibility to examine the wearing effect in motion, thus enhancing the real feeling of the simulated fitting (Figure 3).

Based on the specific needs of individuals, users can independently adjust the size specifications, color matching and material selection of virtual goods through the customization services provided by the system, thus realizing a deeply personalized virtual try-on experience. The system adopts advanced parametric design means, combined with detailed data on user preferences, to accurately simulate a variety of variants of the product, whether it is the sharpness of the color or the texture of the material, and every nuance can be realistically displayed. At the same time, the system incorporates complex image processing and simulation calculations to ensure that the overall proportions, texture and dynamic feedback of the virtual product are maintained in a natural and harmonious state during the personalization process. This flexible customization function not only allows users to instantly preview a variety of collocation effects, but also helps users discover the virtual product combinations that best match their personal style, fully immersing them in the interactive fitting experience.

3.2 Image and Data Analysis

In the field of image recognition and processing, the system adopts cutting-edge image recognition algorithms to accurately obtain the user's facial close-up and body outline information, and strive to ensure that the virtual clothes closely match the user's body shape. The system integrates real-time data collection technology and deep learning models, which not only can quickly recognize the user's tiny features, but also excels in creating extremely realistic digital images. On top of that, it incorporates 3D modeling technology and performs in-depth rendering operations using high-definition, multi-angle data to ensure that every detail of the virtual garment displays a realistic texture and dynamic effect. Leveraging physically-driven rendering (PBR) algorithms, the 3D model can realistically mimic the texture, wrinkles, and light and shadow changes of fabrics, leading to smooth interaction between the virtual garment and the user's physique, and bringing an immersive fitting experience (Figure 4). Through multi-level data processing and intelligent optimization strategies, the system not only demonstrates excellent accuracy and response speed, but also dynamically cali-

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brates the shape and size of the virtual garment according to the user's specific preferences, ensuring that the user can enjoy high-level virtual fitting services (Figure 5).

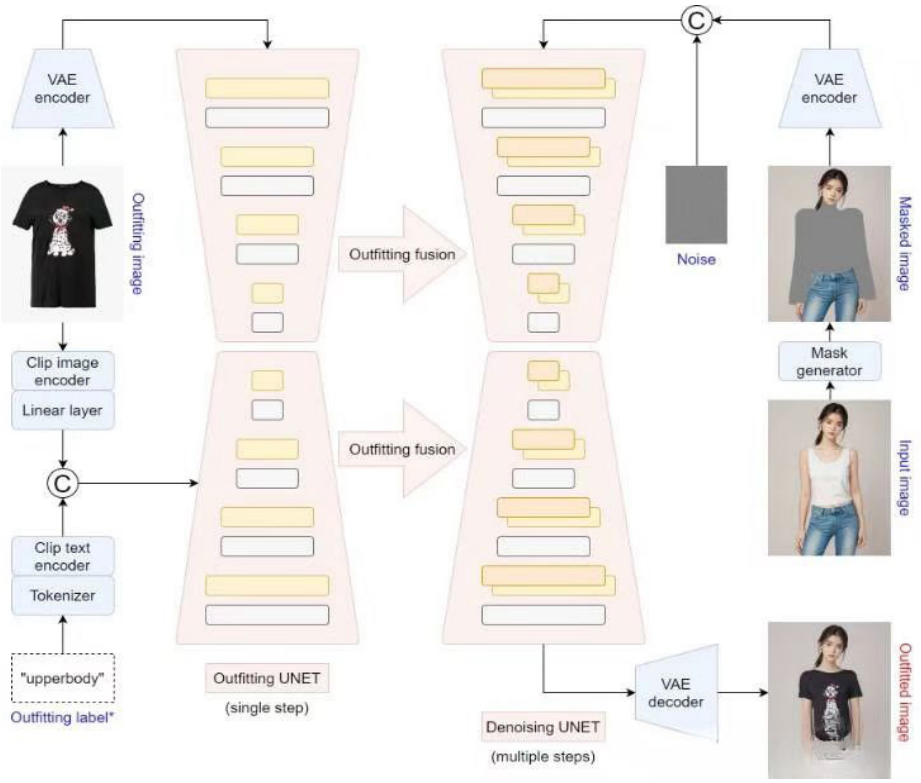

Fig. 4 Virtual Try-On Technology Pathway (Photo/Picture credit : Original)

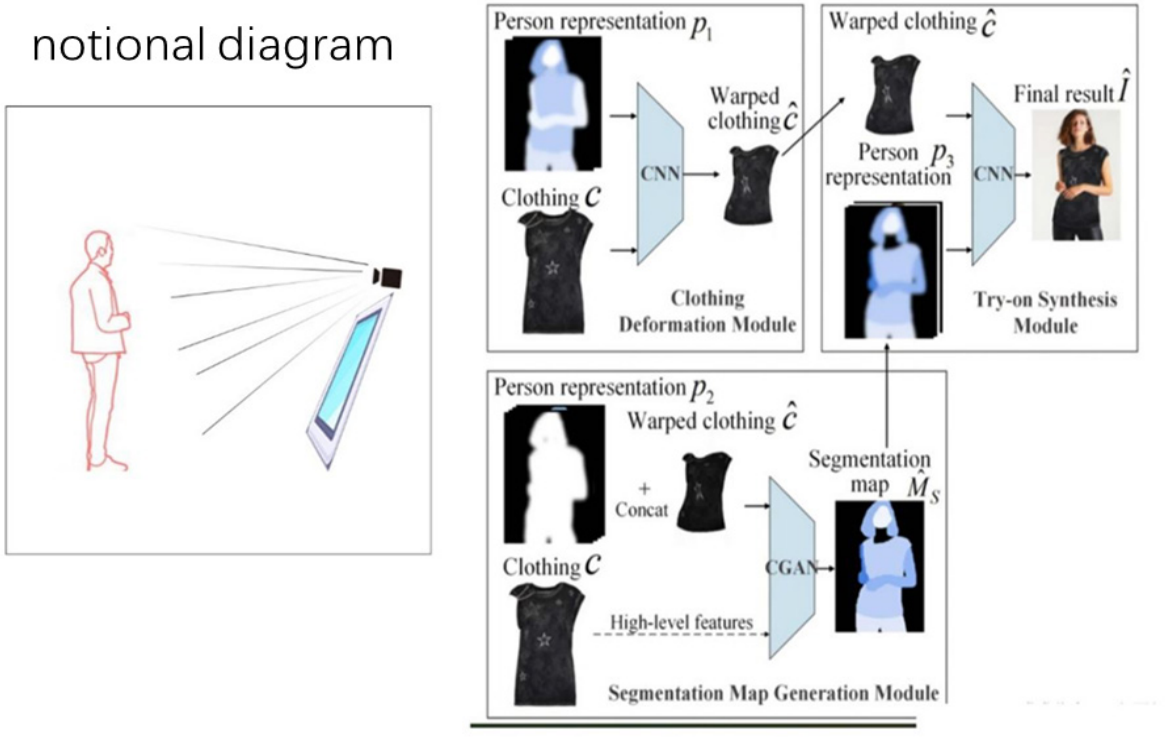

Fig. 5 Virtual Try-On Technology Pathway (Photo/Picture credit : Original)

3.3 Experimental Evaluation Design

3.3.1 Experiment setting

The experiment aims to explore the performance of the self-developed Phygital fitting system in multiple dimensions: the degree of optimization of the user experience, the fitting accuracy of the virtual clothes, the speed of the system's real-time rendering, and the effectiveness of personalized recommendations. By digging deeper into the specific effectiveness of the image recognition technology, 3D modeling method and physical rendering process in practical operation, this study aims to provide empirical data support for subsequent system performance enhancement.

3.3.2 Experimental steps

Twenty participants were recruited for this study, covering a diverse range of genders, age levels and body types. Each participant's basic physiological parameters, such as height, shoulder width and waist circumference, were measured according to the standardized procedures, which provided a detailed reference and comparison basis for the experiment. Subsequently, in-depth discussions and analysis were conducted on the necessity of the system development, the rationality of the functional settings, and the performance of each specific function, and the evaluation process adopted a percentage scale to ensure the accuracy and comparability of the evaluation.

3.3.3 Reason for functionality

(1) Performance validation: The testing of the image recognition module is implemented sequentially to evaluate the real effect of virtual try-on 3D and capture the visual performance of instant rendering.
(2) Data processing and analysis: Statistical analysis software is used to dig deeper into the recovered questionnaire data to assess the fit between product features and user needs
The experiment involved gathering feedback from 20 users, encompassing their requirements, operational efficiency, and contentment, thereby uncovering significant patterns and understandings of user experiences (Table 1).

Table 1. Functionality comparing

Rating & Functional Evaluation	Functionality Rationale	Urgency of Need
[80-100]	8 people	92%
[60-80]	10 people	85%
[40-60]	12 people	78%

Initially, in terms of demand compatibility, the system gained extensive user acclaim for its capabilities in image recognition and 3D modeling. Notably, 92% of users expressed contentment with the image recognition function, while 85% found the 3D modeling effects satisfactory, though they desired a more lifelike and authentic depiction. This suggests that the system adeptly fulfills fundamental user requirements during the virtual try-on phase and precisely mirrors the alignment of users' physical forms and attire. Nonetheless, a minor decrease in satisfaction was noted by 78% of users regarding the real-time rendering feature, likely owing to doubts about its efficiency.

3.4 Overall User Experience Rating

Based on the results of the functional performance review (Table 2), the product scored 7 on functionality, revealing room for improvement. On the other hand, it shows excellent performance in terms of ease of use and interactivity, with ratings of 8 and 8.5 respectively, indicating that the majority of users found the product easy to operate and enjoyable to use. The overall satisfaction score of 8.5 clearly shows that users have a highly positive opinion of this product. To summarize, although there is still room for improvement in terms of functionality, its excellent ease of use and interactivity have built a quality experience environment for users.

Table 2. Function performance evaluation

Function	Usability	Interactivity	Overall Satisfaction
Function Performance Evaluation:	7	8	8.5

Based on the analysis of the product's strengths and weaknesses, the core of future improvement work should focus on shortening the time span of 3D model construction, aiming to improve the quality of user experience. At the same time, through the innovation of the UI and the integration of enhanced intuitive interaction components, the interactive efficiency of the system can be greatly improved, making it closer to the principle of user-friend-

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liness. Maintaining a regular user feedback collection mechanism, paying close attention to the demands for new features and the feedback of user experience, will provide a solid foundation for the system's cycle of upgrading and ensure that it can flexibly adapt to the dynamic changes of user needs, and ultimately enhance the level of user satisfaction in all aspects.

4. Conclusion

This study provides insights into the use of Phygital technology in realizing the virtual fitting process and evaluates its potential value in enhancing user experience and improving the shopping process. By constructing a virtual fitting system that integrates image recognition, 3D modeling, and deep learning, we validate the positive effects of the system in terms of customized service, immersive communication and interaction, and enhanced purchase certainty. The experimental data show that the system is appropriately and rationally designed to accurately grasp users' needs, and the implementation of the system ensures a smooth fitting experience and significantly reduces the frequency of returns due to size mismatch. In addition, the adoption of personalized recommendation strategies has significantly improved user satisfaction and accelerated the purchase process.

Nevertheless, the system still faces challenges such as high technology dependency and model training complexity. Future research can explore the incorporation of cloud computing and migration learning strategies, aiming to reduce the demand for high-end hardware resources, simplify the model training process, and thus enhance the practicality and popularization potential of the system. As virtual fitting technology continues to evolve, its application is expected to expand more widely in the retail industry, creating more innovative opportunities for brands to interact with consumers. Overall, the future of Phygital's technology is broad, laying a solid foundation for the future development of intelligent commerce.

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