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The Sense of Agency of Virtual Hand Representation for Online Shopping

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ABSTRACT

The advancement of virtual reality technology has made real-life manipulation possible in virtual environment since there is a feeling of control, also known as the sense of agency. However, to create a greater virtual experience (e.g., perception of size) of a real-world model (e.g., smartphone) with its model representation in digital or virtual environment (VE) is difficult. For example, the representation model (e.g., in an online shopping website) might visually differ in size compared to the physical world. This study addresses the problem by introducing a calibration method to best match the ratio of virtual hand representation with its associated object in VE and in the real world. This project creates a prototype made by off the shelf motion sensor (i.e., Leap Motion) and Unity software. User can virtually inspect online products as if he is holding the product in the real world. This study evaluates the sense of agency by comparing experience of participants before and after using the proposed prototype. Results showed that the sense of agency is much higher in the proposed method compared to conventional online shopping (i.e., no virtual inspection).

KEYWORDS: virtual environment, sense of agency, virtual hand, online shopping

1 INTRODUCTION

Virtual reality (VR) enables physical items and spaces to be reconstructed through their digital representation [1]. The sense of agency, or the feeling of control is the subjective awareness of initiating, executing and controlling one’s own behavior in the real world [2]. In VR, a sense of agency is one of the components in presence phenomenon [3]. The study in [3] claims that the more realistic the virtual experience, the greater the individual’s belief in interacting with the digital environment, for example, to improve the virtual experience by using the virtual body as self-avatar in the virtual environment. Self-avatars already used in virtual environments as entities for interacting and manipulating. In this situation, embodying the avatars influenced perception [4]. One of a human body parts that can be used to manipulate virtual model is human hand. This part is a very complex mechanism, hence there many studies attempt to calibrate between physical and its virtual hand representation. For instance, the research in [5] use the glove as an input device to track the hand to manipulate objects. The glove presents a quick calibration routine and can match accurately the virtual model for a different user. The work mapped motions of an unrestricted human hand to a non-anthropomorphic planar robot hand. A different format of glove (i.e., data glove) has been studied for VR [6]. There is an advance method to track human hand, i.e., body-tracking technology [7]. This method tracks user hand motions (e.g., fingers, wrist) and maps it to the hand's virtual representation [8]. The virtual hand can visually portray exact movements and gestures of the human hand. However, this method less popular in e-commerce website due to few hardware constraints (e.g., require a depth camera sensor).

E-commerce stores shows unprecedented growth in Malaysia [9]. More customers choose online shopping because of better facilities and devices (e.g., fast network, smartphones). In addition, e-commerce stores provide much better services compared to retail store (e.g., offering more selections, postage service, collection at a point, extra offer for online items, fast payment). However, the downside is the physical appearance of the products are limited (no physical inspection). Most online shops only display products using texts and pictures while physical shops allow customers to interact by viewing the products from all sides [10]. Users have a problem to estimate overall product size or dimensions by using only snapshots of two-dimensional (2D) products [11]. This limitation will create a dissociation between the consumer and the brand image [12].

This project addresses the problem by introducing virtual inspection of products. Users can interact with 3D model representation in an online shopping system with their avatar hand. This project proposes a hand tracking calibration method to improve the sense of agency of the user. This project includes a Leap motion device for the motion tracking since it allow users to interact a virtual environment in a non-intrusive and intuitive manner [13].

2 OBJECTIVES

The objective of this project is as follows:

1. To identify a calibration method for virtual hand representation.
2. To embed virtual hand representation into an online shopping environment.
3. To evaluate the sense of agency after virtual hand representation has been embedded in online shopping.

3 SIGNIFICANCES

In many domains, the use of VR is well established. VR offers many advantages like visualizing, experiencing and analyzing [14]. It simulates a physical presence, providing visual experiences. This is highly advantageous in the marketing sector. VR experience is more enriching than common media used, and it led the development among new generations. Applying VR experience within a shopping environment makes it more user-friendly thus attracting higher customer satisfaction [15]. In addition, these influence the customers' experience in virtual shopping.

4 TECHNIQUE AND EXPERIMENT

Calibration process

The calibration process is done in two steps. Firstly, the system acquires three readings of user's palm-size (i.e., palm unit) and average the values. Secondly, the system uses the palm unit to resize the 3D model representation accordingly. The readings are captured using a Leap Motion sensor and the program is written in C# language.

Sense of Agency Evaluation

This project evaluates the sense of agency (SOA) of the proposed method. The evaluation for SOA was assessed through a questionnaire adopted from work in [4]. The procedure to this SOA experiment will be explained in the next section.

Procedures

In this study, there were two experiments. The participants were explained about the task flow before they begin each experiment. All participants are familiar with online shopping activity.

In the first experiment, participants conventionally buy a smartphone via familiar online shopping platform (i.e, Shopee). Then, the physical smartphone was handed over to them as a result of the purchase. The user then inspected the physical device and answer questionnaires.

Participants will be provided with a short break (i.e., 3 minutes) before continuing the second experiment. In the second experiment, participants have to buy smartphone given the representation model is in 3D and can be virtually inspected. The participants were briefed with instructions of Leap Motion controller. Then, the participants hover hands in Leap Motion viewing range. The proposed system then recorded the participant palm width for calibration. Then, the system calibrated the hand where it scaled the 3D smartphone model according to actual hand scale. The participants inspected the model with their virtual hand. After that, the participants will be given the smartphone that they purchased. Participants then observed and inspected the smartphone and answer questionnaires.

Apparatus and Participants

The experimental apparatus includes a laptop system and a Leap Motion controller. The laptop is running on Windows 10 operating system with 12GB RAM and 1TB storage space. Twenty-two participants (10 males and 12 females, age ranging from 18 - 25 years) took part in the experiment. This number of participants has also been decided in [14]. The participants are all online shoppers and have different backgrounds. However, none of participant's experience Leap Motion controller.

5 RESULT

A total of 22 individuals (10 males and 12 females) participated. Based on data gathered, mostly online shoppers are among 18 until 25 years. Participants rank all conditions in order of preference once at the end, after having experienced each condition in practice. In general, users preferred the virtual hand representation. 91% of the participants preferred to shop with the aid of ability to virtually inspect 3D model with a virtual hand.

6 CONCLUSIONS

Our findings indicate that virtual hand representation (that we have calibrated) improves the sense of agency (i.e., the feeling of shopping as in real life). We can conclude that scaling the size of the 3D model using where the size of body representation as a fundamental metric is significant. We believe that this work can be expanded to many other areas other than shopping (e.g., medical, architecture, construction).

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