Interactive Shopping Experience through Immersive Store Environments

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Abstract. In the era of high competition with E-commerce and online shops, brick-and-mortar retail industry seeks new opportunities to enhance shopping experience through engaging technologies. Even though retailers are applying their omnichannel strategies to attract more shoppers through technology-driven solutions including websites, mobile apps, and so forth, we find that these technologies are somewhat basic and do not represent the "disruptive" innovations. Along with these current technologies, retailers should leverage their store physical real estate, and transform it into immersive store environments (ISEs) that allow shoppers to navigate in 3D store aisles through rich media interface ported onto networked devices. Therefore, we propose our own study of what ISE use-cases are most desirable by customers and retailers in such contexts; we describe the implementation of our cloud-based interactive shopping interface for ISE, before discussing the promising results of its deployment in a "real-world" store.

Keywords: AndyVision, retail technology, human-computer interaction, immersive shopping.

1 Introduction

Today's retail industry is experiencing a dramatic shift, as the market is facing fierce competition with online shops. Retailers are grappling with finding new ways to meet high expectations of modern connected shoppers, and to enhance their shopping experience. According to a recent comprehensive survey on US retailers in 2012 [1], 40% of them believe that the 'inability to find the desired product' is the primary contribution to their shoppers' dissatisfaction in their stores, and therefore, 75% of these retailers agree to develop a more engaging shopping experience that will be essential to their business over the next 5 years. Shoppers now crave more engaging, convenient, efficient and informative shopping experience that provides benefits beyond online shopping.

In response to the rise of the online shops, brick-and-mortar retailers are fighting back aggressively with their omnichannel strategies, in which they attract

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consumers by keeping them informed about discounts, offers, deals, etc. through mobile phones and websites [2]. However, retailers have yet to turn their store real estate into a tool of digital visual merchandizing and to offer shoppers immersive experience of store environments. Indeed, the idea of immersive experience for exploration or information gathering is not unknown to consumers today; in fact, this has become part of their daily lives. Such immersive environments as city-streets [3], international museums [4], deep-ocean exploration [5], and even Mars [6] are among those that are freely available. Similarly, immersive store environments (ISEs) would allow shoppers to virtually navigate the store aisles, to browse products, and to engage with ad-hoc promotional media–directly from their smartphones, tablets, or the in-store digital signage devices. ISEs will become crucial for retailers omnichannel strategies, allowing them to service their customers with cutting edge interactive tools. Retailers may generate augmented multimedia such as product pricing, discounts and offers, related-product recommendations, and user feedback–all dynamically–expanding their upsell strategies in the process.

In this research initiative, we present a design, implementation, and deployment of the cloud-based shopping interface framework for immersive store environment that can be ported to personal computing devices as well as larger networked displays, such as retail kiosks and television (see Fig. 1). This ISE is a part of the multi-faceted research project, 'AndyVision–the Future of Retail' and has been piloted at the Carnegie Mellon University (CMU) Store in Pittsburgh, PA, USA [7]. We have also conducted a user interface study, wherein real shoppers have interacted with our ISE on an in-store digital signage, equipped with touchscreen capabilities. The target use-case for the ISE implementation is to promote store's bestselling merchandises (bestsellers), to help shoppers locate the items, and to present multi-media marketing through this fully-immersive rich media interface.

Fig. 1. Examples of the devices ported with our immersive store environment

2 Related Work

Immersive environments virtually surround individuals such that they psychologically perceive themselves to be enveloped by an environment providing continuous visual stimuli, and feel their presence at the remote environment [8]. Experiencing immersion into a different world has been around in the form of

storytelling, paintings, sculptures, carvings, and so forth for ages. Moviemap, the term defined as virtual travel through pre-recorded spaces, was first produced using a camera car and presented on an interactive touchscreen-based system at MIT in 1970s [9]. There have been several subsequent moviemap projects that demonstrated the potential of immersive environments in the field of media arts [10]. Today, the 3D visualization and exploration of real-world spaces on the computer screen is very much a product of panorama photography and its applications in the field of computing and human computer interactions. The process of generating immersive environments for real-world scenes involves collections of multi-point panoramas and their deformation into spherical, cubical cylindrical planes in order to fit the visualization model [11].

One such example, that facilitates interactions for immersive outdoor environments, is Googles "Street View" feature within the Google Maps framework [3]. Now, efforts are being made to bring the Street View technology to the indoor environments [12], via the Google Art Project [4] that used multi-point panoramas of indoor spaces and then presented them for navigation inside prominent international museums through the user's web-browser. Representation or visualization of the real-world immersive environments, when accompanied by 2D planar maps, eases the process of navigation by enhancing the spatial knowledge acquisition [13] [14].

Our AndyVision team has designed and implemented an immersive store environment that is particularly unique within the world of retail technology. In addition to immersive environment, we purposely used the map interface to establish correspondence between icons on the map and the objects on the real-world environments, and to assist shoppers to better orient themselves in the store with these reference points on the map. Our pilot deployment in the real physical store attempted to produce an interactive and immersive experience for shoppers and to furnish them with augmented information of the merchandises. We also aimed to capture shopper-signage interactions and provide the store staff with the analytics that can help them plan their visual merchandizing fitting to the changing seasons.

3 System Framework

With the increasing number of available computing platforms, namely through the massive adoption of mobile devices, it is important to have a portable and scalable solution that is able to run across these heterogeneous environments. As shown in Fig. 2, the user-end for this solution is based on a web application that uses JQuery, a heavy-duty general-purpose javascript framework, and Seadragon, a deep zoom viewing library that provides support for high-resolution panoramic photos. This web application can be configured to run on any internet-accessed personal computing device with a screen e.g., smartphones, laptops, retail digital signage kiosk.

3.1 Cloud-Computing Back-End

As its cloud-computing back-end, our approach leverages the Google Application Engine (GAE), a Platform-as-a-Service (PaaS) cloud-computing framework that offers hosting for web applications within a comprehensive development environment. We currently use the python web runtime environment–more specifically, Django and webapp2–and the DataStore and MemCached services.

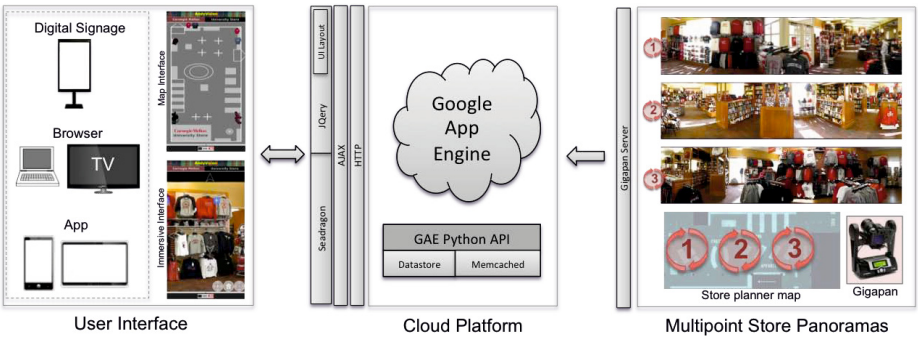

Fig. 2. A framework of the immersive and interactive shopping interface

In order to meet our design goals, we have defined the following interface in our back-end:

LoadItems loads the information of all items to be used in the immersive application.
SendFeedback operation used to send the feedback about the application.
GetBestsellers retrieves the list of bestsellers items.
LogClick operation used to log the click on a particular item.
Analytics used for loading the analytics UI for retailers.
LoadClicks retrieves the list of logged clicks, which is used by the analytics to create the statistical graphs.

3.2 Immersive Store Environment Construction

Gigapan, a robotic camera mount, was used to capture panoramas from various vantage points within the CMU store and to construct the ISE. In our current deployment, we used n=2 distinct panoramas, where n is scalable and can be increased to meet the desired specification goals. Taking the panoramas was a manual process, in which our team visited the store with a camera kit, and identified the best spots in the store for the panorama captures, based on clearance from retail structures in the field of view. After being taken, the high-resolution images were uploaded to the Gigapan server and later accessed by our GAE back-end. Our web application interface provided the functionalities of browsing

and navigating the store by utilizing these multi-point panoramas in the form of a 3D model.

4 Interface Design

Interactive displays are becoming more common in the retail sector, and provide real-time information with personalized service to the shoppers on their fingertips. The CMU store was specifically interested in promoting their bestsellers on the digital signage, but did not want to follow conventional method of digital advertisement e.g., merchandise multimedia slideshow, scrolling flash screen and so forth. Instead, they wanted us to find a unique way of servicing their shoppers by designing an interactive shopping interface, which can not only engage their shoppers, but also facilitate them with merchandise location services.

A digital signage–Touch&GO Digital Lollipop 46P (Micro Industries, USA), 46" touchscreen monitor–was considered for our interface deployment. The interface design was required to adapt to portrait orientation of the touchscreen with the resolution of 1080x1920. The interface is mainly divided into two parts:

(i) Map interface, a 2D planar map view that provides merchandise coarse-grained locations.

(ii) Immersive interface provides merchandise fine-grain locations in 3D store environment.

4.1 Bestselling Merchandise Selection

Our team collaborated with the store staff to identify their bestsellers by statistically evaluating their POS data over the prior 5-month period; we finalized twelve bestsellers that fall into three categories (see Table 1): (i) male gender-specific items, (ii) female gender-specific items, and (iii) unique unisex gifts. Apart from POS data, other selection criteria include merchandise visibility in the store display, stocks in their backroom, and the latest trends among the student shoppers. The bestsellers were coded with their unique identification numbers in our framework database for data collection and analysis.

Table 1. The selected bestsellers and their category distributions

Categories	Qty	Merchandise (database serial no.)
Men	4	T-shirt(1), long sleeve t-shirt(2), hoodie(3), Sweat pant(4)
Women	4	Polo t-shirt(5), t-shirt(6), hoodie(7), pant(8)
Gifts	4	Hat(9), mug(10), t-shirt(11), sweat shirt(12)

4.2 Panorama Overlays

We collected the necessary info and related multimedia for the bestsellers from the store, such as: merchandise name, price, features, and high-resolution merchandise pictures. They also provided us the locations of these bestsellers on a

Fig. 3. Locations of the bestsellers in the store panoramas

2D store planar map; hence, we identified them in the previously-collected store panoramas. As shown in Fig. 3, the bestsellers were tagged with '+' icons, visible in two of the store panoramas. Product description overlay windows, containing merchandise specific information and images, were produced and used as augmented information for the bestsellers.

4.3 Map Interface

As shown in Fig. 4, the 2-dimension store planar map interface displays the locations of the bestsellers with merchandise icons and also allows shoppers to narrow down their search by choosing one of the category button icons in the side menu bar. When a category button is engaged, their corresponding products icons are highlighted in the map-view. As it is conventional of layout map views, whether digital or not, our interface also shows the "you-are-here" icon, which helps users to orient themselves within the store relative to the signage device. We placed a feedback form to capture the shoppers response to this interactive technology. The feedback form consisted of four questions as well as a QR code for promoting our research on the social networking web.

4.4 Immersive Interface

So far, the shoppers were provided the coarse-grain locations of the bestsellers on the planar map. The immersive interface shown in Fig. 5, as its name indicates, lets the shoppers immerse them into the real 3D environment and see the fine-grain locations of the bestsellers. The immersive interface appears on the screen, when a shopper engages with any bestseller icons on the map interface. Shoppers can navigate within this environment by swiping their fingers left/right and up/down. For novice shoppers, we have superimposed arrow icons for easing the navigation process. The panel icons offer zoom-in and zoom-out functionality, while also allowing shoppers to quickly return to the map interface at any time. '+' icons, also superimposed on top of the 3D plane on the item it indicates, unveils the augmented information of the bestsellers when tapped. Touching

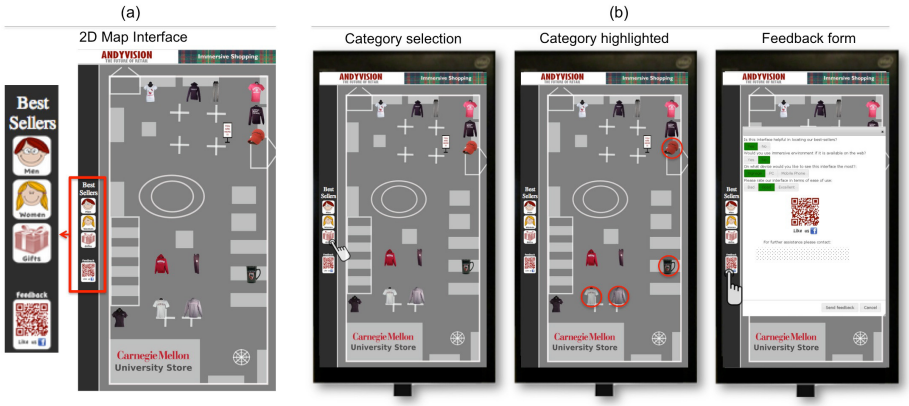

Fig. 4. (a) 2D map Interface showing categories of the bestsellers, and (b) Interface interaction steps on the map interface

Fig. 5. (a) Immersive interface with descriptions of each element, and (b) Interface interaction steps from map interface to the augmented information of the bestseller on the immersive interface.

open areas within the product description overlays themselves will dismiss them, allowing for further store exploration.

5 Signage Deployment and In-Store Pilot

The digital signage displaying our shopping interface was deployed in the CMU store, targeting the university's commencement season in May 2012. During these periods, the store experiences dramatically increased sales and customer interaction from students and their families, relative to comparatively less active, non-event periods. The store staff identified a physical location for the signage inside the store, where the interface could receive the most visibility to the shopping crowd.

At this time, the immersive interface shown in Fig. 6 was displayed on the signage and contained a 2D map as an overlay with the functionality of viewing the store from three different 3D in-store vantage points. To promote this research, the store also generated a special discount on particular items, which could be claimed by scanning the QR barcodes on the corresponding items augmented product description overlays. The merchandises for promotion were randomly picked by the store. Although, during these initial trials, we did not collect any interaction data, lessons learned from this experience helped us to generate a more intuitive shopping interface for the seasons to come. The approach of subsequent high-volume events–Thanksgiving, students/faculty/staff special discount days, Christmas vacation, and the start of the 2013 semester–motivated us to target our interface for collecting shopper-signage interaction data.

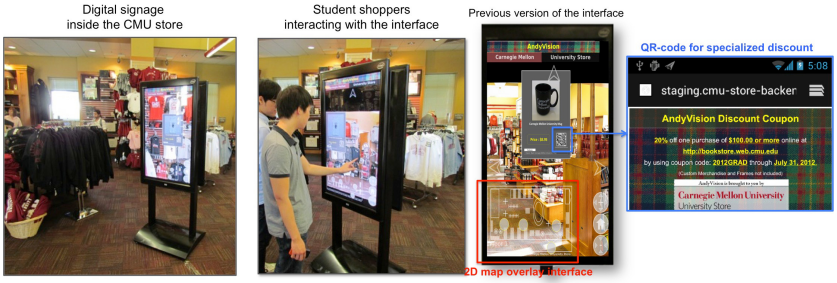

Fig. 6. Images of the interactive signage deployed at the Carnegie Mellon University store and the previous version of the shopping interface

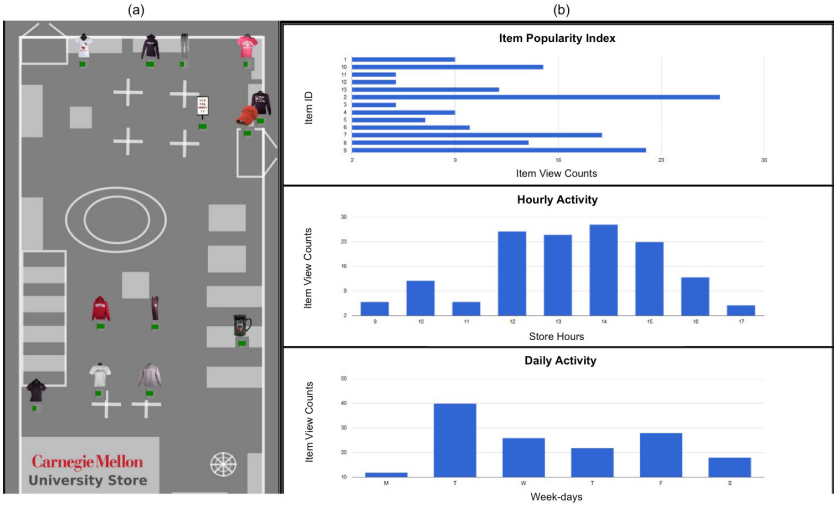

Fig. 7. AndyVision retailer's interface showing the signage activity analytics: a) activity flags corresponding to the items on the map and b) graphs showing shopper-signage overall activity

6 Data Collection of Shopper-Signage Interactions

From the day one of our deployment in the store, we logged each and every interaction of the shoppers on the signage. Our log file included the `item-id` and the `time` and `date` of item view counts. Via our cloud backend scripts, we continually accessed the log file in order to dynamically construct the interface for retail operations (see Fig. 7) that displayed the shoppers' activity in the form of retail-oriented analytics, such as an item's popularity score, based on overall activity, and an item's view-counts per hour and day. The part of interface also showed the overall activity on the stores 2D map along side of the merchandise.

As shown in Fig. 8, there was healthy shopper-signage interaction at the end of the fall 2012 semester. A sudden burst of activity during this period was anticipated, since the students, who were returning to their homes for Winter Break, rushed to the store to shop gifts for themselves or their relatives. Accordingly, we also observed a long inactive period for signage activity during Christmas and New Year break; signage activity resumed as the spring semester 2013 began. Percentage distribution of the activity across the bestsellers contained a good insight of merchandise popularity. The bestsellers falling within the 'Men' category received the highest item view counts.

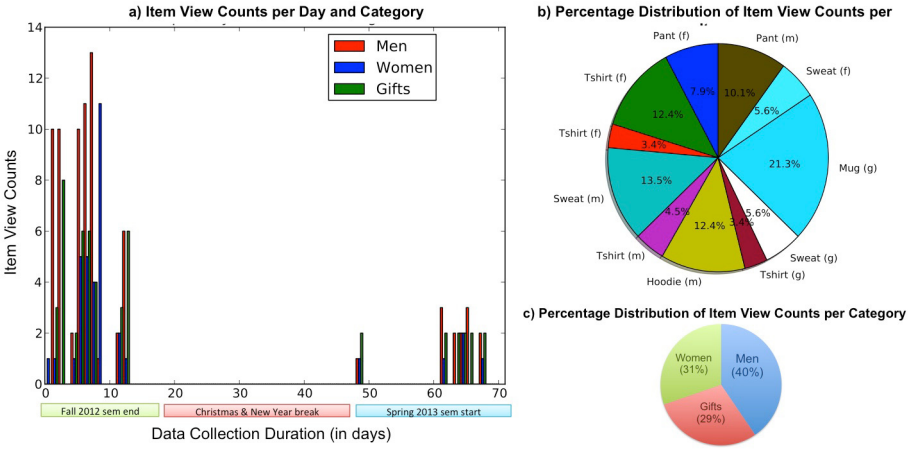

Fig. 8. Graphs of item view counts for a) the entire data collection period, and b) & c) their percentage distributions

7 Conclusions and Future Work

In this research work, we firstly identified the importance of immersive store environments in the retail industry, and later presented a novel design of a cloud-based interactive shopping interface embedded with our ISE implementation. Our shopping interface, which was piloted through interactive signage at the CMU store, allowed the shoppers to locate the stores best-selling items on

the signage without any store-staff intervention. Moreover, the interface also facilitated an immersive shopping experience via 3D environment navigation. The AndyVision ISE interface not only enabled shoppers to virtually walk through the store, but also allowed them to visualize the augmented product description overlays featuring additional merchandise information. Our pilot at the CMU store that captured shopper-signage interaction activity revealed that ISE is an attractive element to shoppers and offers a new channel of visual merchandizing for the retailers.

Our ISE is currently generated manually through multi-point panorama capture, when the store changes its layout. In the future, AndyVision will provide a robot-centric solution to automate the process of ISE construction and store layout mapping [7]. Our on-going effort in this research work is to make our ISE accessible via web browsers and mobile devices, and to expand the coverage area.

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