UNIVERSITI MALAYSIA SARAWAK
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Faculty of Cognitive Sciences and Human Development

# AUGMENTED REALITY LEARNING TOOL FOR STUDYING CHEMICAL COMPOUNDS

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## Statement of Originality

The work described in this Final Year Project, entitled
**"Augmented Reality Learning Tool for Studying Chemical Compounds"**
is to the best of the author's knowledge that of the author except
where due reference is made.

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# ABSTRACT

## AUGMENTED REALITY LEARNING TOOL FOR STUDYING CHEMICAL COMPOUNDS

### Oui Wei Wei

With advancement of technology, Augmented Reality had come into picture to be implemented into educational purpose for assisting students in their learning process. In this project, a learning tool for studying chemical compounds using AR had been developed to provide a more interactive and interesting learning environment for student. Besides, it also helps students in visualize abstract concept while learning thus improve their understanding on materials learned. This learning tool allows students to view the information of the chemical compounds including the 3D models base on their choice.

# ABSTRAK

## AUGMENTED REALITY LEARNING TOOL FOR STUDYING CHEMICAL COMPOUNDS

### Oui Wei Wei

Pada zaman sains dan teknologi yang canggih ini, "Augmented Reality" telah digunakan degan luasnya dalam pembelajaran demi membantu pelajar-pelajar memahami sesuatu dengan lebih mudah. Dalam projek ini, satu alat pembelajaran untuk mempelajari molekul-molekul telah dibina dengan menggunakan teknologi "Augmented Reality". Projek ini bertujuan untuk memberi satu medium pembelajaran yang berinteraksi dengan pelajar demi meningkatkan pemahaman dan minat pelajar terhadap subjek yang dipelajari. Tambahan lagi, alat pembelajaran ini juga membantu dalam memberikan satu gambaran yang jelas kepada pelajar kerana pelajar dapat melihat informasi-informasi atau struktur molekul-molekul dalam bentuk 3D.

# CHAPTER 1

## *INTRODUCTION*

## 1.0 Overview

This chapter will briefly introduce the project's background literature. In this chapter, problem statements, objective, significances of the study, values of the study, scope of the study and the structure of thesis are discussed.

## 1.1 Background of Literature

Throughout the past few decades, rapid developments in technology in computer processing power, graphic systems, power supplies, and miniaturization had been taking place at an increasingly rapid rate. These have give birth to a new technology called augmented reality (AR) which was derived from virtual reality. AR is a technology that enhances or augments the users' view of the real world with

addition information generated from a computer model. (Azuma, 2001). The concept of AR is to blend both the real object and virtual object in the real environment while the user maintains their sense of presence in the real world. (Vallino, 1997). Being partly virtual and real, this new technology offers many potential applications in various field including aiding in education, training, repair or maintenance, manufacturing, medical, military and etc. By displaying information that user cannot directly detect with their natural senses, AR helps user perform real world task as what Fred Brook call Intelligence Amplification where computer is used as a tool to make a task easier for human to perform. (Brooks, 1996 as cited in Azuma, 1997).

Education is one of the most important element in everyone's life because today's society demands for better and more educated citizens in order to maintain it's vitality and upgrade its quality of life. Education is all about learning which can be defined as the synthesis and integration of information received and experiences gained. Apart from that, we can conclude that learning is the goal of education or teaching. (Nelson, 1999).

Traditional ways of learning is through books, which is rigid and motionless. This hardly motivates students to study especially when the knowledge is huge and "bore". With the emergence of new technologies, it gives an impact on traditional learning development. The existing methods or ways for learning such as through books had experience a tremendous change. Demands for better learning methods (tool), for instance, visualization and interactivity, had made Augmented Reality come into picture. AR is an application where the virtual objects superimposed upon or composite in the real world and the users interact with this world in real time. (Azuma, 1997). The virtual object appears as they are part of the scene as the user and allow user navigation in the augmented environment.

AR provides students with a more interesting and interactive graphical environment which can help student in understanding and memorizing as well as

attracting students to study. (Dede, 1995 as cited in Chen, 2006). As mentioned by Hunt & Ellis (2004), "particular processes such as imagery; self-referent encoding and self-generation can enhance memorization". Furthermore, by creating visual image as well as convey spatial cues direct to the user, it enables students to effectively gain knowledge from the system. (Chen, 2006). It is also a trend to use technology to create a constructivist environment to enhance learning. (Dede, 1995 as cited in Chen, 2006). Besides, AR natural which can attract people's attention also constitutes an important factor in learning processes. (Gagne et al. 1992 as cited in Chen, 2006). Another feature of AR that enhances learning is that it enable users to interact with the augmented environment where student is allows to manipulate the model or information displayed which promotes interactive learning.

## 1.2    Problem Statement

Generally, chemistry is the study of atoms, molecules and the chemical reaction. In short, the interaction between different chemical elements. (Michael, 2008). By going through the chemical reaction, breaking and forming of atomic bonds, various compounds can change to new compound with different properties. The new chemical compound formed consists of more than one element, for instance water ($H_2O$) is a chemical compound which constitutes of 2 chemical elements. Molecular formulae are use to represent the constituent atoms and their abundance in a particular chemical compound. (Michael, 2008).

Nowadays, chemistry acts as a fundamental part of civilization where it involve in manufacturing of almost everything including the food that we take every day and being a chemical engineer is one of the highest paying scientific areas. (Michael, 2008).

Chemistry is one of the compulsory subjects for secondary school student who taking science stream in Malaysia. Traditionally, basic chemistry teaches by the

aid of physical model in ball and stick form to represent the structure of chemical compounds. These models are colorful and designed in different size and can be held by our hands. According to Heinich, Molenda, Rusell and Smaldino (1999), "models are the recommended media when realism is essential for learning". Therefore, physical model act as an intuitive representations of chemical compounds and allowing student to explore over several aspects such as bonding. Physical models had been use by educators of chemistry for decades to present the geometry and flexibility of chemical compounds.(Ganesh, Suzanne, Michel, Alexandre, Arthur, n.d). Unfortunately, the physical models available become rather cumbersome when applied to large chemical compounds. Besides, the physical models are not portable where it is difficult to bring those models everywhere when we need it. These models are also not flexible because one physical model can only be used to represent one chemical element or compounds whereas in chemistry there are numerous chemical elements and compounds. If we need all the models for learning purposes that means that we need a huge number of physical models and this is not applicable and economical.

Apart from what was being discussed above, the uses of physical model in learning chemical compounds are not appropriate in this way. Besides, it is also impossible for a student to buy a set of physical models for them to learn chemistry at home. Therefore, there is a need to develop an alternative method to aid students in learning chemistry and inspire students' interest in this field.

## 1.3    Objective

In this project, an AR base learning tool for assisting students when studying chemical compounds will be develops. This system will make use of several techniques such as image processing, mouse interaction and 3D modeling.

### 1.3.1    General Objective

The general objective of this project is to design and develop an AR learning tool for assisting students in learning chemical compounds.

### 1.3.2    Specific Objective

There are a few specifications that this project would like to achieve through this project.

- To design an AR learning tool for studying chemical compounds.
- Use concept of visualization in assisting students learning process.
- Implement real time mouse interaction in AR application.

## 1.4    Values of Study

With the advancement of virtual technologies, the development of Augmented Reality had dispersed into many fields of application. The AR base system has its own potential in education field especially in aiding learning processes of student because of it characteristic which allows user to visualize an object in 3D space. In order to help students understand concepts which are abstract and not visible in our daily life, educators often face the problem in visualizing the object to their student.

Therefore, visual representation or models are developed. (Chen, 2006). Visualization of an abstract concept is rather important in assisting students understanding in their learning process. (Barnett, Yamagata, Keating, Barab & Hay, 2005).

The development of this learning tool would serve as an ideal foundation in bringing in 3D technologies that could aid student in their learning progress. AR is an alternative way to resolve this problem, where it provides an interactive platform for visualization of virtual objects as well as interaction with the augmented scene. According to Shelton (2002), AR platform is a visualization technology that can take advantage of the limitations offered by other visual means of communication for learning. Thus, AR systems have great potential to be developed and applied in classroom learning. (Shelton, 2002). Therefore, it is hoped that this learning tool can help in aiding student when studying chemistry and enhance their understanding of the subject.

## 1.5    Scope of Project

The purpose of this project is to develop a system that can help or aid secondary school's students in studying chemical compounds and inspire their interest in the field of chemistry. By providing better visualization and interactive learning method, students may have more effective learning and come out with a better result. Therefore, this project will focus on implementing mouse interaction in augmented reality system and also visualization of 3D chemical compound model.

## 1.6    Significance of the Study

The significance of this study is to bring in AR system as a more interactive and as an effective learning tool to assist students in their learning process. AR is the

doorway to a more interactive and effective information visualization. Education is a potential area for AR system to develop. Therefore, it is an optimism that more and more research and development will be done and AR applications to be exposed to others.

## 1.7    Structure of Thesis

This thesis consists of 5 chapters, which is the introduction, literature review, research methodology, system design and development, discussion and conclusion of the study. In chapter 1, the background of study, problem statement, research objectives, project scope, values of the study, significance of the study and the structure of thesis will be included.

In chapter 2, some literature reviews related to the study are discussed. Previous works done by other researchers around the world are also included in this chapter. The research method used in this study will be included in chapter 3. The software and hardware used are included.

Chapter 4 will be discussing the system design which is system architecture and system flow. Besides that, the system development including the code and function implemented in the system is explained in this chapter. Finally, chapter 5 will focus on the discussion and conclusion of the study. Strengths and weaknesses of this study, contributions and recommendations for future researchers are also included in this chapter.

## 1.8    Summary

This chapter briefly introduces the overview of this project. Apart from that, background, problem statement, objective, value, scope, significance of the study is also included. The following chapter will discuss the literature review that is related to this project.

# CHAPTER 2

## *LITERATURE REVIEW*

### 2.0 Overview

In this chapter, a brief introduction for Augmented Reality and its application in various fields will be done. The discussion will begin with the definition of Augmented Reality, how it is derived and how it is different from Virtual Reality. After that, the discussion will continue with the real life application of AR in several fields. Finally, the discussion will concentrate on how AR has been applied in aiding learning, for instance in the Augmented Chemistry project.

### 2.1 Introduction to Chemistry

Chemistry is a fundamental element in our daily life and chemistry had become a compulsory subject for secondary school student in Malaysia. Chemistry is

study of atoms, molecules and chemical reaction, the interaction between different chemical elements. (Michael (a), 2008). By going through the chemical reaction, breaking and forming of atomic bonds, various compounds can change to new compound with different properties.

Basically, chemistry deal with different types of chemical compounds that have different properties. By applying knowledge of different chemical compounds we can manufacture almost everything including food. A chemical compounds is a type of molecule that made up of more than one atoms base on it molecular formula and it is held by different chemical bonds such as covalent bond and ionic bond. Different will give different properties to the chemical compounds. The study of chemical compounds will include all the bonding types and the molecular formulae of the chemical compounds. (Michael (b), 2008).

## 2.2    Introduction to Augmented Reality

The field of Augmented Reality (AR) has existed for just over a decade, but the growth and progress in this few years has been remarkable. What is AR? AR is a field of computer research which deals with the combination of real-world and computer-generated data. (Wikipedia, 2008). The aim of AR system is to enhance the user's perception of and interaction with the real world through implementing the real world with 3D virtual objects that appear to coexist in the same space as the real world. An AR system is basically defined as a system that can blends real and virtual object together in a real environment, can interact in real time and is registered in 3D. (Azuma, 1997). The ultimate goal of AR system is to create a system such that the user cannot tell the difference between the real world and the virtual element that are augmented onto it. In the end, the user of AR system should not feel any conflicts and discrepancies between the augmented environment and the rules that user normally

sense the real world. According to Vallino (1998), AR augment the real world with virtual elements while maintain the users' sense and feel of existing in a real world.

Researchers had been interested in developing AR because AR is merging of synthetic sensory information into a user's perception of a real environment. The virtual objects display information that the user cannot directly detect with his / her senses. (Azuma, 1997). The information displayed by the virtual objects help users perform tasks in real world, this is called Intelligence Amplification. (Brook,1996 as cited in Azuma, 1997). Being partly virtual and real, this new technology offers many potential applications in various filed including aiding in education, training, repair or maintenance, manufacturing, medical, military and etc. (Azuma, 1997).

However, there are still challenges in field of AR. Being partially real and virtual, there are some distracting features in AR systems such as the time lag between user's actions and the system's reaction, misplaced or disoriented virtual object due to the tracking error, registration error of model to the real environment and abnormalities in the object orientations. These situations tend to diminish the immersiveness or effectiveness of the system. Furthermore, the real time requirements of AR are strict and tough because it operates parallel with the real environment. (Vallino, 1998).

## 2.3    Differences between Augmented Reality and Virtual Reality

A computer generated environment which allows user interaction and manipulation is called virtual reality (VR). (Wikipedia - Virtual Reality, 2008). Virtual reality is defined as a computer-generated, interactive, three-dimensional environment in which a person is immersed. (Aukstakalnis & Blatner, 1992). The major components in VR are computer-generated, interactive, 3D environment and also immersion. One of the trademarks of virtual reality is the use of fully immersive head mounted display (HMD) device. Virtual environment (VE) is result from

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