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**INTERACTIVE DIRECTORY USING AUGMENTED REALITY IN SHOPPING
MALL**

CHAN JIA EE

This project is submitted
in partial fulfilment of the requirements for a
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The project entitled 'Interactive Directory Using Augmented Reality in Shopping Mall' was prepared by Chan Jia Ee and submitted to the Faculty of Cognitive Sciences and Human Development in partial fulfilment of the requirements for a Bachelor of Science with Honours (Cognitive Science)

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ABSTRACT

In a shopping mall, directory plays an important role in guiding people to their destination and provides related details about the location of destination in the shopping mall. In this research, Augmented Reality (AR) technology is applied in the directory of shopping mall in order to provide the users a more interesting and remarkable experience when they are using the directory in the shopping mall. Besides, the virtual 3D models or objects that appear on the AR directory give a more entertaining experience to the users compared to the conventional directory in shopping mall. Therefore, the interactive AR directory that combined virtual objects with real world environment enables users to memorise the location and related details of their destination better through the interactivity experience with the interactive AR directory. In the system of interactive AR directory, the shops' logo is used as the image target and the virtual objects that involved are the related 3D models and information of the shop. On the other hand, in this research, Rapid Application Development (RAD) model is used to develop the system and technical evaluation is conducted in order to test the system's usability and understand how several issues such as the markers' orientation, lighting conditions, phone camera's resolution, and so on can affect the efficiency of the interactive AR directory.

Keywords: shopping mall, directory, Augmented Reality (AR), interactive, technical evaluation

ABSTRAK

Dalam sesebuah pusat membeli-belah, direktori memainkan peranan yang amat penting dalam membantu pengguna mengetahui tempat yang hendak ditujui serta memberi maklumat yang berkaitan mengenai lokasi untuk destinasi di pusat membeli-belah. Dalam kajian ini, teknologi *Augmented Reality (AR)* telah digunakan dalam direktori pusat membeli-belah untuk memberi pengalaman yang lebih menarik dan luar biasa kepada pengguna apabila mereka menggunakan direktori di pusat membeli-belah. Selain itu, model maya atau objek dalam 3D yang muncul dalam direktori AR dapat memberi pengalaman yang lebih menghiburkan kepada pengguna berbanding dengan direktori konvensional di pusat membeli-belah. Oleh itu, direktori AR interaktif yang menggabungkan objek maya dengan persekitaran dunia sebenar membolehkan pengguna untuk mengingat lokasi dan butiran berkaitan dengan destinasi mereka dengan lebih baik melalui pengalaman interaktif dengan direktori AR interaktif. Dalam sistem direktori AR interaktif, logo kedai-kedai digunakan sebagai *image target* atau sasaran imej dan objek maya yang terlibat adalah model 3D dan maklumat yang berkaitan dengan kedai-kedai tersebut. Sebaliknya, dalam kajian ini, model *Rapid Application Development (RAD)* digunakan dalam pembangunan sistem dan penilaian teknikal dijalankan untuk menguji kebolegunaan sistem serta memahami bagaimana isu-isu seperti orientasi penanda, keadaan pencahayaan, resolusi kamera, dan sebagainya boleh menjejaskan kecekapan direktori AR interaktif.

Kata kunci: pusat membeli-belah, direktori, *Augmented Reality (AR)*, interaktif, penilaian teknikal

CHAPTER ONE

INTRODUCTION

Overview

This chapter discusses about the research background, problem statement, objectives, definition of terms, scope of study, and significance of the study.

Background of Study

According to Kensek, Noble, Schiler, and Tripathi (2000), Augmented Reality (AR) is the overlaying of virtual object onto a real world environment and the real world environment is “augmented”. Besides, AR also defined as the development of real world environment by the virtual object in order to provide meaningful information to the real world environment (Educause, 2005). Before the appearance of AR, Virtual Reality (VR) was first introduced to the public in 1980s; it is a user interface technology that provide interaction between human and computer generated environment through sensors in real time situation (*Virtual Reality*, 2008). Differ from VR, AR does not fully immersed the users into a virtual environment but it allows users to see the real environment with addition of virtual object into the real environment (Kaufmann, 2003).

The application of AR in many fields help to solve problem in various domains such as in medical field, military training, robotics, entertainment, education, and so on (Kensek et al., 2000). In this project, it focuses on the application of AR on the directory of the building where the directory is developed in order to let people have clearer direction and more in details for the location of their destination in the building. This can saves a lot of time for the users of the directory in finding the places they want.

Problem Statement

When people are in a big building such as the shopping mall that full of shops and facilities, they always take a lot of time to find the location of the places that they wanted to go especially for those who are in their first time entering the shopping mall. In this situation, as a guide for them, there will be some directories which stated the location and name of the shops or places at each levels of the building; with the directories, they can refer to it and find the location of their destinations. However, a lot of people are still putting a lot of time on the directories because most of the directories are full or words, numbers, and different colour that specify the different kind of shops and this might confuse the users and they might use some time to look and understand at the directories. Therefore, the directories of the building might lose its effectiveness to guide the users to their destinations as the users are taking time to look at the directories that full of words and numbers as well as colours. In order to solve the problems, this project will helps to develop an interactive AR directory of the building where the users can interact with the virtual objects and pictures in the directory. Besides, the details of the places or related information will be shown during the interaction. With the interactive AR directory, users can easily found their destination in the building and they can know the details of their destination first before they are going for it.

Objectives

General objective. The general objective of the study is to build a system for the directory of building using AR technology. The building is a shopping mall that consists of many shops, facilities, and levels. With an interactive AR directory, users can observe and interact with the virtual objects and pictures in the directory. Furthermore, the related information of places will be shown during the interaction. Therefore, this ease the users in finding their destinations in the shopping mall without wasting their time.

Specific objectives. The specific objectives of the study are:

- i. To develop an interactive AR 3D pop-up directory for the users in shopping mall.
- ii. To evaluate the effectiveness of an interactive AR directory such as 3D models, words, pictures, and interactivity of the directory using technical evaluation.

Definition of Terms

Terms	Conceptual	Operational
Interactive	Interactive is defined as acting one upon or with the other to obtain data or commands and to give immediate results or updated information (Kaufmann, 2003).	In this research, the AR directory is interactive which it interact with the users in order to give them more details and understanding of their destinations in the building.
Directory	An index or list that assists people to find information. (<i>The Free Dictionary</i> , 2014).	In this research, the directory is in the form of interactive AR directory which provide interaction with the people in shopping mall.

Scope of Study

This project will focus on the implementation of AR in the building's directory where the interactive AR for directory of shopping mall will be developed. In the AR directory, the elements such as food models and pictures will display in 3D form in the real world. Besides, the shopping mall that chosen is the Summer Mall that located in Kota Samarahan, Sarawak.

Significance of Research

In a big building, directories are very important for people to know the directions and location of their destinations. Therefore, it is important to improve the directories with the latest technology, in which the development of interactive AR directory in the building will enable users to have more understanding on their destinations through the interaction. Besides, they will be more enjoyable during the interaction with AR directory and memorise better about the directions and details of the places in the shopping mall compare to the normal or traditional directories.

Summary

In conclusion, this chapter has discussed the background of this research, problem statement, research objectives, scope of study, and the significance of research. In the next chapter, literature reviews that related to this research will be discussed.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter included the discussion of Augmented Reality (AR), interaction ways of AR, the conventional directory in shopping mall, and the application of AR in marketing and advertising.

Augmented Reality

Augmented Reality (AR) is a technology that enables the virtual objects to exist in the same space with the real world; it consists of the ability to overlay virtual and registered materials over the real world's view of the users (Thomas & Sandor, 2009). In 13th century, the history of AR started from a person named Roger Bacon who has an idea of producing artificial reality and introduced the optical eye-glasses; in 1993, the modern AR was found and the first software of augmented memory called Remembrance Agent was produced by Starner (Rhodes, 1997). From years to years, AR has received more and more attention and it has become a growing area for Virtual Reality (VR) research. Generally, VR is different with AR because VR is a technology that enable users to immerse into a virtual world that produced by the computer while AR is about the interaction between the real world and virtual elements; therefore, AR and VR are very different in terms of the immersive level (Azuma et al., 2001). Figure 1 shows the relationship between AR and VR based on the Reality-Virtuality (RV) Continuum.

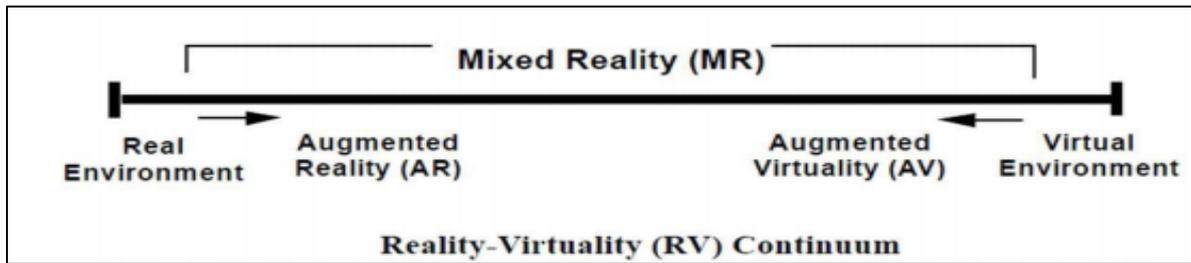


Figure 1. The Milgram's Reality-Virtuality Continuum

Most of the wearable AR consists of head-mounted display (HMD), wearable computer, and also sensor that used to regulate the users' head position; when the users move, the HMD will have updates and change the virtual view in front of the users (Thomas & Sandor, 2009). Basically, the process of AR started with building a virtual world that have the same coordinate with the real world. After that, the position or location of users' head will be regulated and the camera of virtual graphic will be placed in the right position. Next, the process of rendering will take place and the physical image of the world as well as the intersection graphic will be rendered on the HMD in order to show the virtual things to the users (Thomas & Sandor, 2009). On the other hand, the challenging part for AR on mobile phones is the measurement of the position and orientation of the camera to the related object in real world. The process of measuring the position and orientation is called tracking; most of the mobile devices consist of sensors that ease the tracking process (Azuma, 1997).

Interaction for AR

In the field of AR, interaction is very important for users to interact with the virtual objects that appear in the real world environment. During the process of AR, users can observe the real world environment with the addition of virtual objects through the mobile devices' screen that displays the combination of real and virtual objects. Currently, there are two types of common interaction methods for AR in mobile devices which included embodied interaction and tangible interaction (Gervautz & Schmalstieg, 2012). In embodied interaction, the process

of interaction emphasizes on the mobile devices; users can interact with the virtual objects through the movement of their mobile devices with touchscreen (Gervautz & Schmalstieg, 2012). The examples of embodied interaction involve the movement of the mobile devices that relative to the real world environment, navigation, changes of the position and orientation of the devices to produce action, or through the touchscreen function on the mobile device itself (Gervautz & Schmalstieg, 2012).

On the other hand, for tangible interaction, the interaction process emphasizes on the direct operation of the identified objects, in which users can reach the real world environment and manipulate or control the movement of the virtual objects that appear in the real world environment (Gervautz & Schmalstieg, 2012). Besides, the movement can be triggered by the changes of the position and orientation of objects, the closeness between the objects, motions, or the combination of all these methods (Gervautz & Schmalstieg, 2012; Regenbrecht & Wagner, 2002). During the process of AR interaction, the main problem is tracking of all the related objects; most of the objects are detected with markers that provided (Gervautz & Schmalstieg, 2012). Therefore, in tangible interaction, the interaction process might not works well if there are obstructions between the objects and intrusion from users' hand (Gervautz & Schmalstieg, 2012). Nevertheless, some of the AR applications used this as a function by generating activities when the users' hand obstruct certain places in the real world environment.

In addition, there is an interaction mode called ray picking, in which it includes the virtual ray casting through a place on display into the real world in order to select the objects; the initial object that the ray hits will be selected (Azuma et al., 2001); these enable users to hold the virtual objects directly and have higher level of interactivity. In the applications of AR, the famous approach to produce a rapid AR is to use a fiducial marker that tracks by the camera (Azuma et al., 2001; Gervautz & Schmalstieg, 2012). During the process, multiusers can have a united space that consists of shared virtual objects; at the same time, they can view the virtual

objects in their own mobile device (Azuma et al., 2001; Gervautz & Schmalstieg, 2012). This function is very useful for works that need collaborative process, such as the process of revising 3D design in architectures; it also can be useful to apply in the field of marketing and advertising that enable users to have collaborative AR process towards events or products (Azuma et al., 2001; Gervautz & Schmalstieg, 2012).

Conventional Directory in Shopping Mall

Nowadays, most of the directories in shopping mall are in paper-based; when people want to find their destinations inside shopping mall, they will refer to the directories that provided at certain places of the shopping mall. However, people might putting a lot of time to look at the paper-based directories because most of them are full of words, numbers, and different colours that specify different kind of shops (Pagol, n.d.). These might confuse the users and they may spend times to look and understand at the directories.

Nevertheless, there are researches showed that some directory of building such as the shopping mall has used the touch sensitive screen to replace the paper-based or printed directory in order to help users in navigating themselves in a shopping mall (see figure 2); the touch screen directory built up a high interaction with the users and enable users to search their destination in more detailed and accurate (Lester, 2010). However, the technology of the directory in a shopping mall can be improved with the application of AR on the directory; users can interact with the virtual objects in a more interesting way and easier for them to memorise the details of their destination in shopping mall.



Figure 2. Directory on touch sensitive screen

Application of AR in Marketing and Advertising

In today's world, there are a lot of advertisements and marketing strategies around the world. With the uses of AR in marketing and advertising, advertisers can have a more interesting way to reach the people; interactive AR directory that can guides the people in shopping mall as well as providing information for specific shops is one of the application of AR in the field of marketing and advertising (Chehimi, Coulton, & Edwards, 2007). The application of AR in marketing and advertising is a new form of strategy that attracted a lot of people towards the products or events. Besides, with the uses of mobile phones, users can experience an interactive and enlightening advertising on their mobile phones in which they can have a 3D-oriented involvement in between the virtual and real world. With the 3D-oriented virtual environment, it can enhances the users' views and interest towards the advertising products (Chehimi et al., 2007). Based on the previous researches, one of the examples of AR application in marketing involved the virtual footwear that pop out on top of the magazine's advertisement page (see figure 3); users can see the virtual objects in 3D form in which the virtual objects are the advertising product and this provided users a more interesting way in viewing the market products by using AR (Gervautz & Schmalstieg, 2012). In addition, some

of the magazines consist of covers that enable detection from the users' mobile devices and see the virtual videos on top of the magazine covers (see figure 4) (Gervautz & Schmalstieg, 2012).

Other than that, there is application of AR that provides instructions to the users on how to use or control conference phone with the superimposing of step-by-step detailed guidelines on top of the real phone (Chehimi et al., 2007). In museum, the application of AR enables the historic events to become life with the people and attract more people through the interesting AR interactivity (Chehimi et al., 2007).



Figure 3. Virtual footwear that pop out on top of the magazine's advertisement page

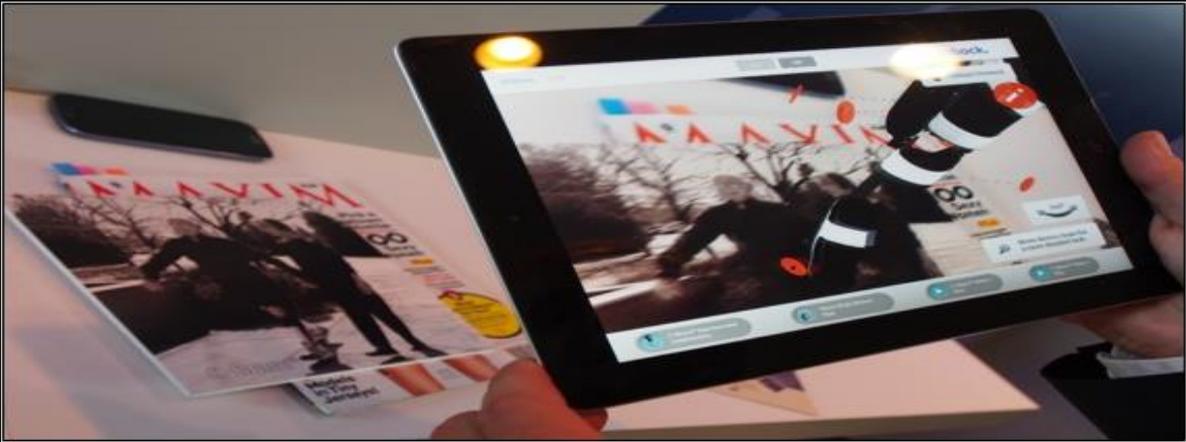


Figure 4. Virtual videos on top of the magazine covers.

AR on building directory. AR can be applied for the building directory in which the technology of AR in shopping can help users to find their destinations with the use of AR directory. There are some research about AR application in vision-based indoor location positioning, in which the system can help people to navigate themselves to their destinations in an unfamiliar indoor place such as the shopping mall (Kim & Jun, 2008). In vision-based methods, the places in a building consist of special identifiers and some locations consist of marker with the colour information and previous data. There are various sensors in order to get and know the information of the users and the locations and guide the users to reach their destination; the accuracy of the system is depends on the number of sensors and the structure of indoor situation (Kim & Jun, 2008). However, the system needs wide-ranging of wiring and therefore, it is expensive and difficulty to install in a building. Therefore, the AR technology can be applied in the directory of an indoor environment such as in the shopping mall; the set up place is small and the cost is lower compared with the AR application in vision-based indoor location positioning.

AR in shopping mall. The application of AR in shopping mall can helps to deliver more information to the users or customers and increase the level of attraction of the customers to the products or events in shopping mall. Some shopping malls used AR that involved avatars to show promotions products to the customer as well as the products information and instructions (Chehimi et al., 2007). Besides, in shopping mall, AR can be applied on the viewing of virtual new car that appears on top of flyers in order to attract the customers and enable them to have a clear vision and information on the new car without reaching the real one (Gervautz & Schmalstieg, 2012). Furthermore, some of the cereal boxes in shopping mall consist of AR games that appear on top of the box (see figure 5); this can attracts most of the kids as well as their parents toward the cereal boxes with AR games (Gervautz & Schmalstieg, 2012). Moreover, there are ketchup bottles that showing virtual recipes on top of the marker that placed

on the bottle when users move over their mobile devices toward the marker (see figure 6) (Gervautz & Schmalstieg, 2012). Therefore, users can use the provided AR recipes to cook dishes by using the ketchup.

In some countries, AR can bring children's favourite animated characters to their real life in order to interact with the children as well as their parents when they are inside the shopping mall; they can interact with the virtual animated characters and have fun in front of a big screen that acts as an AR display (Kuang, 2009). Besides, there are some AR applications that consist of location-based services and guides for shopping in which it can inform the users about the distance between the users and the shop that users wanted to go to as well as the information of the shops (Kuang, 2009). Moreover, there is an AR application that displays the details of the foods before people purchase it; with the virtual food information that display to the users, they can make a better decision when they are buying foods inside shopping mall (Carson, 2014; Kuang, 2009).

In 2009, Lego has created AR kiosks to Lego shops in some shopping mall; when customers direct the Lego boxes to the provided camera, all the digital Lego models that contained in the boxes will be displayed out in 3D virtual form on top of the boxes (*Digital Signage Campaign*, 2011). This enabled customers to know what was inside the boxes before buying it and increase the level of attraction to the customers.

There are a lot of AR applications in the field of marketing and advertising; the similar concepts can be used and applied on the directory of shopping mall in order to provide a high interaction between the interactive AR directory with the users in shopping mall. These can ease the users in finding their destinations in shopping mall by a more interesting way, in which they can experience real time interaction with the AR directory and have more understanding

on their destinations through the interaction. In addition, they can memorize better about the directions and details of the places in shopping mall.



Figure 5. Cereal boxes with AR games that appear on top of the box



Figure 6. Ketchup bottles that showing virtual recipes on top of the bottle.

Summary

In conclusion, this chapter has discussed and reviewed the previous research or study that related to this research and there is a need to further research and improve on the directory inside shopping mall. In the next chapter, the methodology that used in developing the interactive AR directory system will be discussed.