

Fostering fashion retail experiences through virtual reality and voice assistants

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ABSTRACT

This paper discusses the potential of using vocal commands in a virtual reality (VR) fashion store. In fact, online fashion shopping has bloomed in the last ten years, as technological developments are continuously fostering the evolution of fashion e-commerce and branding strategies. The advance in virtual reality devices, which are approaching the consumers' sphere, cannot but further support such trend.

However, such commercial opportunity turns into the challenge of making VR-based shopping experiences enjoyable and easy-to-use to the whole class of users. To this aim, in this paper we resort to one of the most desirable ways a non-expert would use to interact with a new environment: voice. For this reason, the current study explores the benefits of speaking and verbally interacting with a VR assistant, which embodies a salesman at the service of customers. Motivated by an increasing acceptance of voice assistants, we designed and implemented an immersive VR experience where the Amazon Alexa virtual assistant is integrated and exploited, to build a proof of concept. To evaluate our proposal, we selected a specific group of fashion-experts, i.e. demanding and non tech-savvy, which tested our application and appraised the perceived comfort and appreciation of the virtual experience. The preliminary results suggest how working on the VR interface and interaction modalities could open the door to a new wave of fashion e-commerce platforms, supporting a widespread adoption of VR into everyday routines.

Index Terms: Virtual Reality—Usability testing—Natural language interfaces;

1 INTRODUCTION

The recent technological advances are allowing Virtual Reality (VR) to enlarge its field of application. Among all possible contexts, the fashion retail industry represents a particular scenario characterised by a conflicting relationship with technology. On one hand, the expansion of its online segment is a matter of fact: since 2017, the annual retail e-commerce sales grew more than 20% compared to the previous year and the global e-retail sales accounted for 12.2% of global retail sales in 2018 [5]. Such ascent has been promoted by the crescent confidence with online platforms: customization of shopping experiences, capability to access them always and everywhere, integration of audio and video contents, fast payment modalities as well as free and timely shipping and returns have pushed consumers to trust digital services while empowering brands' reputations. On the other hand, in brick-and-mortar stores clients also can enjoy a social shopping experience with friends and salespersons. In addition, the in-store shopping offers the best product presentation: through a tactile interaction with the product, a client can evaluate its manufacturing quality, real beauty and wearability before purchase. In

this scenario, VR represents one of the most interesting candidates as next generation e-commerce platform: it can preserve existing web-based services while helping reduce the mistrust of the most demanding online users, by increasing the digital informativeness of clothes through 3D models and accurate virtual fitting tools.

Nevertheless, VR technologies are far from being pervasively used by the mass of consumers. If the high initial costs are progressively decreasing and the headsets performances are rising, the question is which factors could further hinder the market penetration of VR. One certainly amounts to a low understanding of the currently available means of interaction: for example, hand controllers often support movements that are unnatural with respect to the context where they are used, thus reducing users' comfort, confidence and sense of presence in VR [18, 29]. The semantic meaning of pressing buttons, in fact, is irrelevant to the movement of the finger, so the user's operation is not natural and inconvenient for memory.

The application of verbal commands could overcome these difficulties: preliminary works have already confirmed the potential of integrating dialogues in a simple VR gaming environment [40]. To the best of our knowledge, no scientific contributions have so far integrated voice interactions in retail VR-based commerce applications and measured its adequacy for non-tech-savvy final users. In brief, this is the aim of this work, where an off-the-shelf voice assistant follows a client and converts user's words into (virtual) actions, just as it happens inside physical stores when clients asks salespersons for clarifications and/or assistance.

From a consumers' perspective, nowadays the general awareness of voice technology is already high and its adoption rate is increasing [4]. In fact, we can easily access it through internet-connected smartphones, as Google Assistant on Android operative systems and Siri for the Apple's users already provide several widely used services. Even through virtual home assistants, voice-based interaction modalities are entering in our routines. In Italy, the voice assistant adoption is becoming meaningful and Amazon Echo devices are leading over Google Home 53% to 43% in terms of smart speaker market share [2]. We have thus settled the Amazon Alexa voice assistant as the technology chosen for our experiment.

Now, to assess whether an integrated VR-voice assistant environment may make fashion retail VR-based commerce viable to the mass of consumers, we interviewed a very specific group of testers, i.e. a group of graduate students in fashion, who declared to be skeptical towards e-retail. The rationale behind this approach was to consider a challenging set of users, not tech-savvy or with any particularly positive attitude towards the use of technology, rather than to base our study on an assessment based on an average one. We submitted them a survey to investigate their perceived ease of use and their overall evaluation of the application. In particular, the survey was built using the Technology Acceptance Model (TAM), originally proposed by Davis in [15] for predicting user acceptance of digital systems in 1989. In brief, the TAM states that a user's acceptance of a new technology is based on two personal determinants, namely the Perceived Usefulness (i.e. the degree to which a person believes that using that technology improves his/her performance) and the Perceived Ease of Use (i.e. the degree to which a person believes that using that technology is free of effort). Hence, when dealing

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with VR technology, and independently from a customer disposition, a balance between Perceived Usefulness and Perceived Ease of Use is key to increase the behavioral intention and the attitude towards using: the TAM is here put to good use to understand whether vocal interactions may be considered determinants of making VR devices everyday retail e-commerce tools. Interestingly, although not particularly interested in technology, the students' answers supported the hypothesis that a more natural interface may enhance the appreciation and acceptance of a VR-based e-commerce.

The remainder of this paper is organized as follows. In Section 2 we provide an overview of the most relevant works related to our contribution. In Section 3 the method adopted in this work is described, along with its results and their discussion in Section 4. We finally conclude with Section 5.

2 RELATED WORK

A number of works have considered the use of virtual reality technologies in the context of fashion-related applications, as well as the use of speech in virtual reality contexts. We review both of such domains in the following paragraphs.

When focusing on the use of virtual reality in the fashion application domain, it is possible to individuate two rather different approaches. A first one born within the fashion communication industry and a second within academia. Within the fashion communication industry, one of the first experiences dates back to 2014. In such year, the British multinational fashion retailer Topshop experimented VR during a fashion event [3]: five customers were selected to sit in its flagship store, from where they could enjoy the London fashion week show in real-time, through a 360 degree streaming video. Following such experience, fashion brands like Rebecca Minkoff, Dior and Balenciaga also let their customers access similar immersive VR contents, like catwalks or runway backstage. Dior also designed its own VR headset in 2015 [1]. However, the use of VR in the fashion industry mainly looked at enhancing a brand's attractiveness through event entertainment and/or backstage exploration. On the other hand, a number of academic works focused on the adoption of VR technologies in fashion contexts. In 2012, for example, Pantano and Laria in [26] exploited VR to conduct preliminary studies regarding the aesthetic impact of a fashion store, before its construction. Others have worked on VR-based "virtual fitting" rooms, aiming at solving the recurrent issue of uncertainty about garment size, typical of online shopping [13, 39]. Moreover, "virtual fitting" rooms have also been analyzed through the lens of their ability to increase the purchase intention and accelerate the adoption rate of VR applications [7, 24, 33, 34, 42, 43]. Other works have also analyzed the potential benefits provided by VR tools, when applied to fashion communication strategies [16, 21, 27, 32, 38]. For example, the authors of [22] reported how the interactivity, 3D audio and design styles of their VR environment supported an increase of purchase intention. However, the participants of the study also reported difficulties in using hand controllers, causing an uncomfortable perception of the virtual environment. Interestingly, such observation occurs quite often in VR-concerning literature, independently from the field of application: even popular VR devices have been reported cumbersome or confusing to use [9, 10, 23, 41]. Such common perception suggests that other approaches may be necessary to foster the acceptance of VR-based, even in shopping contexts and routines. This is where our work stands: we study and assess the use of verbal-based interactions within a VR-based fashion e-commerce environment.

Now, directing our review to the works that have already considered the use of VR as a shopping platform, some researchers have already made initial steps towards the definition of a novel immersive shopping concept and its effective implementation. For instance, an interesting contribution has been proposed by Zhao and Zhang in [44], where the authors exhibit a set of rules which may be

useful to build landmarks in 3D environments. Further studies have focused on analyzing the importance of an accurate design of 3D contents and on the potential of applying artificial intelligence techniques to provide smart shopping experiences in virtual malls [8, 14]. Concerning small retail stores, such as groceries, further works have confirmed the adequacy of both smartphone-based and PC-based VR e-commerce platforms, although at the time of their publication state-of-the-art technologies were still in an infancy stage from a usability perspective [35, 36].

To conclude, we review a few works that have so far proposed an integration of verbal commands into VR, to facilitate man-machine interactions and communications, during the first decade of the new millennium [20, 37]. In [37], for example, the authors developed a speech and gesture recognition system to address the question "how to communicate with a helper", but the possible dialogues were restricted to their specific case study. Since then, voice-enabling technologies have been massively developed: academic researches have begun to embed verbal commands, to offer more easy to use human machine interfaces, also in the context of VR applications [6, 12, 19, 29, 35].

Nevertheless, to the best of our knowledge, speech has not so far been massively exploited in everyday-use PC-based VR applications, whereas voice commands have become an almost habitual modality of interaction with other digital platforms, such as smartphones. Thus, our work aims at investigating whether verbal interfaces may pave the way to a widespread adoption of VR technology at end-users' level, considering the specific fashion retail sector.

3 RESEARCH METHOD

To quantify the users' satisfaction for voice-based interactions within fashion VR environments, we designed an immersive fashion store where a virtual assistant replaces a real salesperson. The VR application runs on one of the most popular headsets, the HTC Vive, and exploits the Amazon Alexa skills in speech recognition and interaction. The experience can be seen as a prototype of a VR-based e-retail service: a client can visit the immersive store, interact with clothes or accessories, and purchase items at a cash desk. All possible VR interaction functions, with the sole exception of teleporting (only possible using the hand controller), are always accessible either resorting to the controllers or to vocal dialogues with the virtual shopping assistant. Such design allowed our users to experiment with tactile and verbal inputs, letting them mix both modalities of interaction as they wished and at the same time compare their efficacy during the different phases of the immersive experience. Variables addressing naturalness and engagement were thus measured through a questionnaire, as normally performed in such research context.

3.1 Procedure

The users involved in this study were firstly introduced to VR technologies, they were shown how the HTC Vive headset and hand-controllers should be used, as well as the Amazon Echo Input speaker. They were then exposed to the Virtual Store application as long as they wanted to: each user was free to experience the virtual shop without being requested to implement any specific task. A behavioral pattern that was common to all was that they all wanted to test the voice-based interaction after a short exploration of the hand controller inputs. After the end of the immersive experience, a survey was submitted to each user to collect the data the current study is based on. The details of the experiment are provided in the paragraphs that follow.

3.2 Participants

The user group has been selected among all the students enrolled in the Design and Technology for Fashion Communication master program, held at the University of Bologna. All of the students enrolled in such program are proficient with fashion and its trends,



Figure 1: Snapshot of the Virtual Store application.

however, we intentionally chose those who declared no experience with 3D object manipulation nor immersive environment navigation and to be non-tech savvy. The rationale was to test our prototype with the most demanding and challenging user target, to better evaluate the ease of use of our interfaces and enjoyment of the experience. The resulting participants were nine Italian students, 1 male and 8 females, mean age 24 years old.

3.3 Design and implementation of the test application

The Virtual Store, developed in Unity, reproduces virtually a standard shopping experience: a customer can enter the store and walk through aisles exhibiting both male and female clothes, interact with the items and fill her/his cart before concluding a purchase. The environment is designed with modern-style elements. Even if personification may be strictly related to the presence of the agent [17], our virtual assistant has the form of a smiling emoticon recalling the minimally invasive design of the Amazon Echo Dot interface. Such avatar is always in the user's field of view to better assist the customer. It can instruct the user on how to use the shopping platform and help a customer as a professional salesperson would do: for instance, it can tell the product specifications whenever a user selects an item, add goods to the cart or report which items are in, and proceed to payment. In Figure 1 we show two relevant screenshots of the Virtual Store, displaying how the virtual assistant speeches and actions are also reproduced visually.

As anticipated, the voice-enabled avatar resorts to the Amazon Alexa skills to process and understand user's vocal commands. The Alexa Voice Service (AVS) by Amazon allows developers to exploit cloud-based services, such as voice recognition and vocal synthesis, by mean of its APIs. In our implementation we also resorted to the Amazon Web Services (AWS) platform, which acted here as an infrastructure provider, to take full advantage of the Amazon skills and reduce latency time.

The use of such platform, however, has imposed some technical constraints which resulted in a few undesired drawbacks. For in-

stance, a user is forced to activate a dialog session (with an Alexa proprietary word) to leave it on hold, and the conversational flow is expected to be quite fluent and rapid, otherwise the session expires and Alexa must be waked up again. The specific instance of Alexa used in our experiments also exhibited some difficulties during the recognition of some of the users' voices.

3.4 Evaluation questionnaire

Following the TAM approach introduced in 1, we designed a survey to investigate the perceived ease of use of our voice-enabled interface and the perceived usefulness of the proposed fashion retail experience.

Inspired by [10], we defined a construct to measure the users' comfort during the immersion and called it Naturalness. It encompasses the six items focusing on the interface handling: they have been labelled L1-L6 and reported in table 1. Each question has a specific role: if L1 is the most substantial item, L5 is used as a control question. Since the set participants were never exposed to VR before, L2-L4 served as reinforcing items for a deeper investigation, in case L1 achieved a low score. Question L6, instead, aimed at specifically quantifying the benefits provided by verbal commands in the proposed virtual environment.

With L7, we asked for a broad evaluation of the VR application: taking into account the background of our specific test set, the corresponding result can be used to quantify the perceived Engagement and advanced preliminary observations concerning VR usability in fashion retail [31]. Whereas items L1-L7 were measured on a 5-point Likert scale (1 for "strongly disagree" and 5 for "strongly agree"), L8 was answered using a 0 to 10 scale. In fact, we deemed that asking a tester whether s/he would recommend the experience to a friend would allow us to compute the Net Promoter Score (NPS, [30]), a widely used indicator in customer satisfaction studies which has already been applied also in VR-related contexts [28]. We hence consider such index as part of the Engagement analysis.

Finally, the survey also included a few questions which aimed at learning the personal information of the user, such as his/her gender and age, but also his/her attitude towards digital technologies and any possible previous experiences with VR. The results considered in this work are relative to all and only those testers who declared to be non-tech savvy and experienced with VR devices, as already discussed.

3.5 Reliability check

Before discussing the results in details, we report on the reliability check that was preliminarily performed on the data that was gathered with the questionnaire. In particular, we verified the internal consistency of the data that was collected for the Naturalness group of questions. The value obtained for the Cronbach's alpha is 0.711: the test scores are sufficiently reliable. However, Pallant in [25] has observed that the Cronbach's values are typically low (hence the standard reference threshold may be not appropriate) in case of less than ten items. We thus also computed the Mean Inter-Item Correlation (MIIC), resulting in MIIC=0.317: according to the optimal range 0.2 to 0.4 suggested by [11], the results obtained with our questionnaire are valid.

4 RESULTS AND DISCUSSIONS

In Figure 2 we show the scores corresponding to each L1-L7 item, using a boxplot-like visualization. The Naturalness construct (items L1 to L6) has a mean evaluation of 4.01 with standard deviation 0.21, considering that answers may fall in a 1 to 5 range. We can hence infer that the proposed application is reputed not difficult to use by users experiencing 3D immersion and VR interactions for the first time.

We can also better analyze the Virtual Store application by focusing on some single statements. The L1 mean score with such a small

Table 1: Items of the submitted survey and their clustering into two constructs.

Label	Item	Naturalness	Engagement
L1	The interface is easy to use	×	
L2	Once I learned how to use the interface, it was simple and intuitive	×	
L3	Once I learned how to use the interface, it was simple to manipulate objects	×	
L4	Once I learned how to use the interface, I could express my creativity	×	
L5	I was able to create objects and scenes as I wanted to	×	
L6	The introduction of voice commands makes the system easier to use	×	
L7	I enjoyed the overall experience		×
L8	I would recommend the experience to my friends		×

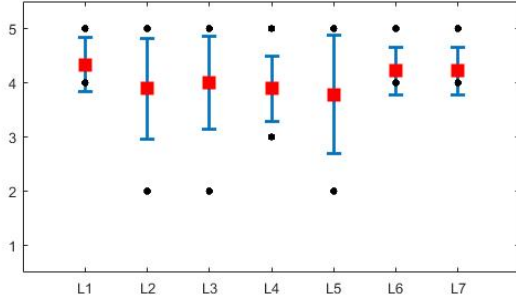


Figure 2: Boxplot-like visualization of the obtained results. For each question L1 to L7, the red square represents the mean score, the blue whiskers the standard deviation, whereas the black points are minimum and maximum registered scores.

standard deviation reflects how much our interface design felt easy and natural to the user set: no one assigned a score smaller than 4. On the other hand, we observe that sentences L2, L3 and L5 also received very low scores, reflecting some difficulties in managing the virtual experience. Some participants explicitly expressed their “feeling weird” inside the virtual environment, due to the alienation from the real world and the surreal teleportation into a digital one. It also meant their feeling intimidated in talking to the avatar: since Alexa always expected a fuel and natural conversation, the hesitations of such subset of users made its listening sessions expire quite often. Nonetheless, the L6 item has the highest evaluation with a very small variability and it explicitly confirms that the introduction of vocal commands and the presence of a virtual assistant made the VR system easier to non-expert users.

Focusing now on Engagement, the L7 high score suggests that the VR-based e-retail experience was appreciated by our testers. In addition, we computed the NPS index, which resulted equal to +11: we recall that all the values that fall within the 0-30 range represent good results. This was not obvious, our user group was definitely more keen at keeping a tactile interaction with clothing items and at preserving the experiential sphere characterizing a brick-and-mortar store, rather than at interacting with a digital system.

5 CONCLUSION

This work addressed the opportunity of leveraging VR devices as platforms for fashion retail e-commerce, in a scenario where the fashion industry has so far exploited VR technologies mainly to amuse and engage its public. In particular, we observed that VR interfaces, where one can try on clothes and accessories, see and manipulate them as 3D accurate models and access their information, could provide effective experiences even to a demanding public, such as the user group recruited for our experiments. In addition, even if the integration of the Amazon Alexa voice assistant in our prototype has imposed some design limitations, vocal commands

may contribute to make the virtual experience more natural and simple: our findings confirm a general high interest in voice-based interactions. Clearly, the results exhibited in this work amount to a first step. Further developments and experiments are in fact required, when aiming at constructing an easy and engaging VR-based fashion shopping experience that may be used, also on daily basis, by customers belonging to all types of profiles.

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