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Ricci, Marina

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Exploiting Virtual Reality for Enhancing the Shopping Experience in the Fashion Industry: Between Interaction and Perception

Marina Ricci*

Department of Mechanics, Mathematics, and Management, Polytechnic University of Bari

Human-Centred Design Department, Technology University of Delft

ABSTRACT

Nowadays, buying a product online is no longer about the product itself but the experience it offers. The planned thesis work aims to understand how to improve the user's shopping experience in the context of online shopping for the fashion industry. To enhance the shopping experience, retailers need to sell new services by leveraging technologies such as Virtual Reality (VR). The first part of the research investigates which shopping experience, between one developed for a desktop computer – Desktop Virtual Reality (DVR) - and one developed in Virtual Reality (VR), generates better results in terms of hedonic and utilitarian values, cognitive load, and user experience. Also, the lack of touch in online shopping is a crucial issue. The second part of the research concerns the implementation of pseudo-haptics feedback within the online shopping experience with VR. Pseudo-haptics can induce haptic sensations without requiring actual touch through the influence of other sensory modalities, such as vision. To this end, we aim to explore the feasibility of recreating the sensation of people's actual touch with fashion products and fabrics through a "visualized touch" on an interface.

Keywords: Retail, Virtual Reality, E-Commerce, User Experience, Pseudo-Haptics, Design for Interaction.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Mixed / augmented reality; Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Empirical studies in interaction design

1. INTRODUCTION

The retail industry is developing at a very fast pace due to the exponential growth of technological opportunities such as Virtual Reality (VR) [1]. Furthermore, the Covid-19 pandemic has further accelerated this process. In this framework, VR represents a promising technology for producing satisfying consumer experiences that mirror those experienced in physical stores [2] and enriching online consumer experiences in the emerging Metaverse [3].

Today's online shops may be functional and efficient but do not offer a sufficiently engaging shopping experience [4]. VR can generate several potential advantages, particularly for retail. Indeed, VR allows the configuration of products at 360°, showing users the configured product through an immersive 3D visualization.

*e-mail marina.ricci@poliba.it
ORCID: 0000-0001-9355-8430

Thus, allowing the user to better understand the configured product's features that could be difficult to perceive through a flat 2D image shown on a traditional monitor [5].

This condition is amplified for high-quality products that feature distinctive shapes, materials, and finishes and require great purchase confidence due to their cost. For example, buying an expensive bag can be considered an emotional process that requires an accurate representation of the 3D product.

Although VR has proven its effectiveness in the field of fashion retail [2], the scientific literature is scattered and still presents limited studies. For this reason, further research is needed in order to assess how VR technology can improve the user shopping experience.

In addition, VR applications could incorporate multiple sensory channels [6], [7] that can offer consumers a more interesting experience through imagination and help improve their ability to evaluate products [8]. Indeed, perception plays a crucial role in purchasing activities, as customers perceive product features through the five human senses.

The lack of sensory feedback - particularly of touch - in the context of online shopping is a complex problem that is still under investigation. However, haptic sensations can be induced without the need for actual touch or haptic devices through pseudo-haptic feedback [9] due to the influence of other sensory modalities, such as vision [10].

The aim of my doctoral research is to investigate how different display and interaction systems in the VR environment can influence the shopping experience and the user's perception of the product.

The first part of the research focuses on the interaction and analyses the differences between the shopping experience on a desktop computer – Desktop Virtual Reality (DVR) - and in VR.

The second part of the research focuses on perception by implementing pseudo-haptics feedback in VR for fabrics interaction.

My thesis work refers to the ISMAR community, as this conference is the premier conference for VR and attracts leading researchers from academia and industry. As we have embraced VR technologies with the intention of improving the shopping experience, we refer to this community as the most knowledgeable about these systems. Furthermore, ISMAR 2021 gave me the opportunity to network and start international collaborations with other universities.

2. RESEARCH APPROACH

The doctoral research starts with a comprehensive analysis of the scientific literature in order to unveil the issues and needs of the fashion retail industry from both the customer and retailer perspectives (See Fig. 1). In particular, the analyzed domains cover

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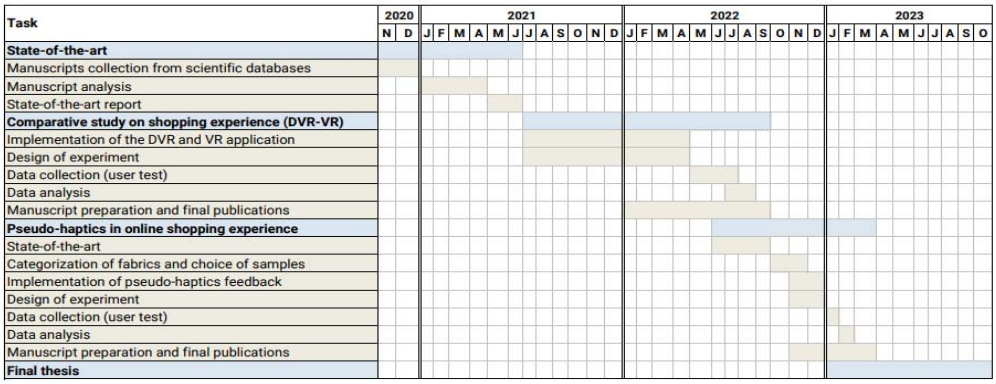

Figure 1: Gantt Chart of the planned doctoral tasks

fashion retail, online shopping, and VR applications in the fashion industry. The literature review reveals the need to improve the online shopping experience in the retail sector.

To this end, we conduct a comparative study between two different virtual shopping experiences that differ in terms of both display systems and interaction: DVR vs. VR.

The case study concerns a bag shopping experience and aims to investigate which of the two systems (DVR and VR) delivers better results in terms of hedonic and utilitarian values, cognitive load, and user experience. These metrics return useful insights to evaluate the user's overall shopping experience [4], [11].

Then, I plan to implement pseudo-haptics feedback within the online shopping experience by leveraging VR technology. This part of the research will be accomplished during my doctoral visiting period at TU Delft.

2.1 Desktop versus Virtual Reality Shopping Experience

In the literature, only three contributions present a bag shopping experience [4], [12], [13].

Altarteer et al. (2016) [12] conduct a comparative study to investigate the customer attitudes toward a 3D VR system against the existing 2D static images personalization system for a luxury brand online regarding product customization. Results demonstrate that the VR system makes available using a high level of product visualization and real-time interaction and promotes hedonic values elevating the customer experience in the shopping environment.

Altarteer and Charissis (2019) [13] present a VR prototype that enables luxury brand customers to view, interact and customize life-size and photorealistic VR models of bags before proceeding to purchase. Results indicate that the perceived experience value, presence, ease of use, and usefulness significantly influenced the attitudes towards the VR system.

Wu et al. (2019) [4] design a set of typical VR shopping tasks for the bag shopping experience. Each participant is asked to complete the same shopping task set as quickly as possible using three different interactive techniques: virtual handle controller, ray-casting, and user-defined gestures. Results show that the freehand-gesture-based interaction technique is rated as the best in terms of task load, user experience, and presence without the loss of performance (i.e., speed and error count).

These contributions show that companies can better engage potential customers by presenting products in a VR shopping environment, however, it is still unclear whether customers will adopt this technology for their shopping experiences.

Furthermore, comparative studies between VR and DVR applications for retail have only been conducted in one other retail sector: grocery [11]. Results related to the exploration of muesli packages in both scenarios reveal that VR shopping environments positively influence a hedonic path due to telepresence, but surprisingly negatively influence a utilitarian path due to the poor readability of product information. The authors suggest further studies to replicate their experiment for high-involvement categories as fashion products (e. g., clothes, accessories), expecting immersion's effect on the utilitarian and hedonic path to be more pronounced and positive for these product categories.

By definition, the hedonic shopping value reflects the value gained through the multisensory, imaginative, and emotional aspects of the shopping experience. In contrast, the utilitarian shopping value reflects the efficient acquisition of products and/or information and can be seen as a more task-oriented, cognitive, and non-emotional shopping outcome [14].

Therefore, we conduct a comparative study asking the question: "Does VR shopping experience deliver better results than DVR in terms of hedonic and utilitarian values, user experience, and cognitive load?". In this study, we intend to compare the bag shopping experience in both VR and DVR to evaluate these metrics. Before the experiment, we make the following hypotheses:

- H1. VR shopping delivers higher hedonic and utilitarian values than DVR.
- H2. VR shopping improves user experience.
- H3. Users' cognitive load in VR does not differ from that in DVR.

To test the differences in terms of metrics, two versions of the application are developed using the Unity engine (See Fig. 2). The first is developed as a traditional desktop application and the second is developed for Oculus Quest 2. Both versions present the same functionalities and simply differ in the interaction and display devices. In the desktop application, interaction occurs with the keyboard and mouse and the display is on the computer monitor. In contrast, interaction occurs with the controllers in the VR application, and the scene is viewed through the Head-Mounted Display. The user is seated on both the desktop and the VR version to avoid VR sickness in a large shop environment. Locomotion in VR is by teleportation, whereas in the desktop scenario through the movement of arrows on the keyboard.

The proposed shopping experience differs from traditional online shopping experiences in that the user does not have to interact with a 2D interface on an Internet browser, but with a virtual shop, either in DVR or VR. The user enters the shop, searches for the bag, and once found, selects it, and interacts with its properties presented on a panel menu.

We conduct a within-subject experiment (n=60, 24 women and 36 men). User experience is measured with the User Experience

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Figure 2: Users testing both DVR and VR versions of the application

Questionnaire (UEQ) [15] and cognitive load with the NASA Task Load Index (NASA-TLX) [16].

We refer to the model developed by Peukert et al. [11] for the hedonic and utilitarian values measurements. The model identifies perceived telepresence and perceived enjoyment as relevant dimensions for the hedonic perspective of shopping and perceived product diagnosticity and perceived usefulness for the utilitarian perspective.

We are currently analyzing the results to confirm the hypotheses and preparing a manuscript.

2.2 Pseudo-Haptics for Online Products Perception

In online stores, the lack of actual contact with products can sometimes make it difficult for customers to evaluate the product.

The lack of touch is a crucial issue in retail, especially in those product areas such as clothing where it provokes the lack of hedonic and utilitarian values and realism within the virtual experience and generates negative user shopping experiences [17].

On the one hand, without direct contact, people may be unsure of their purchase activity because there is not enough information about the material, texture, and finishes. But, on the other hand, limited interaction with products online could mislead product perception and sometimes cause a mismatch with the real one.

Several technologies have been developed to address this problem [18]. For example, online shoppers can interactively zoom in on product details with zoom-in technologies. Many online fashion and apparel stores also use other technologies such as full-angle viewing or short video clips. Research has indicated that these technologies can improve the online shopping experience by developing advanced perceptual systems.

Therefore, we aim to explore a new form of online interaction with products, which simulates people's real-life behaviors through VR.

The main goal of this work is to propose a "visualized touch", a new way to interact with online products, and to examine to what extent it can help people evaluate products and increase engagement.

We refer to pseudo-haptics, intended as the use of touch-based illusions created by cross-modal perceptual interactions, altering the visual feedback of the hand (or mouse cursor). Many studies have shown that it is possible to use visual or auditory stimuli to simulate the experience of touch, movement, and force [19].

Pseudo-haptics is useful in many applications, particularly where the user may not have a haptic device available but where the sensation of haptic feedback provides information or creates a sense of presence. The objective of pseudo-haptic feedback is to simulate haptic sensations, such as stiffness or friction, without necessarily using a haptic interface [9]. Lecuyer et al. (2004) [20] developed a technique for simulating texture and relief on 2D images displayed on the computer screen using pseudo-haptics feedback.

For this reason, online shopping is one of the best candidates for the development of pseudo-haptics feedback [21].

Clothing is considered one of the most complex items to be displayed in virtual environments [11]. Additionally, fabric physics is complex and difficult to manage with graphics engines for VR development.

Improving the shopping experience in the fashion industry by addressing the lack of actual touch would bring a series of advantages, enriching it with new multisensory stimuli. In addition, online shopping would gain benefits such as increased realism of clothes, customer engagement, and satisfaction, decreased return shipping, and the possibility to virtually perceive fabrics. Moreover, VR technologies could help make the fashion industry more sustainable by reducing the environmental impact of garment production.

From these assumptions, we will consider the questions "How pseudo-haptics can be used for visualizing fabrics in an online shopping context with VR?" and "What influence do fabrics' pseudo-haptics feedbacks have on users in an online shopping context with VR?".

We will start by studying user-fabric interaction, categorizing fabrics based on their properties, and selecting definite fabric samples for user testing. Then, we will implement pseudo-haptic feedback based on the mouse cursor's position. Finally, based on the obtained results, we will transfer this approach to an immersive VR environment using a virtual hand position.

Then, we aim to measure user experience, hedonic and utilitarian values, and Customer Engagement (CE) [22] with the CE scale evaluating three factors (i. e., conscious attention, enthused participation, and social connection).

3. Conclusion

My research path exploits VR technology in retail to improve the online shopping experience in the fashion industry.

From our user tests, we expect positive results in terms of hedonic and utilitarian values, cognitive load, user experience, and customer engagement.

The research leverages two approaches related to:

- Comparative study on shopping experience in DVR and VR.
- Implementation of pseudo-haptic feedback in the online shopping experience with VR.

I am in the mid-stages of my Ph.D., and I consider that my topic has wide room for improvement.

Since the scientific literature on the subject is fragmented and VR applications are few, there is wide scope for research in this area to obtain useful insights for academia and industry.

From the Doctoral Consortium, I expect to:

- Discuss the applied methodologies or be suggested new to pursue my doctoral research.
- Discuss the choice of state-of-the-art hardware to implement the system in order to conduct user studies.
- Be advised on future research and directions.

Future research could therefore investigate the opportunities and barriers for VR implementation, both from the retailer and consumer perspectives, always focusing on interaction and perception.

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