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Application of Augmented Reality Technology for Interior Design

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Abstract: Societies' and consumers' demands have changed. Traditional marketing techniques can no longer satisfy consumers' needs. Augmented Reality (AR) is an extension of Virtual Reality (VR), which focuses on the real-time interaction under real environment. Our study will focus on home furnishing experience integrated with AR, utilizing the AR system to increase interaction with home furnishing operating model and process. We hope the study will provide valuable information for future digitized furniture business and consumer-related studies.

Key words: Consumer interaction, Furnishing experience, augmented reality

INTRODUCTION

Schmitt (1999) pointed out that low price and product functions alone can no longer sustain customers. They seem to care more about exciting, entertaining, educational and challenging experience. Schmitt's integrated experience marketing is based on psychology and sociological behavior theories. It includes two constructs: experience marketing model (experience model) and experience marketing strategic tools (experience media). The experience model is divided into sense, feeling, thought, action and relation. Pine and Gilmore (1998) indicated that farm products can be further processed. Products are visible while service is invisible and experience is memorable. They suggested that other than entertaining customers, companies must make customers want to be part of it. They also pointed out that shopping environment has been changing along with the society change. Although, hard to evaluate, the significance of customer participation and interaction are undeniable. Service is a real time product; therefore, it requires customer's participation at the same time. Service providers and recipients are both involved in the process. Therefore, service is relatively invisible, instant, unstandardized when compared with other products. It also requires the presence of both service providers and customers.

Csikszentmihalyi (1975) proposed the concept of "Flow experience" indicating that people integrated themselves into the situation when participating in some activities. They became so involved and would eliminate unrelated senses and ultimately they entered into a soothing state. Flowing is the best experience and enjoyment in life. Schmitt (1999) indicated that the differences between experience marketing and traditional marketing are the key elements of traditional marketing namely. Schmitt (1999) indicated that "experience is an

individual's response to a certain event, it could be anything in life and it is usually caused by individual's directly observing or participating in the event, no matter it is real, imaginary, or virtual". Holbrook (2000) divided consumer experience into fantasy, feeling and fun, or called 3Fs. He also suggested that consumer experience originated from the pursuit of fantasy, feeling and fun.

AR (Augmented Reality) is changing the way we see the world. AR is the extension of VR (Virtual Reality), which provides consumers experience with real environment. Augmented reality is a new field combining real and digital environments into a mixed physical and digital reality. Milgram and Kishino (1994) proposed an AR-related theory, Reality-Virtuality Continuum, which suggested that AR is in between reality and virtuality. In another word, AR is formed when the element is closer to reality than virtuality. Azuma's research indicated that AR should include three key Components:

- Integration of virtuality and reality
- Real-time interaction models
- Existence in a 3D space

Stapleton *et al.* suggested that AR was a combination of virtual, physical and imaginary elements. However, the ways of experiencing AR are quite divergent. Rekimoto (1998) applied the theory to the demonstration of dinosaur fossils and painting. Bimler *et al.* (2000) converted experience of humane cognition into digitalized interface process. The physical integration was designed with real objects to create interaction with actual environment, which changes the object's original value and enhances the real feeling of experience. Ulbricht and Schmalstieg (2003) used the projected objects to create real-time interaction with the photographed objects. Above AR experiences are classified into four categories (Fig. 1).

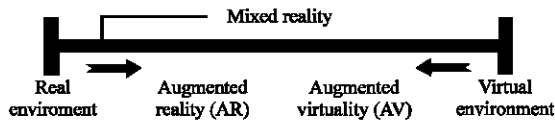


Fig. 1: Taxonomy of mixed reality visual displays, Milgram and Kishino (1994)

The rapid development of computer and internet enables more and more people get access to internet. Since, internet is not limited by time and space and it is instant, interactive, low cost and easily accessible, it has affected human life and made many major changes in the world. People have started using internet to communicate with each other, to exchange information, to search and purchase products and to conduct entertaining activities online. Internet has changed people’s consuming behavior and living style worldwide and it brings large business opportunities as well.

The development and integration of AR technology creates a unique space through human-machine interface, which provides instant simulation and interaction for users and make them feel like they are going through the real purchase experience. Therefore, combining AR technology with e-commerce does not only make the product more real, it also makes virtual fitting room more similar to that of traditional regular stores. On top of that, it also adds the aspect of social interaction to online shopping. It reduces consumer’s purchase risks and provides them an environment where they are able to select products freely and experience real try-on experience, sustaining consumer’s customization demand.

The market of furniture and decorations designed is booming. More and more home products are specifically designed and produced for consumer; therefore, the purpose of our study is to seek a feasible design of a “home furnishing” model to sustain desire of experiencing the enjoyment of trying home furnishing and design. We hope that females can have real time “home furnishing” experience through the AR application. We will utilize AR technology to increase the real experience between consumer and “home furnishing” experience and provide diversified information to increase interactions with consumers.

IDENTIFICATION FUNCTION

In my study, tangible AR is used to design and construct consumer outfit try on operation. It is not convenient for users to put on extra device or instrument on them; therefore, we adopt tangible AR so that users can observe with their naked eyes. We have learned the

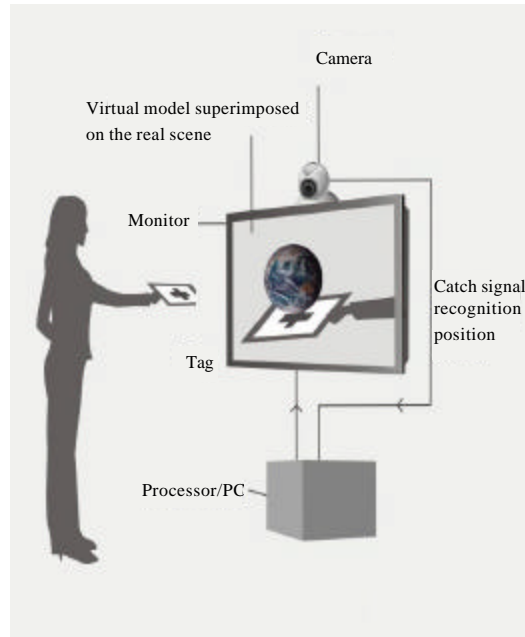


Fig. 2: AR processing steps use

features of AR through literature review. Our study focuses on diversified information service and consumer interaction, so the limitation and inconvenience of traditional fitting room experience can be clearly shown. Consumers can obtain real try-on experience and the interaction between buyers and products can be enhanced through tangible AR. In addition, tangible application can increase multiple product application. Digital technology makes the task of product selection easier for consumers. Consumers are able to select their choices on the screen with their own hands. Thus, it is easy for customers to get used to this system (Fig. 2).

The middle of the basic AR card is a white area and different patterns can be drawn to represent different virtual objects in the area. The shape of the card has to be square. The size of the pattern affects the identification range. The larger the card is, the farther the identification range will be. Other factors affecting cards include the complexity of patterns, environmental lighting and the angle between the lens and the card (Fig. 3). The material of the card has to be non-shiny material. Shiny material such as transparent plastic or acrylic will result in surface reflection and might cause error during the process. There is no firm standard for the size of the card; however, size will directly affect viewable vision through webcam. Therefore, the pattern will not be recognizable from a distance if it is too small.

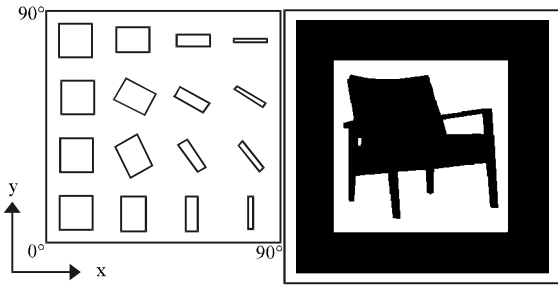


Fig. 3: Angle that will affect the identification of pattern

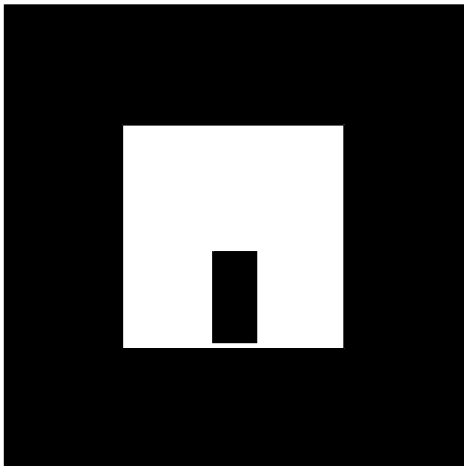


Fig. 4: Patterns used in the early stage

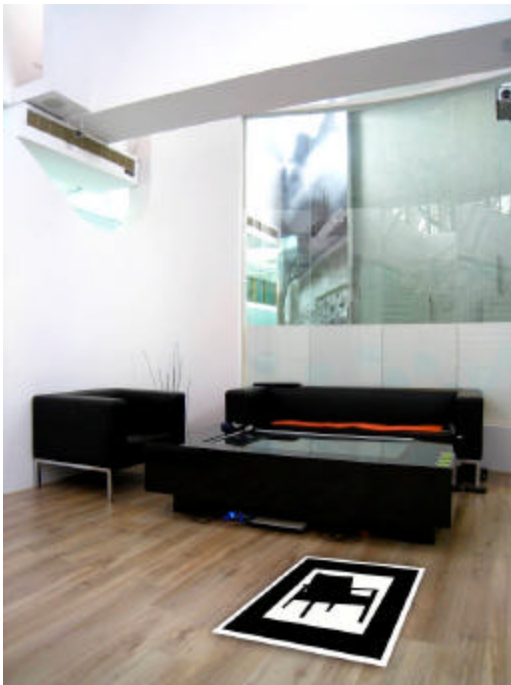


Fig. 5: Pattern we adopt is hand carry type

My study adopts the application of basic AR patterns. Geometric patterns (Fig. 4) were used in the early stage for easy identification, but users often could not understand the meaning of the pattern. Our study is based on the principle of GUI. Basically, we want users to understand the meaning of the patterns and computers to recognize the application of the patterns. The application of the patterns is hand carry type (Fig. 5). Based on the location and position of the furniture selected by users, the furnishing experience can be operated by the hand carry type. Cards can be used according to the selected furniture. Users can get a clear view of the objects and learn how the furniture would look like in the position and location they select, which provides users flexibility through AR application.

SYSTEM ESTABLISHMENT

The focus of this study is to design and develop an interactive system. The major process is: (a) Obtain the image from the video camera, (b) Search for labels in the image, (c) Calculate the distance and direction between the label and the camera, (d) Draw visual objects. The visual objects can be integrated with the actual environment through these four steps. Users can rotate visual objects and observe objects with different angles by turning the labels. Other than static objects, 3D animations can be created through software such as 3DMAX or Maya as well. Therefore, Users can view both static and dynamic objects to increase their visual experience.

Two external programs, MIDAS and DART, are used in our study and combined in Macromedia Director. MIDAS is a development tool which basically is not used for programming. Though, it can easily combine software and hardware through media interaction such as physics calculation, user interface and interactive media art. MIDAS simplifies AR application and supports the output and input equipment of user's system in Macromedia. DART is used to support quick display of additional AR patterns and modules. It can enhance the media editing environment of Macromedia Director and practically satisfy the development of multi-media editing creation. DART also allows users to operate the software for AR environment display.

The functions of DART are provided by an external program called Xtras which provides Macromedia Director a multi-media writing system. The function of Macromedia Director can be extended to integrate the entire AR experience into a platform through DART: Three dimensional objects, film development and tracking pattern marking information. MIDAS can shift X, Y, Z axis



Fig. 6: Patterns that correspond to the location of the furniture

position, control the size of objects on the 3D model and adjust the pattern selected by users to an appropriate ratio. DART on the other hand, can define the pattern and combine it with the actual image (Fig. 6). Overall, in the AR application of Macromedia Director, the difference between MIDAS and DART is that most functional language of DART is presented with pictures, which can make users understand the meaning and the purpose of the cards better.

In the AR system panel, the graphical user interface is adopted and this kind of interface is formed by the following components:

- **Windows:** Windows is included the monitor which cell phone could be shown. The basic frame is divided four parts as below:
 - Title
 - Tool bar
 - Status instruction
 - Command bottoms

According to the operation procedure, we can classify five kinds of windows:

- Father windows/Son windows
- Dialogue windows

- Divided windows
- Jumping windows
- Control tools windows

- **Icons:** The purpose of using images is to save display space, speed the search orders, or assist memory information by visional way to represent abstract idea. Appearance is the shape and color of itself and it won't be confused with other icons. It means that is it obvious that it appointed, or can it let users to see the icons and know the meanings of them. Display method depends on that the practical display of icon could be reach the design requirement of itself, like the DPI of monitor could display delicately the icons. Appearance, meanings and display methods decided the usability of icon. Graphic design in adopts vision design to let users realize. According to the functions and condition design to esteem users experiences to make the interface be coincidence and has great vision definition. And then it could offer vision clues, graphic signs and vision stimulus

- **Pointer:** The cursor is the object that pointer controlled in the window systems. User can operate the position of cursor by pointer and the bottom on pointer and the movement of drag is operated to the object which pointer appointed. Users must have the comparative ability of assorting with hands and eyes and then they could be according to the position of the cursor to operate the pointer. Applying the way of touch to pick the information to let the function bottom of cell phone appearance is simplicity. It is mainly using the touch pen or finger to pick the screen of monitor; it's an obvious change to traditional operation of applying appearance bottom
- **Menu:** Menu symbolizes the position of orders issuing, they could divided five types by different representative ways:

- Menu list
- Pull-down menu
- Jumped menu
- Tear-off menu
- Hierarchical menu

INTERACTION OF HOME FURNISHING EXPERIENCE APPLICATION

In the era of web2.0, information conveyance has changed to two way communication and group share. Such trend produces an entertaining type of participation. People do not consider technology as just a cold tool but

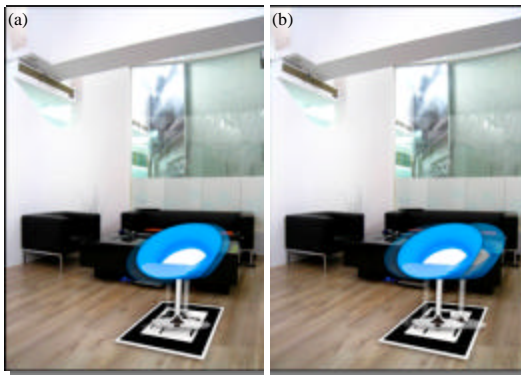


Fig. 7(a-b): Ways of viewing home furnishing:
(a) Automatic operation, (b) Operated by users

a feedback of emotional and joyful combination. It is similar to online shopping environment; shopper's demand from online system is no longer merely the modern technology but the pleasant feeling they can gain in the process of online shopping. Although most of today's online shopping websites provide only product information and descriptions, since there are some major technological breakthroughs have been made and the importance of consumer experience has been recognized, there are a small part of online shopping websites are working toward this direction.

Each 3D model is similar to a Director Sprite and has its own characteristics such as size, color, shadow etc. After building a 3D model in 3ds max or a 3D program and set the output format as ".w3d", it can be used in Director. In Shockwave 3D window, there are some tools that can modify the position of the camera (described as the window, view or angle that can observe the entire 3D world) in the 3D world. There are three different ways to adjust camera, panning, rotating and dollying.

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Furniture can be turned, moved and rotated automatically for viewers (Fig. 7a). After opening Director, import w3d and place the model in a single frame on the stage. Set the frame as "go to the frame" and set the lighting direction in "Director Light" of "Property

Inspector". Open "Library", set "List" as "Action", select "Automatic Model Rotation" and drag the icon into the 3D model on the stage, which will add the Action onto the model. Set up the parameters when the parameter window of "Automatic Model Rotation" appears. Procedure of viewing furniture-operated by users (Fig. 7b).

Use different lens adjusting tools to bring camera to the center of the stage after starting Shockwave 3D. Camera's angle and position of this 3D Cast will be reset when users select "Set Camera Transform". Then, put new world in a single frame of channel 1 and set the Lingo of the frame as "go to the frame". Choose "Actions" in the "List" in "Library" and select "Pan Camera Horizontal", then drag the icon onto the "Sprite" on the stage and the behavior will be added to this Sprite. When "Pan Camera Horizontal" parameter window shows, key in a group name and click "ok" in the section of "Which group does this behavior belong to?". Drag the two produced buttons to the lower left hand side of the stage. Time should all be set as one frame and set the "List" in Library as "Triggers". Left click the mouse and drag the icon to "Pan camera right" on the stage; the behavior will be added onto this Sprite. If a parameter window shows up when left clicking the mouse, select "Group→Pan Camera Right" for "Select a Group and its Action" then set the "List" in "Library" as "Triggers". Left click the mouse and drag the icon to "Pan Camera left" on the stage; the behavior will be added onto this Sprite. When a parameter window shows while left clicking the mouse, select "Group→Pan Camera left" in "Select a Group and its Action".

CONCLUSION

Before a purchase is made, merchandise usually is apart from consumer's living space. Traditional retailers display products in the stores while online stores display products on user's computers. Consumers will have to make a purchase and get the products first before they can learn how the product look in the house. If the product does not blend with consumer's living environment, ex. inappropriate size, color, shape, location and so on, consumers might feel disappointed. Our study integrates AR technology into the female home furnishing experience application and hopes to provide more information to users through more efficient human-machine interaction. To sustain the desire and demand that consumer have toward home furnishing experience, AR application provides real home furnishing experience, gives more information about furnishing a home to consumer and triggers consumer's desire of home furnishing.

In E-commerce, products are displayed by digital means. It combines a variety of computer advantages such as being computable, repeatable, storable and fast. It creates many forms of commercial multimedia and provides more product information to consumers. Therefore, if the technological integration can be effectively utilized, it is possible that more services can be created. We hope to combine AR technology with e-commerce interface, providing consumers more real experience on the product so that they do not need to “imagine” how the product will look in their real living environment. AR combines virtual objects with real environment, so consumers are able to learn about the products and see how they look in their living environment through their visual experience. When there are multiple choices, what they need to do is simply changing the virtual product and find the differences among products. It makes purchase easier for consumers.

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