INTERACTIVE LEARNING USING AUGMENTED REALITY

NURLIANA BINTI RAMLI

A report submitted in partial fulfillment
of the requirements for the award of the degree of
Bachelor of Computer Science (Graphic & Multimedia Technology)

Faculty of Computer Systems & Software Engineering
Universiti Malaysia Pahang

JUNE 2012

ABSTRACT

A learning interactive project is developed to provide a platform for user to interact more in the learning environment compared to conventional learning environment. This project purposes a conceptual model for exploring the prospect of a new form of Virtual Reality (VR) application called Augmented Reality (AR) technology in education domain. AR sets itself apart from VR by allowing integration of 3D virtual objects into real environment in real time thus allowing student to relate with their physical environment and also making learning more interesting. AR learning offers interaction such as screen touching, device flipping, device rotating, etc. to let users experience a new technology learning style. Overall project has less difference in term of materials of learning, changes will be made in term of performances and how represent the materials in AR such as adding multimedia elements and sound. This project will benefits teachers as well as students. It provides the teachers teaching aids and transforms the learning session to be more interactive, attractive and effective. It will assist students in building their creative thinking, improving their comprehension, and changing the paradigm of learning.

Keywords: Augmented Reality, multimedia elements

ABSTRAK

Satu projek pembelajaran yang interaktif telah dibangunkan untuk menyediakan satu platform untuk membolehkan pengguna lebih berinteraksi dalam persekitaran pembelajaran berbanding dengan suasana pembelajaran secara konvensional. Projek ini mencadangkan satu model konsep untuk meneroka prospek baru aplikasi Realiti Maya yang dipanggil teknologi Realiti Terimbunh dalam bidang pendidikan. Realiti Terimbuh adalah sebahagian daripada Realiti Maya yang membenarkan integrasi objek 3D maya ke dalam persekitaran sebenar yang membolehkan pelajar mengaitkan pembelajaran dengan persekitaran fizikal mereka dan membuatkan suasana pembelajaran lebih menarik. Pembelajaran dengan menggunakan Realiti Terimbuh menawarkan interaksi seperti sentuhan skrin dan sebagainya yang membolehkan pengguna merasai gaya pembelajaran teknologi baru. Secara keseluruhan, projek ini tidak kurang bezanya dari segi bahan pembelajaran tetapi perubahan dibuat dari segi cara penyampaian bahan pelajaran dalam Realiti Terimbuh seperti menambahkan elemen multimedia dan bunyi. Projek ini akan memberikan manfaat kepada guru serta pelajar di mana ianya menyediakan para guru bahan bantuan mengajar dan mengubah sesi pembelajaran menjadi lebih interaktif, menarik dan berkesan. Ia akan membantu pelajar dalam membina pemikiran secara kreatif dan meningkatkan kefahaman mereka serta mengubah paradigma pembelajaran

Kata kunci: Realiti Terimbuh, elemen multimedia

TABLE OF CONTENTS

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Introduction

A learning interactive project is developed to provide a platform for user to interact more in the learning environment compared to conventional learning environment. This project purposes a conceptual prototypical for exploring the viewpoint of a new form of Virtual Reality (VR) application called Augmented Reality (AR) technology in education field. AR sets itself separately from VR by allowing mixing of 3D virtual objects into real environment in real time thus allowing student to communicate with their physical environment and also making learning more interesting. AR learning offers interaction such as screen touching, device flipping, device rotating, etc. to let users involved in a new technology learning style. Overall project has less difference in term of materials of learning, changes will be made in term of performances and how represent the materials in Augmented Reality such as adding multimedia elements and sound. This project will benefits teachers as well as students. It provides the teachers teaching supports and changes the learning session to be more interactive, attractive and effective. It will assist students in building their imaginative thinking, improving their understanding, and changing the model of learning.

1.2 Problem Statement

An interactive learning allows the user to participate in the learning environment. However, due to the enhancement of learning environment, the conventional way of learning does not satisfy the students and the learning activity started to experience bored. It is because the interaction between the learning tools and students is limited to static stuffs such as text. It seems hard for students to visualize and they will easily fail to focus.

Augmented Reality is a term for a live direct or an indirect view of a physical, real-world environment. Learning using Augmented Reality enhanced the view and experience of learning. The learning interactive application using Augmented Reality concept will add in multimedia elements such as pictures, graphics, sounds, animations, etc. It is used to enrich the learning environment and to let the students fully involved in the learning activity. Students can move around and see the virtual object or animation from different views as the Augmented Reality system performs alignment of the real and virtual cameras automatically.

1.3 Objective

The objectives of this project are:

i. to create an interactive learning environment using augmented reality
ii. to introduce augmented reality as one of learning medium in the kindergarten
iii. to improve the way of learning style in the kindergarten

1.4 Scope

The scopes of this project are:

i. Teacher
   - Implement a new way to teach in kindergarten

ii. Kindergarten

- Implement augmented reality in kindergarten environment.

iii. Content Application

- The application is an augmented reality application.
- Interactive augmented reality application.
- User can interact with the application.

1.5 Thesis Organization

This thesis will consist of six (6) chapters. The first chapter which is chapter 1 will explain briefly about the overview of the entire project including the objective of the project, scope and problem statement.

Literature review in Chapter 2 will explain about the manual or the conventional process of learning and learning materials in the kindergarten and background of the project. Other than that, this chapter also will be discussed about the comparison with the similar existing application.

Chapter 3 is methodology that will discuss about software process or flow process for the application. These chapters will also explaining the detail about the method to develop this augmented reality content application which is using the Software Development Life Cycle (SDLC) method. This chapter also discussed the detail about the software and hardware specification that are being used for development of this project.

After the methodology explanations, next chapter which is chapter 4, will discuss more about the output of the application, all the constraints of completing the project, result and recommendation for further research of the system.

Chapter 5 will describe about the result of the application that have been develop. The advantages and disadvantages of this application also will be discussed. It will conclude all this augmented reality content application from the beginning of the development until the accomplishment of the project. The conclusion will explain overall of this augmented reality application.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

It has been about forty years since teachers and computer scientist began using computer for instructional purposes. Incredible advances had been made in computer technology and its availability in that time span. Explosive growth of computer technology used for learning in schools, universities, business, industries and the professions in last ten years. Thus, the number of educational software has growth dramatically. Unfortunately the availability of bad courseware has also increased partially because the delivery of courseware has become so much easier mostly through the web. This is true of Web-delivered contents which usually not very interactive, lack quality control, and can be confusing to use. Software that supports truly active learning is still the exception. Also more than ever before there is a great deliberation about how computers should be used to ease learning and instruction. However this field has progress extraordinarily. According to Alessi & Trollip [26], the multimedia and multisensory abilities of today's computers are so advanced that skilled designers have the hardware needed for creating and implementing better software. It is no longer necessary to convince people that computers can be advantageous for learning. Schools and business are all growing their equipment and software purchases and keen to get and use more effective software.

This chapter is about the concept idea and theory of AR technologies. There are many advantages that can be used with this AR technology in education field. A learning interactive project is developed to provide a platform for user to interact more in the learning environment compared to conventional learning environment. Billinghurst [3] said that education sector gains benefits from AR where it helps to create new exciting method of delivering teaching materials.

2.2 Overview of Conventional System

Kindergarten, system of preschool education is to be responsible for an educational less formal than that of the elementary school but one in which kid's creative play instincts would be structured practically. Through use of songs, stories, games, simple manual materials and group activities for which delivering of a kindergarten are adapted, kids improve habits of cooperation and application, and the change from home to school supposed to be made less difficult.

There are hundreds of researched studies have been conducted to prove that using computers to teach is better than using books, teachers, films, or other more traditional methods [24]. Overall reviews of these studies claim a small effect in favour of computer-based instruction [14].

2.3 Existing System

There are some examples that using AR in classroom for learning process. However, there are so many studies conducted to prove that AR useful to implement in classroom and can help to develop the learning process.

For example AR technology is now suitable to implement in storytelling. The MagicBook application developed by Billinghurst [4] replaced the traditional method of book. It seems the imaginary since students can see the 3D animation computer-generated model appearing on the current pages using the

AR display. They can see the pop-up avatar characters from any viewpoint. It liked students participate in the situation both real and virtual knows as mixed reality.

AR also can be found to be applied in the geometry teaching, spatial relationships between planets and molecule arrangements [11]. These research tried to consume the benefit of AR to help visualize the abstract theory in more natural way which is believe could lead to an development in student's understanding. In addition, interactivity is added to support the learning method, thus making learning more entertaining and exciting.

2.4 Overview of Interactive Learning Using Augmented Reality

Developing effective system in any medium that facilitate learning need an understanding and appreciation of the principle underlying how people learn. This project is developed to implement a new way of learning instead of the traditional methods. The traditional method have been change with the new material or tools to increase the efficiency teaching method [8] and AR can offer new experience to the kids. According to Billinghurst [3], AR technology is suitable to applied to the educational area where this technology a valuable and interactive tool in academic process. He said that the educational in AR is the ability to support smooth change between two environment which is reality and virtually. It will nurture creative thinking among the kids and enhance their learning by using AR in education. It also provides exciting tools for the kids to learn and explore new things in more interesting way.

Many researchers [1, 2, 3, 6, 9, 11, 12] supported that have many advantages in implement AR technologies in academic especially to increase and empower the tool for education and make learning more attractive and enjoyable for students learning environment [5, 16]. According to Kaufmann [10] and Martin [16s], the technologies cannot guarantee academic achievement but it provides to students the alternative ways to ease understand the topic using innovative tool technology.

According to Alessi & Trollip [26], the discussion of the major methodologies of interactive multimedia and the design of multimedia programs are primarily guided by some issue central to cognitive psychology. The domain of cognitive theory that most important to multimedia design are those involved in perception and attention, encoding of information, memory, comprehension, active learning, motivation, locus of control, mental models, metacognition, transfer of learning, and an individual differences [8]. Those categories reflect most of what is significant when designing and evaluating multimedia. This will be discussed in the next chapter "Methodology".

2.4.1 Interactive Learning

Learning is often observed as information transfer from one person head (teacher) into another's (learner). Kids are thought to obtain information from their teacher and add it to their own memory.

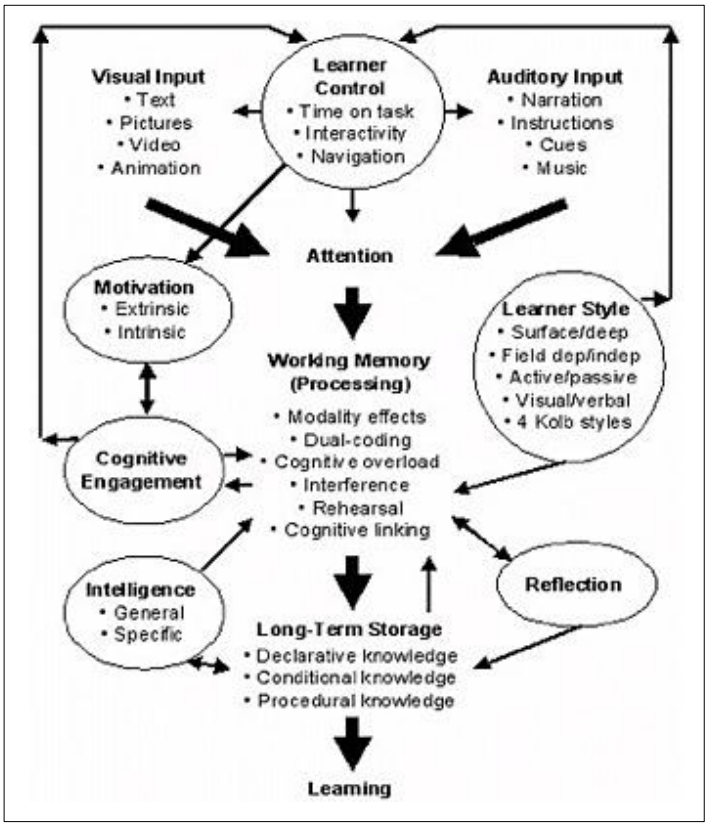

Figure 2.1 Hede and Hede's [7] model of multimedia effects on learning

Figure 2.2 Learning as information transfer

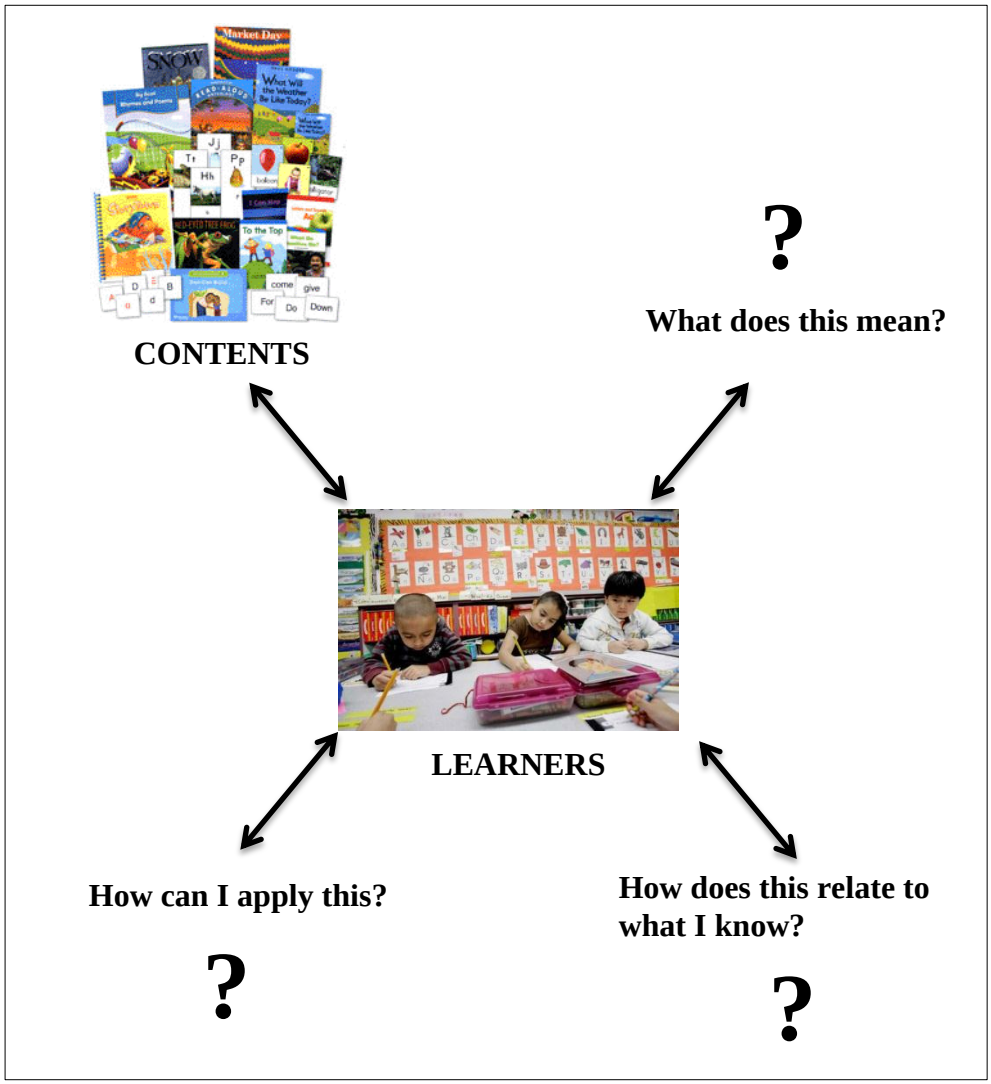

Figure 2.3 Learning as a complex integrative process transfer

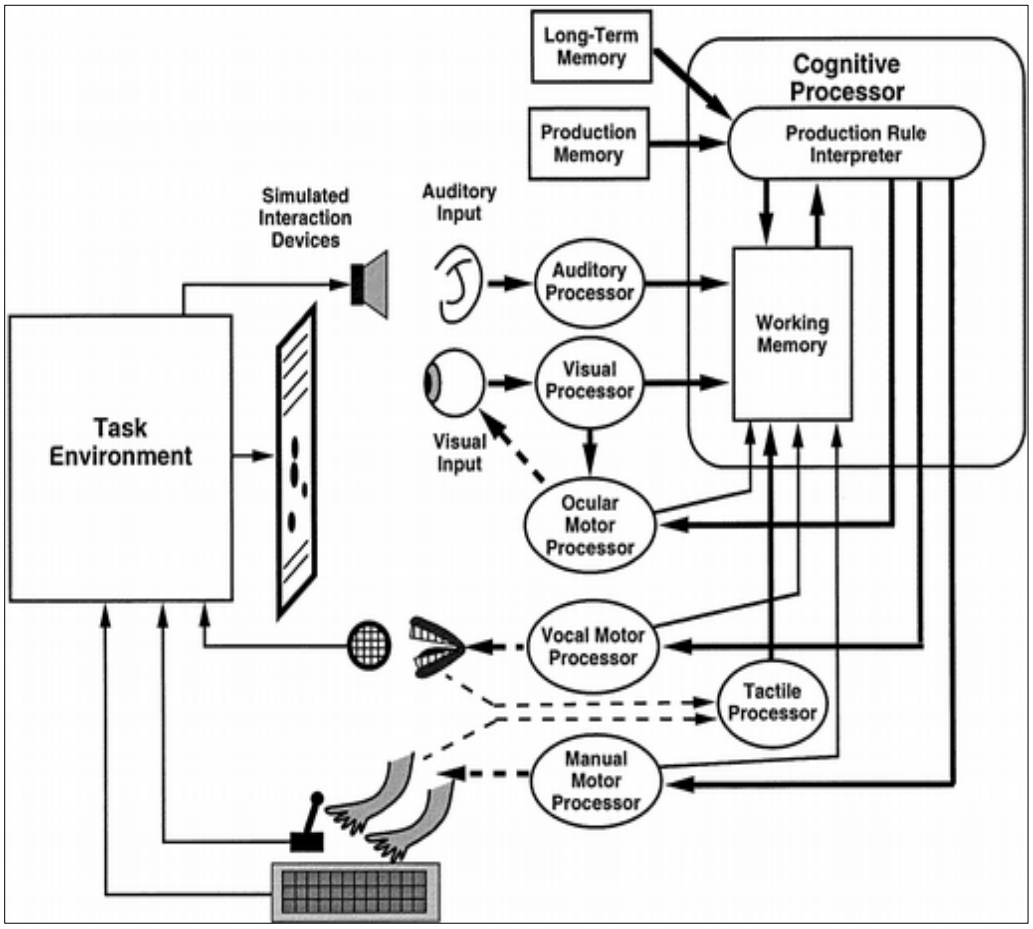

Figure 2.4 A unified extended cognitive model containing both human and machine processing systems. [13]

It is requires a carefully combining media in well-reasoned way in order to take advantages of each medium's unique characteristic in effective multimedia for learning. The most effective multimedia provides learning experiences that reflected real-world experiences and let learners apply the materials in various contexts.

Meyer [18] explains how we can process information through two basic channels which are verbal and visual channel. Researchers have found that multimedia helps people learn more easily because it appeals more readily to various learning preferences. Multiple media can be used to take the benefit of the fact that our brains access information in nonlinear ways.

Human factor researcher Lawrence Najjar [22] looked at current research on how multimedia affects learning and found that these practices could be useful for learning effectiveness:

i. Select media with the best characteristics for communicating the particular type of information for example, graphics help people retain spatial information better then text
ii. Use multimedia specifically to support, related to, or extend learning, not just as embellishment
iii. Present media element together so that they support each other
iv. Elaborative processing. Use multimedia that effectively employs verbal and visual processing channel to help learners integrate content with prior knowledge.
v. Allow learners to control, manipulate and explore positive impact learning and elaborative processing
vi. Use familiar metaphors and analogies, feedback and personalization to augment motivation
vii. Encourage learners to actively process and integrate rather than receive passively
viii. Match assessment media to presentation of information media

Research by Mayer [18] is commonly cited to show preservation and transfer effect resulting from multimedia when the principle in below are followed.

Table 2.1 Principles that influence the effectiveness of multimedia [18]

PRINCIPLE	DESCRIPTION
Multimedia	Learning from text and graphics is better than from text alone
Spatial Contiguity	Learning from corresponding text and graphic is better when the corresponding text and graphic is near each other
Temporal Contiguity	Learning from corresponding text and graphic is better when the corresponding text and graphics are presented simultaneously rather

	than consecutively
Coherence	Learning is better when there is no superfluous text, graphics or sound
Modality	Learning is better with animation and narration than from animation and on-screen text
Redundancy	Learning is better with animation and narration than from animation, narration and on-screen text
Individual differences	The effects from this principles are stronger for low-knowledge and high-spatial learners than for high-knowledge and low-spatial learners

Well-designed multimedia helps learners build more precise and effective mental prototypes then they do from text alone. Shepard produced studies displaying potential benefits of well design-designed multimedia, including:

i. Alternative perspectives
ii. Active participation
iii. Accelerated learning
iv. Retention and application of knowledge
v. Problem solving and decision-making skills
vi. Higher-order thinking
vii. Autonomy and focus
viii. Control over pacing and sequencing of information
ix. Access to support information

Meyer [19] also describes potential advantages of multimedia. Given that humans possess visual and auditory information processing capabilities, multimedia, he clarifies, takes advantage of both capabilities at once. In addition, these two channels process information quite contrarily, so the combination of multiple media is useful in calling on the abilities of both systems.

2.4.2 Augmented Reality

Augmented Reality is a field of a computer science that involves combining three dimensional virtual worlds; the physical world and an interactive. The technology is still in early phase however, the potential of AR technologies will grow fast and it can be applied in so many fields not only in engineering [16], medical [25] and construction [27] but also in education [3]. Augmented Reality augments the real world with artificial information and adds electronic data from a cyberspace on the physical space.

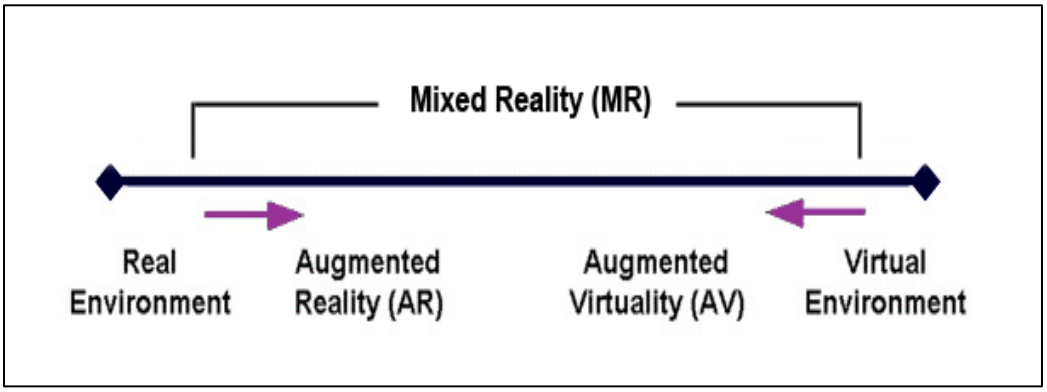

Figure 2.5 MFilgram‘s Reality-Virtuality Continuum [19]

Augmented Reality and Virtual Reality are significantly different from several aspects. The details of the differences are:

Table 2.2 Comparison between Augmented Reality and Virtual Reality [11, 21]

Differences	**Augmented Reality (AR)**	**Virtual Reality (VR)**
Environment	Combined both real and virtual objects coexist in the same space and in real-time at real environment	VR is requires totally immersive in the virtual world environment that a replaces the real world
User View	Allows user to see the real world around him and the virtual object	User see the virtual environment only
Need Space/Room	No	Yes
Health Issue	AR solved the "motion sickness" problem through superimposed virtual image in real environment through special marker where human brain can still process and accept such idea	Known as "motion sickness" where human brain unable to differentiate between virtual and reality and cause nausea and heavy headache.
Safety	Users feel comfortable and able to control the environment	User feel unsafe because their view blocked by the virtual environment
Sense of Immersion	None - Low	Medium - High

Based on the table above, it can be assumed that AR is more suitable to be implemented in education field because it does not distract the students from the real world. At the same time they can receive orders from teachers and they are able to make use of the technology. AR is suitable to be used as tool in teaching and learning since AR solved the "motion sickness" issue raised by VR.

According to Billinghurst [3], the reasons to implement AR in education domain includes its support of all-in-one interaction, use tangible interface metaphor and transitional interface. The all-in-one interaction means students can be seated in a group viewing the same display on the same space merging the virtual object and real environment at the same time. Meanwhile, tangible interface metaphor controls the virtual objects using the HMD or Interaction system could be using keyboard. Furthermore, the ability to transit well between the real and virtual environment allows the students to experience both world's activity concurrently. Several benefits to integrated AR technology in education are to improve the skill of teaching when teacher become a creative to handle the learning tools.

2.5 Development Tools

The tools that been used for development of this application are Adobe Flash CS4 with FLARToolkit and Papervision 3D. We used FLARManager to generate the marker and Blender is used to model the object.

2.5.1 Adobe Flash CS4

Adobe Flash is a multimedia platform used to add animation, video and interactivity to web pages and it is frequently used for advertisement, games and flash animation for broadcast. Recently it has been positions as a tool for "Rich Internet Applications" also known as RIAs. Flash provide animation of text, drawings, and still images by manipulating vector and raster graphics. It supports bidirectional streaming of audio and video. It also can capture user

input via mouse, keyboard, microphone and camera. Flash contains an object-oriented language called ActionScript. It also supports automation via JSFL, JavaScript Flash language.

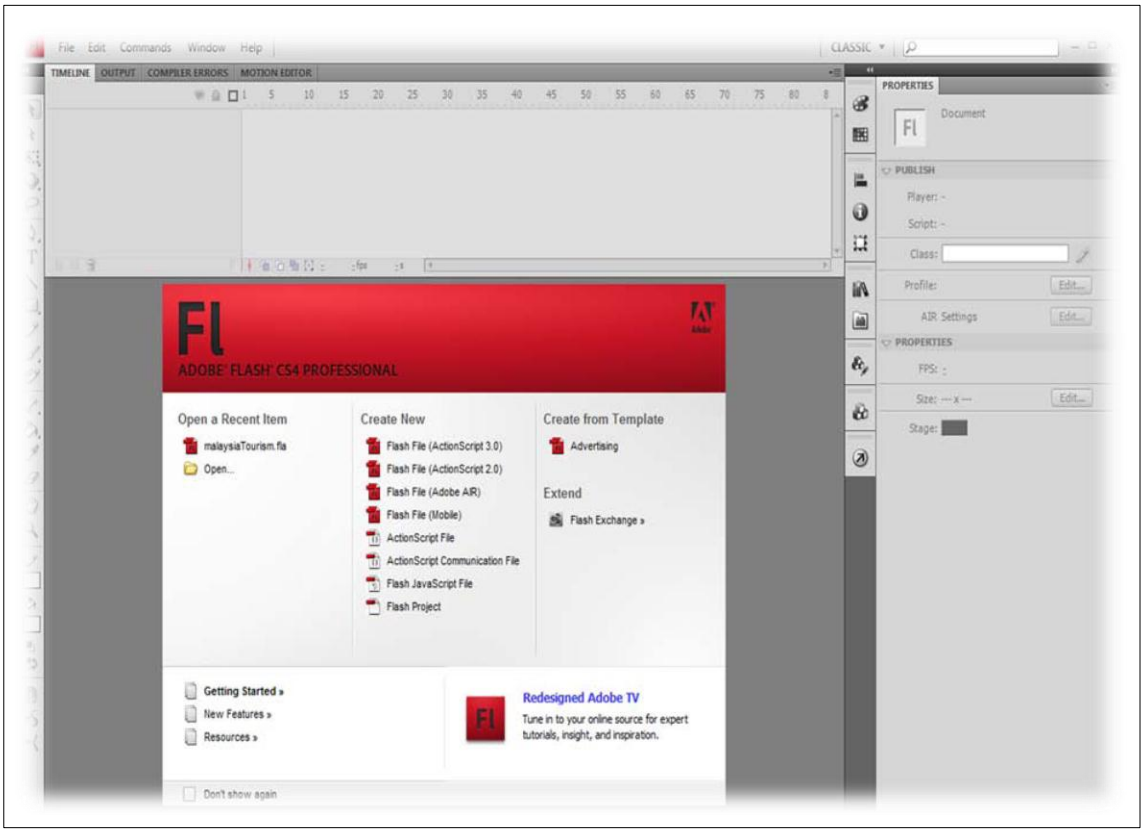

Figure 2.6 Adobe Flash CS4 screenshot

2.5.2 FLARToolkits

FLARToolKit is the Flash Actionscript 3.0 (AS3) version of ARToolKit which can be used to quickly develop web-based AR experiences and is the most widely used Flash-based AR library. FLARToolKit recognizes the marker from an input image and then calculates the camera orientation and position in 3D world and visualize the virtual graphics on the live video image. FLAToolKit has support for all of the major flash 3D graphics engines to render 3D objects such as Papervision3D, Away3D, Sandy, Alternativa3D because it does not render the 3D objects.

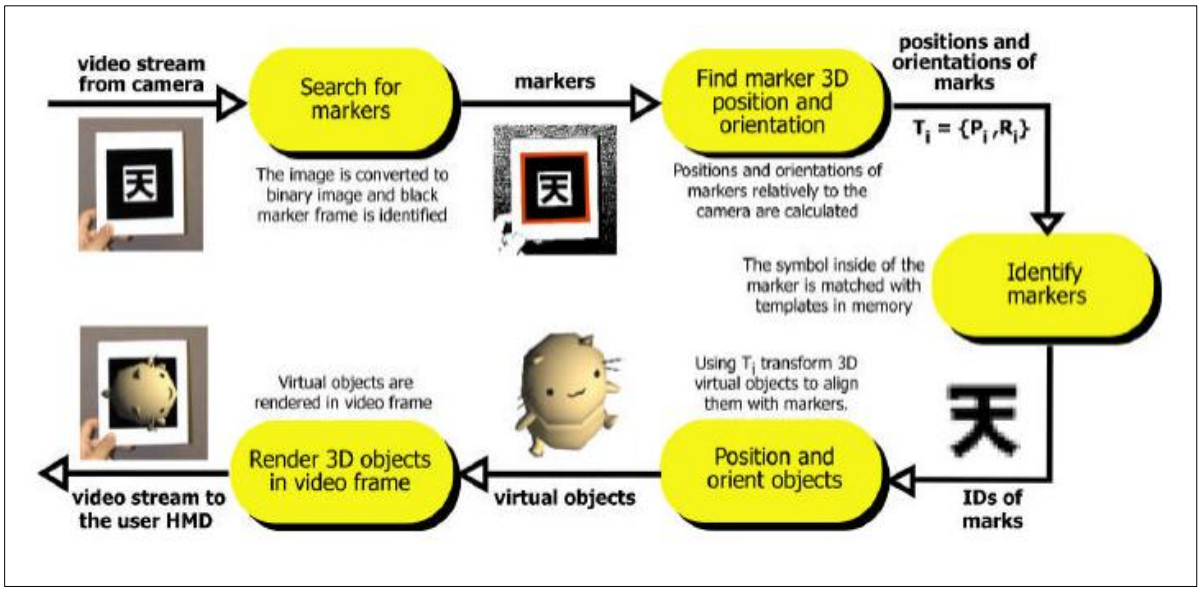

Figure 2.7 Example of image processing used in Augmented Reality

2.5.3 Papervision3D

Papervision is a 3D engine built with Actionscript that enables developers to start working in 3D. The Papervision team has found a way to create a simulated 3D environment using a ton of mathematics. Papervision involves a ton of Actionscript classfiles that developers can use to create objects, scenes, and even worlds in 3D space. 3D applications and engines generally build objects using smaller objects. Papervision uses triangles as the building blocks for larger objects in the scene. The more triangles that are used, the better the quality but more triangles mean that it is harder on the processor.

Papervision3D is an open source real-time 3D engine for the Flash platform. Being open-source, developers are able to see all the code that they are working with which allows for a better understanding of what they are using. This also means that the development community has to ability to build on what the original developers have done without having to go through the hardships involved in extending something that is not open-sourced. The features linear texture mapping, optimized for rendering speed and quality. Papervison has been designed to be simple and easy to use.

2.5.4 ActionScript 3.0

ActionScript 3.0 is a powerful, object-oriented programming language that signifies an important step in the evolution of the capabilities of the Flash Player runtime. The motivation driving ActionScript 3.0 is to create a language ideally suited for rapidly building rich Internet applications, which have become an essential part of the web experience.

ActionScript 3.0 providing superb performance and ease of development to facilitate highly complex applications, large datasets, and object-oriented, reusable code bases. With ActionScript 3.0, developers can achieve excellent productivity and performance with content and applications that target Flash Player. ActionScript 3.0 is based on ECMAScript, the international standardized programming language for scripting.

2.5.5 FLARManager

FLARManager is a lightweight framework that makes it easier to build augmented reality applications for Flash. It is compatible with a variety of tracking libraries and 3D frameworks, such as FLARToolKit. FLARManager provides a more robust event-based system for managing marker addition, update, and removal. It supports detection and management of multiple patterns and multiple markers of a certain pattern. The supported tracking libraries are include FLARToolkit, flare*tracker and flare*NFT while the supported 3D frameworks include Alternativa3D, Away3D, Away3DLite, Papervision3D and Sandy3D.

2.5.6 Marker based/ Image recognition

This application recognizes the marker or an image in the real world and calculates its position and orientation to augment the reality by using a camera. In simple words they overlay the marker/image with some content or information. One thing that should take care of is that a coordinate system is different from Papervision3D's. The global coordinate system of Papervision3D