Final Report:
Utilizing Projected Pixels in a Retail Environment

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ABSTRACT

Over the past several years, traditional retail outlets have seen a noticeable decline in shoppers, as digital shopping has provided a newer and less costly shopping alternative for consumers. While online digital shopping provides immediate product information, it lacks the experiences provided by physically touching a product that a retail store provides. Newer immersive digital shopping environments bring together digital product information with physical products in order to increase customer engagement and enhance the retail shopping experience. In this paper, I propose a potential avenue of increasing customer engagement for retail spaces, with a project exploring the applicability of low-resolution projected pixels in a spatially aware multi- surface retail space. The primary goal of this project is to investigate ways of engaging users to interact with information in a virtual space. First, I give an introduction to the problem, an overview of the current work in this area, followed by a potential solution for the retail space. I then report on the results of a pilot study that explored how users respond and interact with projections in a multi-surface retail environment and conclude with future work.

Keywords

Retail; Multi-surface environments; Device Interaction; Projected Displays;

1. INTRODUCTION

In general, retail is extremely focused on providing goods and services to a customer, while retail environments are specifically focused on the overall customer experience provided during the process of purchasing goods and services. The global retail environment is extremely competitive and has seen increasing competition, resulting in an increased focus on customer experience and engagement instead of prior approaches that were more product-focused. One approach in enhancing the retail environment is to provide interactive devices to aid customers and enhance their shopping experience, e.g. touch screen information kiosks.

Currently, the biggest threat to the retail environment is online shopping, where information is typically consolidated in a manner that allows consumers to make more informed decisions quickly. With the increase of online shopping, the typical brick and mortar stores have begun revisiting their approach to keep their customers engaged.

Research has been exploring interactive devices and technologies as solutions for increasing engagement [18] by enhancing the retail experience from a customer perspective (e.g. engaging customers with attractive content on displays). Two of the biggest identified technologies being explored are based on (1) location and (2) mobile payment [18]. Location is used to allow stores to push promotions to customers when they are at or near a store, while mobile payment allows for significantly less friction when purchasing a product. More recently, retailers have created highly specialized store locations to test new technologies [7]. One example of this type of store is the digital 'lab' store concept launched in 2013 by Sport Chek[1].

As a typical consumer already enters a retail store with an interactive device (e.g. smart phones), my research goal is to utilize these devices to explore interactions and visual connections in a spatially aware and interactive retail environment. Spatially aware environments track user and device location, activity, and proximity to other users and devices in a specified region. In prior work, the Agile Surface Engineering (ASE) lab[2] investigated the role of multi-surface environments (environments with a variety of different devices, such as tablets and digital tabletops, that are spatially-aware) in scenarios that are common for a typical customer, e.g. browsing for product information, requesting product information, product purchasing [39]. In that work, we participated in a year-long collaboration with a retail design partner to explore a multi-surface prototype to create immersive retail environments. For my research project, I build upon on our previous work by adding projected pixels – the ability to create low-resolution computer output on any surface in the space, floors, walls, ceilings, furniture, etc. – in order to investigate ways to engage customers to interact with virtual information in a multi- surface retail space.

2. RELATED WORK

With the surge in popularity of online shopping, retail stores are searching for new and innovative ways to increase the customer's in-store retail experience. One approach to improving the retail shopping experience is to integrate physical products with digital environments. To accomplish this integration, various technologies have been introduced to designing retail environments.

An early approach to this problem was a prototype of an interactive system for a retail environment developed by Sukaviriya et al. [49]. The prototype used a steerable projector and user tracking to display product information and track customer interactions. They developed product directories (on a digital table and on a wall display), interactive clothing shelves

[1] http://www.theglobeandmail.com/technology/tech-news/sport-

[2] http://ase.cpsc.ucalgary.ca/index.php

and a mixed media product table. Sukaviriya et al. specifically focused their research on the interactions a user would have while moving around a retail space without relying on any other devices [49]. The prototype was developed using the Everywhere Display projector [19, 20, 37, 49, 35]. This device uses a rotating mirror to steer the light from a projector onto different surfaces in an environment [36, 35]. Steerable and rotatable [14] projection systems can project across an entire room however, they are limited to one direction at a time. The system that I am exploring uses a hemispherical mirror in order to project across an entire room simultaneously.

Meschtscherjakov et al. investigated the use of a dynamic map in a retail store [28, 42]. The enhanced store map displayed metric information such as customer "hotspots", sales ranks and also displayed customer-specific information such as product location and promotions. A primary outcome of their research was that customers respond well to technologies that aid them in familiar tasks such as searching for a specific item and view promotions.

Researchers have also explored the use of mobile device applications with a relationship to a physical space. For example, Newcomb et al. created a mobile application to aid in grocery shopping [34]. They examined how location based information, such as alerts in a specific retail-area could increase sales. Another example is the work by Guven et al. [17]. They investigated ways that social media on mobile devices can be used in the physical store to access product information and make more informed purchases. Li et al. attached a mobile device to a shopping cart to scan and highlight passing items on shelves [23].

Providing product and location information through RFID and NFC sensors is also frequently seen in research for retail systems [15, 24, 25, 26, 38, 40]. These sensors not only help provide product information but also information about the customers potentially buying them [25], such as their proximity to the product [15]. RFID tags have been used in dressing rooms to create virtual mirrors making a more personalized customer experience [26].

Researchers are exploring ways to integrate small interactive projection systems to mobile devices to expand the display [12, 16, 29, 45]. Although these systems have not been applied to the retail domain, potential future research could investigate how personal projections from mobile devices could be integrated into my prior research work. In more recent work, researchers have been exploring wearable projectors that provide public floor displays and a private hand display [57].

Multi-surface Environments (MSE) allow information to be shared among various devices such as tabletops, wall displays, mobile phones and tablets [8]. Spatially aware MSEs use knowledge about location and orientation of devices and people in the space to enhance interactivity. An early example of a MSE is the i- LAND environment [48], which includes an interactive wall display, digital tabletop and specialized interactive chairs. These components come together and allow users to share content across the different devices. How content is shared has been done in various ways. For example, Rekimoto design a 'pick-and-drop' technique where a pen is used to transfer information from one device to another [43]. Dachselt et al. explored a throw gesture using mobile devices to send information to a wall display [13]. Where Collomb et al. investigated different ways to perform a drag and drop across various devices [11]. Research in MSEs has been applied and analyzed in different fields [29, 44, 47]. Furthermore, a significant amount of research explores different interactions that can take place in a MSE [46] with a majority of the research involves supporting collaborative workspaces.

The majority of the research in the retail space, particularly with digital devices, has focused on improving the retail shopping experience by integrating digital information in the physical store, and less on digital devices interacting with each other. A user is interacting with one type of device at a time in much of the presented research. For this research, I investigate the integration of a low-resolution full coverage room projector in a multi-surface

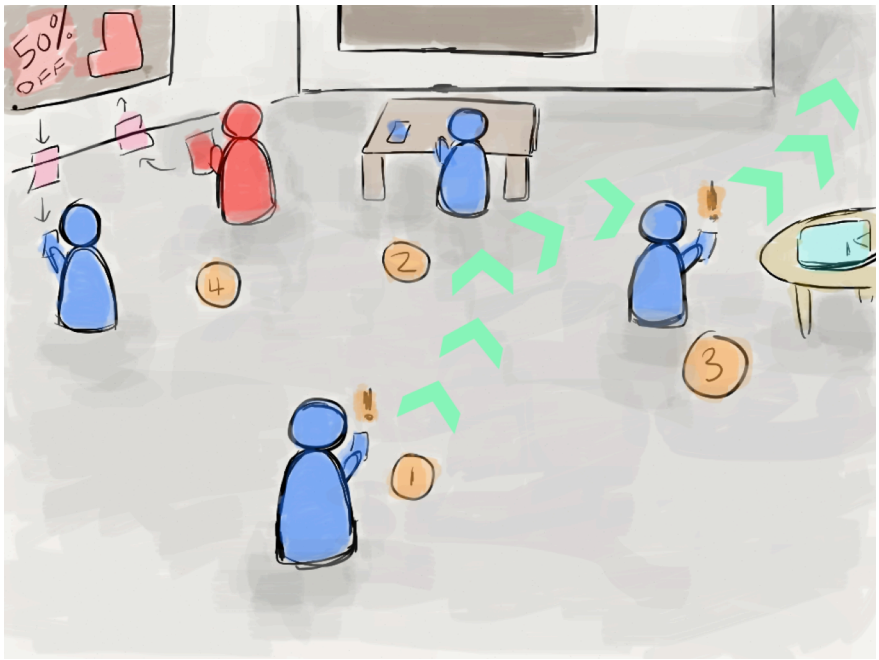

Figure 1. Overview of a retail design scenario.

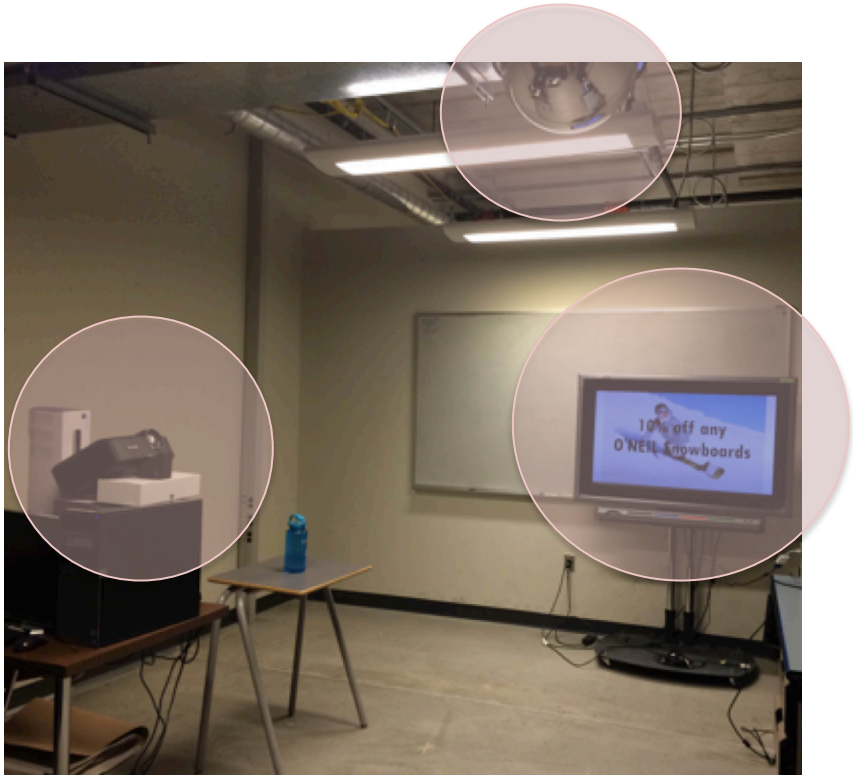

Figure 2. Development room setup with projector (left), wall-display (right), spherical mirror (ceiling).

retail environment. The projection system I am using is the UltraLux system developed by Nacenta et al. [33, 58]. UltraLux is built of previous work (Ubiquitous Cursor) using a hemispherical mirror with projector. This work is the first to cover an entire room with a single static projector and is relatively inexpensive [58]. However, very little applications have been created to explore the system, particularly in the context of MSEs and the retail domain. My research work for this project creates a retail application that is also spatially aware and multi-surface.

3. THE PROJECT

In order to investigate ways to increase customer engagement in retail stores, I focused my research on providing feedback and awareness in multi-surface environments. In retail environments, both feedback and awareness are crucial from both a customer and store perspective, as it creates a more meaningful immersive environment.

I explored how projected pixels could be used to enhance user navigation, awareness, and interaction feedback in multi-surface retail environments. To explore projected pixels in the retail environment, I built upon on a multi-surface retail environment [39] that was previously developed by the ASE group in collaboration with an industry design partner in the retail domain, The Brigade Creative Corp., located in Calgary, Canada. From our year-long collaboration, we created a prototype of a multi-surface solution for the retail environment, with the goal of allowing different retail stakeholders (e.g. customers and employees) to interact with information across multiple devices.

For this research, I integrated a novel projection system (UltraLux [33]) and created a visual feedback system – called *projected pixels* – for interactions between devices, which served as a means for users in multi-surface environments to visually see the outcome of their interactions. This work allowed me to investigate the retail domain and examine how visual feedback can effect person-to-device interactions in projection enhanced multi-surface retail environments. Projected pixels directs a user's attention to intractable virtual information. For example, it can visually guide a user to a location, highlight information when a user is at a location, or answer user's questions about products in the physical context of the product.

3.1 A Retail Design Scenario

In order to illustrate how projection-based feedback can be used in a multi-surface retail environment, I first describe a design scenario, as well as personas that were used with our industry partner (as shown in Figure 1). This design scenario provides the grounding for this research.

3.1.1 STEP 1: A CUSTOMER ENTERS THE STORE

With the desire to purchase a new pair of ski boots, a customer enters our store. As they enter the store, their mobile phone (through a mobile application) notifies them of a type of boot that they might be interested in and directs them through projections to a digital tabletop for more information.

3.1.2 STEP 2: A CUSTOMER USES A TABLETOP

The customer approaches the tabletop and places their mobile phone on the tabletop and personalized content appears on the tabletop. The customer then views product information, recommendations, ratings and store location, before eventually finding a pair of ski boots. The customer then selects the "find in store" option on the tabletop by taping the icon, causing a map to appear on their smart phone and projected arrows on the store floor showing the path to the location of the boot.

3.1.3 STEP 3: A CUSTOMER APPROCHES A DISPLAY

On the way to the location of the boots, the customer sees a clothing display. A projection appears on the clothing display

Figure 3. Projected pixels showing a promotional ad transferring from a wall-display to a customer's personal device.

indicates that, based on previously purchased items, the customer may like the displayed item and that there is one in their size. The customer decides to buy one, selects their size and continues on the path to the boots.

3.1.4 STEP 4: MARKETING CONTENT

After locating the boot, the customer heads towards a checkout counter and passes by an advertising display showing new and promotional products. At the same time, a store employee is using a tablet to add a new ad to the displays carousel. The employee "flicks" an ad towards the adverting display, a projection shows the new ad travelling from the employee's location to the display. The customer sees that the ad is a coupon for the ski boots and approaches the display in order to receive it. The customer performs a "flick down" gesture on their smart phone, a projection travels from the display to the customer and the ad is now saved to their personal account for checkout.

3.2 Implementation

Based on the previously described scenario, I built a prototype system with interactions and gestures from prior research [39] into a projection enhanced multi-surface retail environment. I focused the prototype on the previously described design scenario in order to explore how users interact with virtual information in a spatially aware environment. The system consists of the following components: (1) a high-resolution wall display used to display new promotions, (2) personal devices such as smart phones and tablets that can interact with the environment and (3) a low resolution projected display to visualize the information. The room setup can be seen in figure 2. The devices and the environment were built using the SoD toolkit[3] developed by the ASE lab. I refined the existing SoD toolkit by integrating the UltraLux projection system developed by Nacenta et al. [33].

[3] http://ase.cpsc.ucalgary.ca/index.php?page=sod---main

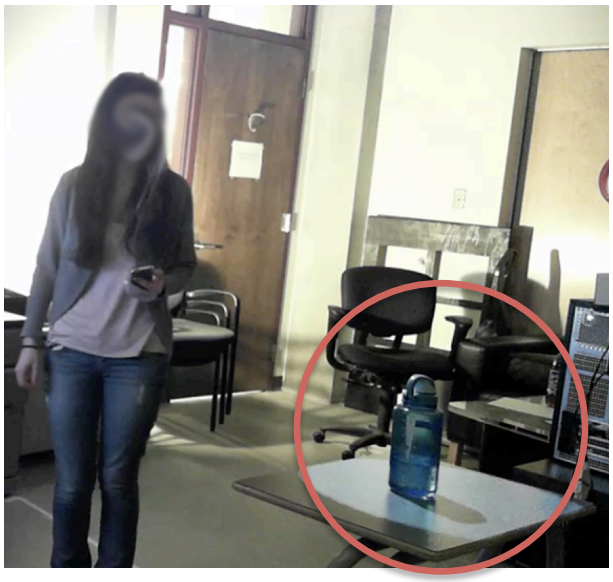

Figure 4. An item from a customer's personal list being highlighted when approached.

Once the environment for this integration was completed, a client library was used to convert the spatial coordinates of the room to the projector system and to handle the events specifically for this environment. Using these components, a retail prototype was created. The prototype consists of the previously mentioned devices that are spatially aware and connected visually with projections.

As shown in Figure 2, at the wall-display, employees can send new promotional information to customers using their tablet devices while customers can retrieve the information on their smart phones as seen in figure 3. These interactions are supported with visual feedback using a low-resolution projected graphic to indicate the information transfer.

Smart phones are used to initiate navigation and also contain the customer's personal information such as previously purchased items, wish lists, and ratings. In the retail environment, this information is used to project the location of items a customer may wish to purchase. When the customer passes within a certain distance of an item that they may wish to purchase, a projection is used to draw the customer's attention and highlight the item (figure 4).

In order to gain an understanding of what customers consider good feedback in a multi-surface retail environment, I conducted a small pilot study. For the study two main features (steps three and four of the design scenario) were implemented to introduce projection feedback to participants. The first feature is the certain distance from an item, the item gets highlighted and more information is displayed on their smartphone device. When the user walks away from the item the highlight projection is removed (see figure 4). The second feature is the feedback for information transfer. An employee can add a new marketing item to a display from their tablet device. When the employee sends the new ad, a projection travels from the user to the display. This feature also works in reverse. The employee can approach the display, perform a gesture on their personal device and receive the ad promotion for later use. A projection also travels from the display to the customer as seen in figure 3.

4. PILOT STUDY

The pilot study was consisted of three parts. First, the participants were asked to fill out a pre-study questionnaire to gain an understanding of their previous exposure to projection-enhanced systems. Second, an explanation of the system was given and its intended usage followed by a brief interactive demo of the highlighting and information transfer features in order to show the participants the system and what the projected feedback looks like. Third, a semi-structured interview was conducted to get criticism of projection-enhanced feedback and potential areas for improving interactions. The first two parts were 10 minutes in total and the interview was between 20 to 30 minutes. The pilot study was conducted with 4 participants. Three of the participants are from Computer Science and one from Political Science.

5. RESULTS AND DISCUSSION

The pilot study resulted in some very interesting initial findings despite the lower number of participants. The beginning of all interviews were focused on questions related to the projection-based feedback in the demo application. When the participants were asked about features they thought would be the most useful in a retail environment, 3 out of 4 really liked the highlighting item feature. All mentioned that it draws their attention to the item and could make finding an item faster. The fourth participant liked the information transfer feature the best because they felt it would be useful from the stores perspective by reducing signage costs. When asked which feature (if any) they would remove, 3 of 4 said they would not necessarily remove any, however the information transfer feature was seen as incomplete. One participant suggested improving this feature by providing a visual link or path between the customer/employee and the display. Other participants suggested showing a visualization of the information being transferred, for example the coupon. Other improvements to the feedback that the participants suggested was slower, smoother transfers. One participant stated that the feedback had to be personalized or else it would just be annoying like "spam emails for stores".

After discussing the demo systems feedback, the interview moved more to the topic of the retail environment itself. Participants were asked what information is important for them personally. Participants indicated that comparisons between items from different stores (best price) and between similar items within the store are very important while shopping. Special offers (sales and coupons) was also mentioned along with item availability (size, colours, information). Based on these results it is clear that there is a lot of room to explore many different types of feedback in the retail space. For example, if a customer is looking for a certain item, similar items nearby can also be highlighted to draw the customer's attention.

Participants were also asked about their opinion on personal versus private information. This stage of the interview revealed very interesting results. Even though all four participants regarded previous purchases private information, the level of objection was different between each one. For example one participant considered previous purchases as completely private and did not want the store to have knowledge of this at all. While another said since the store technically already has this information, if there is a level of user control over which items get used then it can be public. In fact, for the wish list all participants indicated the need for the ability to manually separate items into public and private lists. With this ability to separate in mind, all participants said that if information is pre-approved then using it in projection feedback is acceptable. Again this separation varied in amount between each participant. These responses indicate that not only does their need to be the ability to separate public and private information but there is also a need to allow the user to set their own level of awareness and engagement in the store. The user needs to be able to set their own level of personalized experience within the store.

6. CONCLUSION AND NEXT STEPS

In this paper, I present my final report for a multi-surface prototype designed specifically for the retail domain aided by low-resolution projected pixels. The interactions implemented were based upon prior research, as well as experience in several other domain areas [44][47]. The goal of my work was to design and evaluate how projections and user interactions with projections can benefit the retail domain. For this project, I focused my research on the interaction between products and users through location, proximity, projections and user's devices in order to get initial user reactions to projection-enhanced feedback in a MSE.

I evaluated person-to-device interactions and feedback in the system by conducting an initial pilot user study that consisted of an introduction to the system followed by an interview of 4 participants. The goal of this system is to create a greater interest in adapting a multi-surface environment in the retail domain and create richer and more engaging retail experiences. The results indicated that in order for projection feedback in a multi-surface retail space to be of value the projections and information being used needs to be richer. Participants revealed that a user controlled separation between public and private information needs to be added.

The next steps in my research include adding additional interactions between other devices (e.g. wearables) and personalized virtual information. Additionally, I would like to explore how to effectively create separate personalized experiences within the environment. Once these interactions have been implemented, I will then conduct user studies to evaluate the impact on customers (e.g. user experience, feedback) as well as retailers (e.g. impact on sales). It is my hope that this initial work will create a greater interest in adapting a multi-surface environment in the retail domain and create richer and more personalized retail experiences.

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