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Bring Store in My Room: AR Store Authoring System for Spatial Experience in Mobile Shopping

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Abstract

We propose an AR store authoring system that enables the users to customize a physical space to promote spatial experience in mobile AR shopping. The current state of AR shopping research attempts to enhance the shopping experience by presenting virtual items onto the user's space. However, under the notion that the stores and products are inseparable in creating a holistic shopping experience, we set to make a shopping experience that encompasses both elements. Instead of simply augmenting a whole store, this study introduces a space adaptive AR store that divides a virtual store into multiple sections and places them onto physical space according to the labeled surfaces. This prototype mobile application intends to deliver a complete spatial shopping experience by allowing the users to customize the stores in their space and ultimately attach the store experience to the AR shopping system. This study aims to introduce new scalability of the AR technology application in remote shopping.

Index Terms: Human-centered computingHuman computer interaction (HCI)Interaction paradigmsMixed/augmented reality; Human-centered computingHuman computer interaction (HCI)Interaction paradigmsGraphical user interfaces;

1 Introduction

Stores play a crucial role in creating a shopping experience since the retail store's spatial layout can affect the customer's shopping behavior [3]. In mobile shopping applications, the spatial depiction of a store is limited to 2D-based interfaces and interactions. However, AR technology enables the accurate 3D rendering of the digital objects to combine spatial components to the online shopping experience [1]. Current research and mobile AR shopping services mainly focus on augmenting 3D items in 2D online store/in-store [5]. Several studies only augment a single 3D representation of a 2D object by scanning the 2D image [1, 8] or just displaying a sequence of 3D items in a 2D mobile screen [7]. Another previous research attempted to apply Hololens HMD on their AR retail system but it only augmented customer reviews or additional information on physical products [2]. AR is only a supplementary or advertising tool for conventional online shopping interfaces in those examples. Given that AR shopping research intends to create a simulated shopping atmosphere, just as if customers were in an actual store, it may be critical to implement both the store and products as experience factors. Therefore, this study aims to implement spatial experience by augmenting *Store* in the AR Shopping scenario.

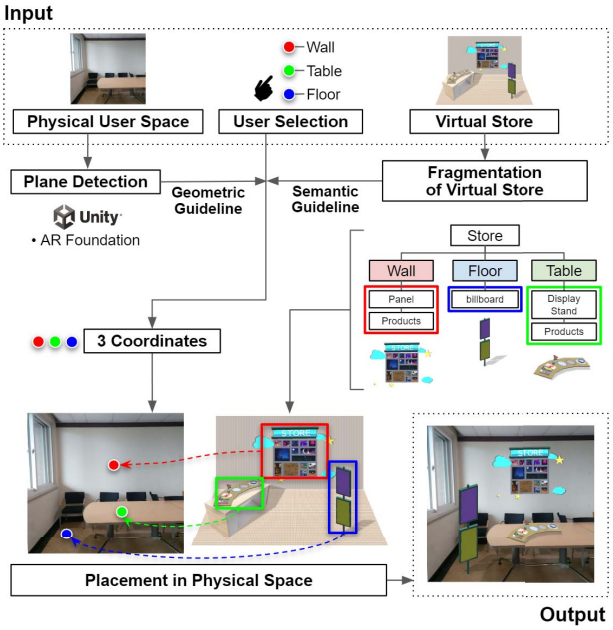

Figure 1: Systematic flow of the space alignment and AR store placement

The user's physical environment and virtual shopping space are structurally and morphologically different. Augmenting virtual shopping space directly onto physical space without considering spatial context can cause the restriction of user action ranges and occlusion on users' perspective. In order to solve the dissimilarity problem between virtual and physical spaces, this study proposes a system that helps users adaptively arrange the virtual store in their physical space. Previous studies in AR domain have tried to use semantic [6] or geometric information [4] for the adaptive arrangement of virtual contents . We attempt to apply this adaptive AR method to the 'space' itself. Our suggestion is to fragment and label both virtual and physical space. Then, place the virtual space elements based on physical space elements with a common spatial label. This authoring system is implemented as hand-on interactive media. Implemented through the mobile platform, users can easily access from anywhere, maximizing the benefits of online shopping that allows them to browse and purchase products anytime, anywhere. A sophisticated approach is also used to design an interface to utilize the characteristics of the mobile platform.

This study is a mobile AR shopping app including an AR Store authoring system. This system has the following contributions.

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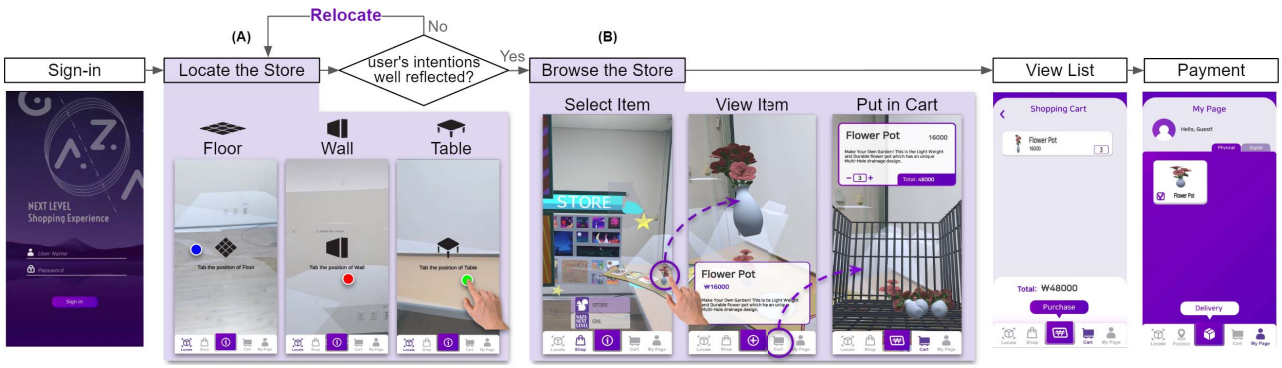

Figure 2: User Flow of our Mobile AR Shopping App. (A) is the screenshot of step 2, "*Locate the store*". (B) is the screenshot of step 4, "*Browse the Store*"

- Generate AR store based spatial experience that was absent in mobile shopping.
- Propose a method of resolving the discrepancy between the virtual and the physical space through let users adaptively place the AR store on the physical space.
- Implement Application for holistic shopping scenario with proposed system.

2 System Design and Implementation

To align the virtual store experience with the physical space, our proposed system fragments and label both space components and augment virtual elements according to the common labeled objects of the physical environment. By placing the parts appropriately onto the physical environment, dissimilar virtual stores can be adaptively represented in user space, replicating the experience the virtual store is intended to provide. Our system was developed in the Unity 2020.3.6f1 environment and built as an Android application. The device used for testing was a Galaxy A90.

2.1 AR Store Authoring System

Labeling Virtual Store As shown in Figure 1, when the virtual store is input, it is fragmented into three spatial labels: floor, table, and wall. The sub-elements of each label are classified according to the spatial relation rule defined in [6]. The three labels are also used as a semantic guideline for user selection, one of the inputs for physical space labeling.

Labeling Physical Space The spatial labeling of physical space is determined by user selection based on guidelines due to the diversity of real space. For guidelines, both semantic guidelines and geometric guidelines are used. The semantic guideline is based on the label set in the virtual store. As a geometric guideline, the system use "Plane Detection" provided by AR Foundation. With plane detection, the app guides the user to easily select the location of each wall, table, and floor.

Placement in Physical Space The key to placing the fragmented parts of the virtual store in the physical space is to find the object with the same spatial label in both spaces. For example, an object labeled as 'wall' in a virtual store is placed on an object labeled as 'wall' by the user in the real space. This process applies to all wall, floor, and table labels. It allows the system to augment while maintaining the spatial relationship with the labeled object, despite the dissimilarity of the store and the physical space.

2.2 Holistic Shopping Experience

We implement the prototype of a mobile AR store to show how such a system can be applied in real-life shopping. We designed an app with two kinds of AR stores that allow users to experience the entire AR shopping, from login to payment. Figure 2 shows the User Flow of our App, and sections colored in purple are spatial experiences implemented by our authoring system.

Locate the Store After logging in, users will choose where to augment their store based on the following guidelines (Figure 2 (A)). Then, the user is prompted to select a location for the Wall, Floor, and Table as a semantic guideline. The geometric guideline is displayed in a transparent white-colored plane. After selecting a desired point on the plane by following the app's instructions, 3 coordinates are stored in order and used whenever users augment the store. If the augmented store is not located as intended, they can relocate the store.

Browse the Store After the store is located well, users can walk around and browse products as if they were in a real shopping mall (Figure 2 (B)). They can view items at a closer distance and check details using two-finger interactions. We used a 3D shopping cart to let people choose digital items as if they were putting physical items in a cart, giving them a more realistic shopping experience.

Furthermore, we applied a user-friendly 2D interface like scroll-view in later phases to enhance the user's convenience and minimize the unfamiliarity of the new AR system.

3 Conclusion and Future Work

We generate spatial experiences in mobile AR shopping using the AR Store authoring system that helps users adaptively place stores in their physical space. The proposed system resolves the heterogeneity of space through spatial fragmentation and arranges it in a physical space considering spatial labels. We also implemented a mobile AR shopping application with our proposed method to show how it can be applied to real-world scenarios.

Although the current study divided the shopping space into three simple structures (Wall, Table, and Floor), a more sophisticated sub-element analysis will be needed to apply to more diverse stores. Also, the system will be demanded to cope with more dynamic places that share no element with the same spatial label in the physical environment. As a future plan, we will conduct user tests to prove how our AR authoring system could improve users' spatial experience on mobile shopping. Also, we plan to expand our system from a single-user scenario into a remote multi-user scenario. We hope this study will serve as a starting point for providing a more immersive spatial shopping experience in mobile AR shopping.

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