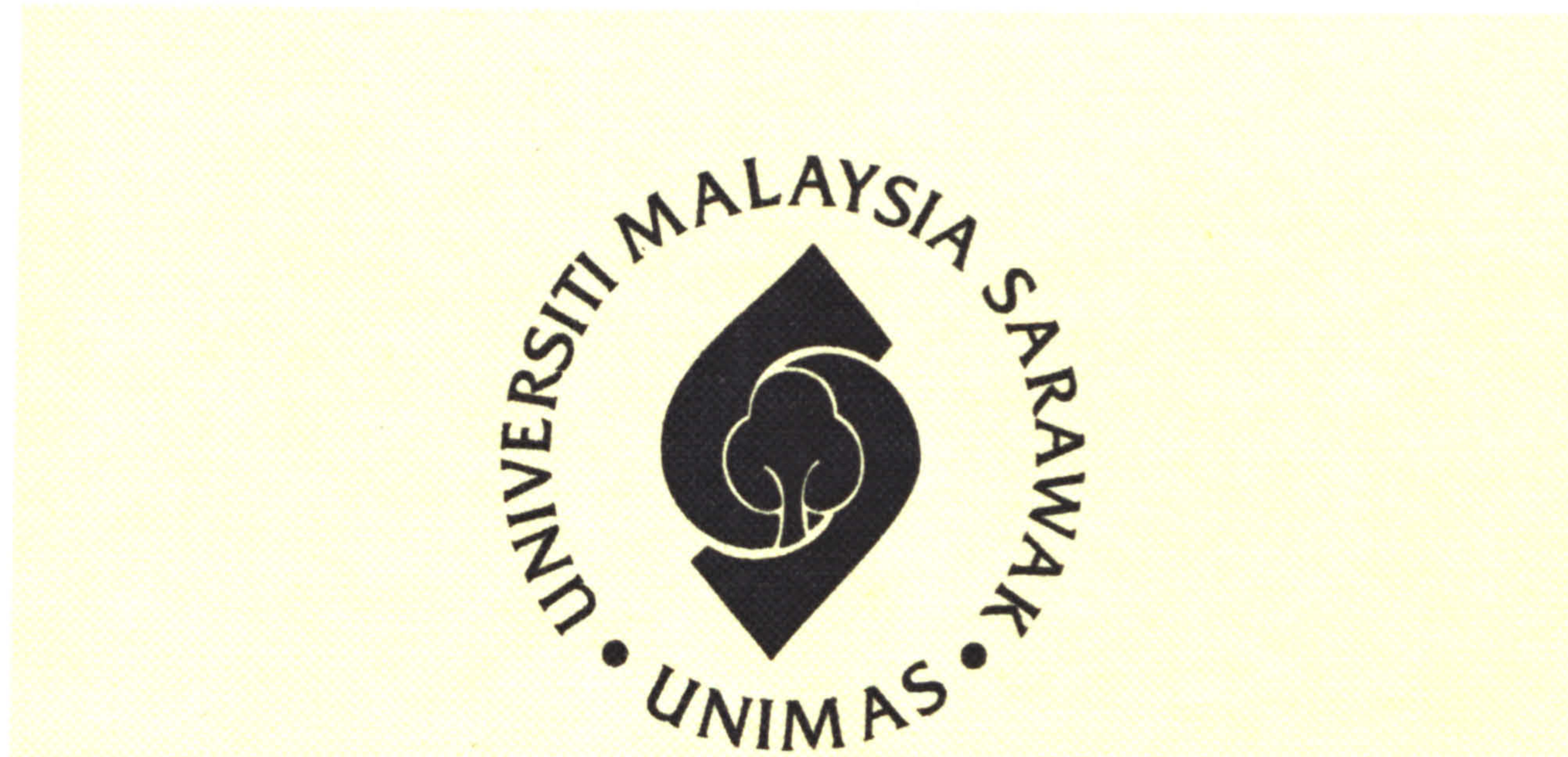

Faculty of Cognitive Sciences and Human Development

AN ASTRONOMY MAGIC BOOK USING AUGMENTED REALITY

Fong Shu Lin

Bachelor of Science with Honours
(Cognitive Science)
2008

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SESI PENGAJIAN : 2007/2008

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AN ASTRONOMY MAGIC BOOK USING AUGMENTED REALITY

FONG SHU LIN

This project is submitted in partial fulfilment of the requirements for a
Bachelor of Science with Honours
(Cognitive Science)

Faculty of Cognitive Sciences and Human Development
UNIVERSITI MALAYSIA SARAWAK
2008

The project entitled 'An Astronomy Magic Book using Augmented Reality' was prepared by Fong Shu Lin and submitted to the Faculty of Cognitive Sciences and Human development in partial fulfillment of the requirements for a Bachelor of Sciences with Honours Cognitive Science.

Received for examination by:

Dr. Ng Giap Weng

Date:

8 May 2008

Gred

ACKNOWLEDGEMENT

First and foremost, I would to express my heartfelt gratitude towards my supervisor, Dr. Ng Giap Weng. His constant guidance and supports keep me working on the right track throughout this whole project. Besides that, I am also grateful to Mr. Allen Choong for his assistance and guidance during the development of this project.
Apart from that, I would like to thank my fellow friends and lecturers in UNIMAS for their supports and cares all these while.
Last but not least, my sincerest thanks to my family members, especially my parents for their encouraging words, continuous support and cares throughout my pursuit of degree in UNIMAS.

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AN ASTRONOMY MAGIC BOOK USING AUGMENTED REALITY

FONG SHU LIN

Augmented Reality (AR) is one of the variations of Virtual Reality (VR). It is a different application where the virtual objects superimposed upon or composite in the real world and the users are interacting with this world in real time (Vallino, 1998). It is also an emerging technology that allows the users explore the world of knowledge through manipulation of virtual objects in real world. It has shown a great potential in developing and creating an interactive and interesting for the users. In this project, a system which is a magic astronomy book using technology in Augmented Reality is developed. It is an application of AR where the users can have a different and enjoyable experience compared to traditional learning environment, and thus promoting an interest in learning astronomy.

ABSTRAK

BUKU MAGIK ASTRONOMI UNTUK AUGMENTED REALITY

FONG SHU LIN

"Augmented Reality" (AR) adalah salah satu cabang daripada realiti maya (VR). Aplikasi ini adalah berbeza di mana objek maya akan dipaparkan dalam dunia sebenar and pengguna dapat berinteraksi dengan dunia ini dalam latar belakang situasi secara langsung. Aplikasi ini juga merupakan satu teknologi yang berkembang dan membolehkan pengguna untuk menjalani explorasi dunia ilmu dengan berinteraksi dengan objek maya dalam dunia sebenar. Ia juga menunjukkan potensi dalam membangunkan dan menyediakan satu persekitaran yang menarik dan interaktif di kalangan pengguna. Dalam projek ini, satu sistem iaitu buku magik astronomi dengan menggunakan teknologi "Augmented Reality" telah dibangunkan. Ini adalah satu aplikasi AR di mana pengguna akan ada pengalaman yang berbeza dan menyeronokkan berbanding dengan persekitaran pembelajaran yang tradisional, dan seterusnya memupuk minat dalam pembelajaran astronomi.

CHAPTER 1
INTRODUCTION

1.0 Introduction

The advancement in technology has resulted in a tremendous change in the field of computer science development. Computer graphic has given birth to a new technology which is the Virtual Reality (VR). This is an application where the users are totally immersed in the environment. Meanwhile, the development in virtual reality has being widen to the extent that we are able to extract and utilize the virtual objects in the real environment. This is where the Augmented Reality (AR) comes into picture.

Augmented Reality (AR) is one of the variations of virtual reality. It is a different application where the virtual objects superimposed upon or composite in the real world and the users are interacting with this world in real time (Vallino, 1998). The virtual objects appear as if they are part of the scene as the users navigate in the environment. The goal for an augmented reality system is that a system that a user cannot differentiate the real world and the virtual augmentation of it (Vallino, 1998).

Augmented reality is different from virtual reality. Virtual reality is defined as a computer-generated, interactive, three-dimensional environment is which a person is immersed (Aukstakalnis & Blatner, as cited in Vallino, 1998). The virtual

environment is a generation of three-dimensional scene by computer and it requires high performance computer graphics system to provide a sufficient level of realism. The virtual world is interactive where the users interact with the system with real-time response in an effective way. Then, the users are immersed in this virtual environment. On the other hand, AR is the generation of the environment which the users view the image that is the combination of the real scene and a computer-generated virtual scene. It is to augment the real world and maintain the users' sense and feel of existing in a real world (Vallino, 1998).

This project is to design and develop a system which is a magic astronomy book for education using technology in augmented reality. It is aimed to give a new definition to the learning environment with these special characteristics of AR.

1.1 Application of AR in Education

In the past decades, there are many researches conducted in examining the effect of 3D computer technologies in supporting learning. The result is positive and encouraging. Findings include better symbolic retention of human cell organelle information (Gay, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), enhancement in spatial understanding of architectural spaces, significant higher scores on performance and achievement tests (Youngblutt, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), more accurate and complete understanding of engineering concepts (Bell & Fogler, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), increase in learning speed-of-life skills (Moshell, Michael, & Hughes, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), long-term retention of the atom (Byrne, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), improvement in the ability to identify and draw perspective of pyramid (Ainge, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005), and the improved ability of low scorer to draw mental models of ecology concepts (Osberg, Winn, Rose, Hoffman & Char, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

The advancement in technology has greatly improved the existing education setting. The traditional teaching material has been enhanced and undergone revolution where the interaction between the learners and the learning material is no longer paper-based and one-way. With current technology, the learners can learn many things in an interactive way and it always gives positive result on the learning performance.

Augmented Reality (AR), an emerging technology that enable to learners to learn and explore the world of knowledge through manipulation of virtual objects in real world. It has shown a great potential in developing and creating an interactive and interesting learning environment for the learners. For instance, there are many AR systems with features that allow two-way interaction between the users and the system are developed for the educational purposes. One of the systems is Earth-Sun Relationship which shows the seasonal transitions in light and temperature of the Earth. The virtual sun and earth can be manipulated with a handheld plate in such a way that the users can orient the virtual objects' position with respect to their viewing perspective (Shelton, 2002). Another AR application is Construct3D which is designed for teaching mathematics and geometry. It is a 3D geometry construction tools that provides a basic set of functions for building primitive forms of geometry (Schmalstieg, 2002). Besides that, Augmented Chemistry is a virtual chemistry laboratory that allows the users to view simple atoms and construct complex molecules according to subatomic rules (Asai, 2005).

Apart from that, there are many other AR projects which related to story telling. For instance, the MagicBook project is an AR application where the learners can become part of the story by interacting with the virtual objects on the book. It is an application that allows multiple users where the users can immerse themselves and communicate with each other as they are represented as virtual characters in the virtual scene. One or more people may immerse in the virtual world while others view the content of the book as augmented reality scene while those who are viewing the AR scene will see a miniature avatar representing the immersive user in virtual

world (Bilinghurst, 2001). Meanwhile, Magic Story Cube is another AR project in education that make the story telling process an interesting experience to the users as they can unfold the cube with 3D objects or characters popping out. This research explores a new approach and an interface for children education and entertainment. With the playing of music, sounds and tangible story cube, the users will feel more entertained and give a greater sense of satisfaction compared to traditional video playing, story book reading or "magic book". The Magic Story Cube explores the application of cube as a medium in improving the effects of interactive storytelling in AR. With this Magic Story Cube, storytelling becomes more attractive, enjoyable, exciting and entertaining (Zhou, 2004).

1.2 Problem Statement

Many students face difficulty in comprehending spatial related knowledge which involved complex concepts, phenomena and theory. There is a few research studies revealed that students have difficulty in developing understanding of astronomical phenomena (Sneider & Ohadi; Stahly et al., as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

The difficulty in developing an understanding in astronomical concepts occurs due to the requirements to have an understanding on the relationships of the objects in 3D spaces and viewing the events between these objects from different perspective. Many learning situations require students to transform 2D objects in dynamic 3D objects within some particular process or state of being. In addition, learners may need to translate among reference frames, to describe the dynamics of a model over time, to predict how changes in one factor influence other factors, or to reason qualitatively about physics processes that are best explored in 3D space in order to understand many science concepts. These supportive findings have motivated the educators to examine the use of 3D technologies as an approach to support students in constructing and visualizing scientific phenomena (Parker & Heywood, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

Most astronomy resources available to students are in the form of 2D charts and images in text books that attempt to emulate 3D scientific phenomena (Keating, Barnett, Barab & Hay, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005). Students viewing these images may lack the sense of depth or scale of these phenomena that is needed to understand the dynamics of the concepts (Dede, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

1.3 Research Objectives

The objective is divided into two categories which are the general objectives and specific objectives.

1.3.1 General Objective

The objective of the research is to design and develop an interface for astronomy learning using AR technology. This interface can make the astronomy learning process an interesting and enjoyable experience for the users.

1.3.2 Specific Objective

The specific objectives for the study are:

- To construct the three dimensional Solar System in Augmented Reality.
- To provide an interactive learning environment.
- To give a new definition in learning environment with AR technology.

1.4 Significance of the Study

According to Shelton (2002), AR interface is a visualization technology that can take advantage of the limitations offered by other visual means of communication for learning. Besides that, there is a great potential of AR in classroom learning (Shelton, 2002).

Many learning situation require students to mentally transform 2D objects into 3D objects within some particular process or state of being (Dixon, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005). For instance, the ability to

conceptualize scientific processes and phenomena in 3D is important if a learner is to understand the scientific concepts of transition of seasons on Earth, or different kinds of genetic and cellular processes (Gotwals, Windschitl, Winn & Headley, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005). Besides that, in order to understand many important science concepts, the learners may need to translate among reference frames, to describe the dynamics of a model over time, to predict how changes in one factor influence other factors or to reason qualitatively about physics processes that are best explored in 3D space (Dede, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

There are over 100 research studies conducted which concluded that students have difficulty in developing understandings of astronomical phenomena and students typically have poor or contrary explanations of such scientific phenomena which is the explanations that are in conflict with those currently being accepted by the scientific community (Pfundt & Duit, Wandersee, Mintzes & Novak, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005). This difficulty in developing an understanding of astronomical concepts occurs partly due to the science of astronomy requiring students to develop an understanding of the complex relationships and dynamics between objects in 3D space and also to examine objects and events from different perspectives (Parker & Heywood, as cited in Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

The results from these studies have encouraged the educators to study the use of 3D technologies in assisting students to construct and visualize scientific phenomena in details. For instance, the CoVis project developed educational activities which allow the students to analyze and interpret complex visual representations in atmospheric science. Furthermore, there are other projects that allows students to construct and view scientific models that can be used to visualize weather cells, gorilla behavior, the dynamic and ecological processes of the Puget Sound, the Solar System, and the Newtonian physics phenomena from various perspectives using computational modeling software. Basically, these studies have found that 3D

computer modeling technologies is supportive and useful in helping students to understand spatial relationships between objects and the relationships between variables that constitute certain phenomena (Barnett, Yamagata-Lynch, Keating, Barab & Hay, 2005).

Apart from that, according to a research project which utilizes ARToolKit in helping to teach undergraduate geography students about earth-sun relationships, there is a significant overall improvement in student understanding after the AR exercise, and also a decrease in student misunderstandings. Detailed analysis of the findings also revealed that there is a close relation between the ability to learn complex spatial phenomena and the way students control "when" and "how" they are able to manipulate virtual 3D objects. From this study, we know that AR is potential to transform instruction and learning of complex spatial concepts and content. Moreover, the study also explores the potential of AR to be improved as a visualization tools in education and for the design and development of technologies in learning. AR provides an efficient, beneficial, useful and powerful medium that allows students to view and interact with sophisticated phenomena as well as provides flexibility that allows query and exploration of component parts of this system such as time, position, angles, rotation, and revolution. The characteristics of AR allow the presentation of any 3D phenomena to be scales to dimension that are convenient and suitable for observation and manipulation in classroom (Shelton & Hedley, 2002).

The project is to develop a magic book as an interface for astronomy learning that applies AR technology. The book helps to enhance the users' interest towards the world around them and make learning astronomy, exploring the Solar System an interesting and fun experience to them.

Furthermore, this magic book assists the learners in their learning environment with a mixture of virtual and real objects through seeing and touching. This book also can be helpful in encouraging the learners in learning as it is interactive and attractive. With this interesting book as an astronomy book, the children will be motivated to

learn. This can enhance their spatial abilities and improves their conceptual understanding of the Solar System as well as to develop understanding of the complex dynamics related to the Solar System.

1.5 Project Scope

The scope of the project is to develop a system that can project the eight planets and the Sun in the Solar System as well as the annotation about the descriptions of the planets displayed. The virtual objects will be projected on a book with corresponding markers on every page. In the last page, there will be an overall view of the Solar System with the eight planets and the Sun rotating at their position respectively. According to The International Astronomical Union (IAU), the definition for a planet is now officially known as "a celestial body that (a) is in orbit around the Sun, (b) has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape and (c) has cleared the neighborhood around its orbit." (NASA, 2007). The 8 planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. The descriptions that will be annotated along with the planets are the distance of the planet from Sun, number of Moons around the planet, diameter of the planet, and the length of day and year on the planet.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

Augmented Reality (AR) is the creation of a view of real scene by incorporating computer-generated virtual objects, including those with full three-dimensional properties into the scene. The virtual objects appear as if they are part of the scene as the users navigate in the environment. The goal of an augmented reality system is that the user cannot differentiate the real world and the virtual augmentation in the system.

Augmented reality is different from virtual reality. Virtual Reality (VR) is defined as a computer-generated, interactive, three-dimensional environment is which a person is immersed (Cited in Vallino, 1998). The virtual environment is a generation of three-dimensional scene by computer and it requires high performance computer graphics system to provide a sufficient level of realism to the environment. The virtual world is interactive where the users interact with the system with real-time response in an effective way. Then, the users are immersed in this virtual environment. On the other hand, augmented reality is the generation of the environment which the users view the image that is the combination of the real scene being viewed and a computer-generated virtual scene. The obvious difference between VR and AR is the immersiveness of the system. The main objective of VR is