Haptic Feedback and Online Shopping

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Abstract

With the increase in online shopping and emerging technologies for haptic feedback, there is growing interest in finding ways to provide tactile information for products in online stores. The question is whether these products can provide this information and if the users or customers really need and desire this information. This paper seeks to explain what haptic technology is able to provide in tactile information for users and if this can actually enhance the online shopping experience. First, we will define haptic feedback and examine different haptic devices. Then, we will explore whether or not people seek tactile information with products and how this affects purchasing decisions. We will then look into the different ways haptic devices can provide this tactile information, while also considering studies on how effective these devices are in communicating this information and whether or not that affects users' understanding of the products. Next, we will explore the research in how haptic feedback and/or tactile information can affect the online shopping experience and purchasing decisions. Lastly, we will discuss what we can conclude about haptic feedback and online shopping based on this research, what the implications are for HCI, and provide suggestions for further research. Overall, while haptic devices show promise in helping users understand different tactile dimensions of products, more research needs to be done on whether this will actually have a profound effect on purchasing decisions and in enhancing the online shopping experience. There is also the issue of cost-effectiveness and accessibility with these technologies. In the meantime, providing textual tactile information might be the best option as haptic technology continues to advance.

Keywords: haptic feedback, online shopping, Need For Touch (NFT), haptic device, purchasing decisions

Introduction

Online shopping, a growing way in which we use the internet, has been and is continuing to rise in the retail market. In 2016, Pew Research surveyed Americans and found that 79% had bought something online at some point in their lives (Smith & Anderson, 2016). 15% said they make online purchases weekly, and 28% said they make purchases a few times a month. Even with the move towards online shopping, 64% of Americans said they prefer to buy from a physical store if all things were equal. When buying something for the first time, 78% said that it was important that they try out the product in person. Interacting with a product before buying can help us make a decision as to whether or not we actually want to buy it. Part of this is to understand its dimensions, see how it works, and what it looks like. Thanks to innovations in technology, it is easier to get a sense of these qualities online instead of just in the store, but when it comes to the texture, weight, and size of objects, there is a lack of this tactile information in online shopping. This is where haptic feedback can be a possibly valuable contribution.

Literature Review

What Is Haptic Feedback and How Does It Relate to Online Shopping?

According to Merriam-Webster's Dictionary, haptic means "relating to or based on the sense of touch." So far, technology has mainly provided visual and audio information, especially in regards to interactions. One of the few forms of haptic feedback used prevalently in technology currently is vibration. This is typically used as a substitute to audio notifications (Ex: vibration as a substitute for an audio ringtone), a way to mimic the feel of interacting with buttons on a device without the use of physical buttons (Ex: Apple's Force Touch), or as a way to enhance the interaction with elements on a device (Ex: Apple's 3D Touch). This use of haptic feedback does not provide much of the tactile information we are looking for when evaluating

physical products. Therefore, it is important to take a look into emerging technologies for haptic feedback, explore if this information is desirable and necessary for users and how much it has or can have an effect on our online shopping behavior and experience and if the current state of haptic technology can provide that information in a cost-effective and accessible manner.

What Are Haptic Devices and What Can They Do?

A look into emerging technologies for haptic feedback and information for objects includes two devices: ones used to collect haptic information and ones used to produce haptic feedback. The devices that produce haptic feedback are typically called haptic actuators, with some of them aptly named "haptuators." There are many types of haptic actuators ranging from ones that produce vibrations (ERM, LRA, Piezoelectric actuators), to ones that use force from motors to manipulate movement of an item (force feedback actuators), to air vortex rings, which blow air; to ultrasound wave actuators, which are used to create a sense of pressure. Haptic devices themselves can be sorted into three categories: ones you can grasp, ones you can wear, and ones you can touch. One of the most popular haptic devices used in the research of haptic feedback is a graspable stylus-like device called the Phantom Omni. Devices that collect haptic information are a much newer emerging technology.

Is Touch Important for Understanding Products?

In pursuit of understanding individual differences in need for touch, i.e. a person's preference for haptic or tactile information, Peck & Childers (2003) conducted several studies to create a "Need for Touch" (NFT) scale. Based on the responses to scale items in each of these studies, a NFT scale was slowly refined and its validity and reliability were tested. Another study was conducted to see if high NFT people would use haptic information earlier in their evaluation of products than others, and that correlation was found to be significantly significant. Subsequent

studies were conducted to evaluate patterns between a person's spot on the NFT scale and their evaluations of products with and without the presence of haptic information in the form of actually touching an object or through textual explanation. Those higher on the scale generally sought out this haptic information more for increased product evaluation confidence. This shows that the lack of haptic information in online shopping may either limit a person's preference to buy online and/or limit which products they choose to buy, depending on their NFT.

Can Haptic Feedback Help You Feel Virtual Objects Similar to Real Objects?

Feeling Shape

One study that examined the ability of communicating the shape of a virtual object using haptic feedback was Zhang et al. (2017). They conducted a study to explore whether the use of a haptic device could increase the user's understanding of the shape, weight, and texture of a product online. In the experiment, 33 participants were randomly assigned to two groups. One group interacted with a mock online shopping site which provided only text and images, while the other group interacted with the same site with the haptic device providing haptic feedback in addition to the text and images. After browsing, participants from both groups filled out questionnaires that asked them to compare their understanding of the object in relation to shape, weight, and texture. The findings showed that the use of haptic feedback led to statistically significant higher ratings of understanding the geometry (shape) of the object.

Feeling Size

One study that examined the ability of communicating the size of a virtual object using haptic feedback was Funahashi, et al. (2009). Their study evaluated whether participants can measure the size and weight of a virtual object through a proposed online shopping system called CyberTouch using haptic feedback devices. Two experiments were conducted with 10 subjects.

In the first experiment, subjects felt a real object and then had to pick the virtual object with the same size. There were also trials where they "felt" the virtual object and then had to pick the real object with the same size. The findings suggest that participants could distinguish the size of the virtual objects relative to the real ones; however, there were too few participants to conclude that the results were statistically significant.

Feeling Weight

Both the studies by Zhang et al. (2017) and Funahashi, et al. (2009) also evaluated the ability for haptic feedback to communicate a virtual object's weight. In Zhang et al. (2017), it was found that the use of haptic feedback led to statistically significant higher ratings of understanding the weight of the object. In Funahashi, et al. (2009), their second experiment was specifically for weight. Subjects felt a real object and then had to pick the virtual object with the same weight. The findings suggest that participants could distinguish the weight of virtual objects relative to real ones, but again, the sample size was too small for significance.

In a study by Maisto et al. (2017), three experiments were conducted to test two wearable haptic devices. The 14 subjects participated in three experiments where they had to do three tasks: holding, placing, and balancing virtual objects. It was found that the haptic feedback significantly improved the performance of the participants in all three tasks. Haptic feedback was also preferred by participants than when there was no haptic feedback. This showed that they were able to get some sense of the weight of the virtual objects and enjoyed the experience.

Feeling Texture

Zhang et al. (2017) also studied whether haptic feedback could provide information on the texture of a virtual object. While there were significant effects on participants' understanding of a virtual objects' shape and size as noted previously, there unfortunately was an insignificant

effect on the participants' understanding of the texture of the product.

On the other hand, a study by Culbertson & Kuchenbecker (2016) shows some promise for communicating texture with haptic feedback. In this study, an experiment was conducted with 30 subjects to evaluate how haptic feedback affected the realism of virtual objects in terms of three properties: slipperiness, hardness, and texture. Fifteen surfaces with varying properties were tested. One group of subjects felt and rated real objects based on slipperiness, hardness, and texture. The second group did the same but with virtual surfaces using the haptic devices. They then rated the similarity between the virtual objects and the real objects they represented. There was a high correlation between the real and virtual ratings for all three components suggesting that the haptic feedback renderings were successful in communicating these textural properties.

In a similar study by Jiao et al. (2018), there were again promising results. In this study, an experiment was conducted with 14 subjects. The goal was to evaluate the ability for an electrotactile display to render textures of fabrics that are perceptually similar to the real fabrics. Four subjects were used to determine values for the factors that allowed for realistic renderings. The values were manipulated and the subjects expressed which value allowed for the virtual rendering of roughness to be similar to the real fabric. Using these values, the other ten subjects rated the similarity of the virtual object's roughness to its corresponding real fabric in two different conditions: one with visual feedback as well and one without. It was found that the haptic feedback renderings were similar to the feel of the real objects and there was no significant difference whether there was visual feedback present or not.

Can Haptic Feedback Help You Distinguish Between the Feel of Objects Virtually?

While users may find haptic feedback valuable in getting some general understanding of the dimensions of a product, it may be necessary for them to compare between products. The

question is whether haptic feedback can enhance a user's ability to perceive the differences between virtual objects based on these tactile dimensions.

Distinguishing Weight

One study that sought to find out how well haptic feedback could help people distinguish the weights of virtual objects was Bamarouf & Smith (2010). In this study, experiments were conducted with 15 participants to test and determine the optimum discrimination thresholds in three different weight ranges (low, medium, and high) for comparing relative weights of virtual objects through the use of haptic feedback. The results showed that the lower the weight range, the higher the threshold needs to be, and that distinguishing weights of virtual objects can be done with the use of discrimination thresholds and can help with increasing the consistency of product comparisons based on relative weights through the use of haptic applications.

Distinguishing Texture

A study that looked into whether haptic feedback could help users distinguish the textures of virtual objects was Coquillart et al. (2011). In this study, an experiment was conducted with 20 male subjects to determine the minimum Just Noticeable Difference (JND) for making relative comparisons of surfaces based on dynamic friction. Two virtual objects with certain levels of "stickiness" (levels of resisted relative motion) were presented to the participants. They were able to use the haptic device to "feel" the two objects and then they had to tell which one was "stickier" or if they are the same. There were 45 trials in total. It was found that 14.1% was the discrimination threshold on average, and this finding can assist with the consistency of product surface comparisons through haptic-based applications. It also demonstrates that haptic feedback can be used to help users distinguish the textures between virtual objects.

Can Haptic Feedback Lead to an Enhanced Shopping Experience?

One Promising Study

Very few studies have been conducted to see if providing tactile information about a product through haptic feedback can enhance the online shopping experience. One that attempted to do so was Zhang et al. (2017). After testing to see if haptic feedback could help users understand a product's size, shape, and texture, they had participants rate their overall shopping experience in comparison to if they had gone to a physical store. They found that the use of haptic feedback led to statistically significant higher ratings of the overall shopping experience.

What About Just Haptic Information?

In contrast, another study shows promise that providing textual tactile information without the use of haptic feedback could be beneficial for online shopping. Rodrigues et al. (2017) aimed to find out if providing rich textual haptic information could help substitute the shopper's Need For Touch in relation to buying clothes online. The levels of NFT for each of the 38 participants were determined, and then participants went onto an online shopping website. Participants either saw the condition with little textual haptic information or the condition with rich textual haptic information for the articles of clothing in the online shop. It was found that the textual haptic information did not affect the NFT, but it did have a positive effect on the perceived image of the product and the intent to purchase the product. This shows how those with higher NFT may benefit more from the use of haptic feedback when deciding whether to buy something online. On the other hand, it also suggests that where providing haptic feedback is not feasible, providing haptic information can possibly increase the selling of that product online.

What About a Database for Similar Textures?

There has also been work on ways to use haptic devices to collect haptic information so that it can be shared. One interesting work is that of Hanamitsu et al. (2015), which introduces a

device called Twech that can be used to capture haptic information and play it back. It does this by using a microphone to collect a recording of the sounds evoked from friction with an object, and then uses a haptic actuator to play these back. Their platform also includes a search engine for a database of the haptic information collected by the device for different objects, so that one could search for and discover items with similar textures. Even without the playback device, the ability to provide haptic information about a material through disclosing items with similar textures that the user may already know about could have use with online shopping. As the authors of this paper state, "…were this engine included in an online shopping store, for instance, users could find clothes with a particular feel to the fabric based on an analysis of the recorded signals." (Hanamitsu et al., 2015, p.1). While the online store owners would need the device in order to disclose this information, this would not require that the user would need to buy any new devices in order to receive this haptic information that could assist in their purchasing decisions.

Conclusion

Implications for HCI and The Future of Haptic Feedback in Relation to Online Shopping

Overall, the research shows that haptic feedback can enhance the tactile understanding of a product, and it can also enhance the phenomenological aspect of the shopping experience. This is especially important for customers who have a high NFT and/or for products with experiential qualities (Ex: a sweater). However, more research needs to be conducted to know how much of an impact haptic feedback from devices has on customers' product evaluation confidence and purchasing decisions and whether this justifies the cost of having to buy these haptic devices in order to obtain this information as these devices are currently inaccessible to most consumers due to their high-cost. In the meantime, textual tactile information may be the most cost-effective answer to help compensate for the lack of haptic information in online shopping.

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