INTERACTIVE GAME FOR CHILDREN WITH DOWN SYNDROME USING MARKERLESS AUGMENTED REALITY

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This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Interactive Media)

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2011

DECLARATION

I hereby declare that this project report entitled

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is written by me and is my own effort and that no part has been plagiarized without citations.

STUDENT : _____ Date : 04.07.2011

(OOI TZE YIN)

SUPERVISOR : _____ Date : 12/7/2011

(SYARIFFANOR BT HISHAM)

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ABSTRACT

At present, computer games for children with Down syndrome that available in the market are inefficient as they lack of interaction between the users and the game. The real time interaction offered by Augmented Reality makes it possible to create games for children with intellectual disability. This project is focus on implementing markerless Augmented Reality in order to develop a fruit recognition game application for children with Down syndrome. The architecture of the application consists of two engines: Augmented Reality engine and game engine. OpenCV is used to build the Augmented Reality engine which will be used for object detection; while Adobe Flash is used to build the game engine that defines rule of the game play. Prototyping methodology is used in developing the application. From the testing and evaluation, the result shows that only 1 out of 5 children are able to complete the game successfully. This paper will benefit to the children with Down syndrome and contribute to the upcoming research on markerless Augmented Reality application. As a conclusion, the application still needs some improvement in order to make it works for children with Down syndrome.

ABSTRAK

Pada masa sekarang, permainan komputer yang terdapat di pasaran untuk kanak-kanak Down sindrom adalah tidak berefisien kerana kekurangan interaksi antara pengguna dan permainan. Interaksi *real time* yang ditawarkan oleh *Augmented Reality* boleh digunakan untuk membuat permainan untuk kanak-kanak yang kecacatan intelektual. Projek ini tertumpu pada aplikasi *markerless Augmented Reality* dalam pembinaan permainan komputer untuk kanak-kanak Down sindrom. Rangka aplikasi terdiri daripada dua enjin iaitu enjin *Augmented Reality* dan enjin mesin permainan. OpenCV digunakan untuk membina enjin *Augmented Reality* yang akan digunakan untuk mengesan objek, sedangkan Adobe Flash digunakan untuk membina enjin permainan yang mendefinisikan peraturan cara bermain. Metodologi *prototyping* digunakan dalam membangunkan aplikasi tersebut. Daripada ujian dan penilaian, keputusan menunjukkan bahawa hanya 1 daripada 5 orang kanak-kanak yang dapat menghabiskan permainan system ini. Projek ini akan bermanfaat bagi kanak-kanak Down sindrom dan menyumbang dalam kajian akan datang yang mengaplikasikan markerless Augmented Reality. Secara kesimpulannya, aplikasi ini masih perlu diperbaiki supaya ia dapat berfungsi sepenuhnya untuk kanak-kanak Down sindrom.

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API	–	Application Programming Interface
AR	–	Augmented Reality
DS	–	Down syndrome
fps	–	frames per second
HCI	–	Human Computer Interaction
I/O	–	Input Output
KL	–	Kanade-Lucas
MAR	–	Markerless Augmented Reality
OpenCV	–	Open Source Computer Vision
SfM	–	Structure from Motion
SSD	–	sum-of-square-difference
TTS	–	Text-to-Speech Software

LIST OF ATTACHMENTS

CHAPTER I

INTRODUCTION

1.1 Project Background

The selected area of this project is an interactive game for children with Down syndrome (DS) using Markerless Augmented Reality (MAR) technology. "Augmented Reality (AR) combines real and virtual, is interactive in real time, and is registered in 3D" (Azuma, 1997). Therefore AR becomes a perfect platform to create the interactive game for children with DS, as it is foreseen that the 3D interactivity will be a huge hit among them.

Currently, there are a plenty game applications in the market. However, most of the games are designed without considering the special needs that children with DS require. In fact, there are games which are specially designed for children with DS, yet they lack Human-Computer Interaction (HCI) that could potentially increase the learning ability of children with DS.

Children with DS might be turned off with the current games offered as they are deemed boring and unattractive. Children with DS might feel left out, bored, or even frustrated when they are not fully engaged with the games. Hence, the aim of this project is to develop a game that utilizes MAR technology which allows the users to explore and

interact with the virtual world, in which it is believed to be able to spur learning interest among children with DS and eventually improving their learning abilities.

1.2 Problem Statement

Current computer games offerings for children with DS are inefficient as they lack interaction between the users and the game. As children with DS are known to have learning difficulties, this project aims to create a fun and appealing gaming experience by using markerless technique in AR that specifically caters to needs of children with DS.

1.3 Objective

The objectives of developing this project are:

- To study the use of computer games by children with DS.
- To explore markerless technique in developing an AR game.
- To develop an AR game for DS children with the use of markerless technique.

1.4 Scope

The targeted users of this project are children with DS age ranging in between 5 to 12.

The interactive game will consist of five different interfaces, which are: "Home", "Instruction", "Play", "Game Over" and "Help". Users are first led to the "Home"

interface every time they start the game. When click on play button, the system will lead the user to "Instruction" interface. The instruction will ask the user to complete the mission through a story telling method. In "Play" interface, the users are required to show the correct fruit that was mentioned by the computer in previous interface. The user will be lead to "Game Over" interface when they finish the game. The user can then choose to exit the system or play again. The game will have a user friendly design that comes with an easy "Help" function to provide guidance to the user who are lost or confused. As of now three fruit models are used as the interactive tool with the computer for this game, with more models will be added on as the game develops further.

The interactive game would be a standalone application that works on a computer workstation that comes in a DVD format. It requires webcam in order for the game to work.

Some limitations have been identified in developing this project. First, there is a concern on the accuracy of the object detection due to the algorithm and the condition of the environment. The other limitation would be on the computer device – mouse, that user use to interact with the computer system. Last of all, due to time constraint, only three fruit's object will be introduced in this game.

1.5 Project Significance

By the end of this project, an interactive game specially designs for children with DS will be developed through a comprehensive study on the computer games habit by children with DS. Additionally, the developer of this game will be able to leverage and gain more knowledge on MAR technology. Furthermore, this specially designed interactive game will be able to fulfill the special needs of the children with DS. The interaction involved in the game would reduce the learning barrier for children with DS as it creates an exciting learning environment that appeals to them.

1.6 Summary

This project focuses on developing an interactive game that utilizes MAR technology and exploring the opportunities it offers to children with DS. Study on the use of computer games by children with DS will be carried out at the same time as the exploration of the MAR technology. This is to ensure a successful development of the project.

At the end of this project, the developer is expected to gain the knowledge in MAR technology and able to develop an interactive game for the children with DS. Children with DS are also expected to benefit from this development as they are able to gain invaluable knowledge and apply it in real life that turns their disability into mobility. Literature review and project methodology will be discussed in the next chapter.

CHAPTER II

LITERATURE REVIEW & PROJECT METHODOLOGY

2.1 Introduction

According to Hart (2003), literature review can be defined as "the selection of available documents on the topic, which contain information, ideas, data and evidence written from a particular standpoint to fulfill certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed."

In this chapter, the domain of the project is identified. Next, a comparison of existing system will be carried out through studies on past researches, references, case studies and other findings that relates to this project. Finally, the selected project methodology and list of project requirement for developing the end product will be discussed.

2.2 Domain

Current computer games offerings for children with DS are inefficient as they lack of interaction between the users and the game. Thus, to develop a computer game

for children with DS that will be fully interact with the users, the domain of the project will be focus on interactive game that implement technology of AR.

In an AR system, user's view of the real time environment will be augmented with 3D graphics or objects. In order for the virtual graphics and real time environment to align properly, Genc et al. (2002) has mentioned that "the pose and optical properties of the real and virtual cameras must be the same. Estimating the pose of the virtual or real camera in which some augmentation takes place, is the most important part of an AR system." This estimation process of the pose in virtual and reality world is called "tracking". The tracking devices include mechanical, magnetic, ultrasound, inertial and vision-based trackers; while hybrid systems combine the advantages of two or more trackers.

"Availability of powerful processors and fast frame grabbers has made vision-based trackers a common choice amongst many other technologies mostly due to their accuracy as well as flexibility and ease of use" (Genc et al., 2002). Corresponding with this statement, vision-based tracker is chosen as the tracking devices in this project since it is effective in consistency, flexibility and usability.

Vision-based tracker that used in AR is applying image processing approaches to calculate the camera pose relative to real world objects. The technique of tracking using vision-based tracker can be classified into marker based AR and markerless AR.

2.2.1 Marker Based AR

Marker based AR uses a fiducial marker to determine the center, orientation and range of the real and virtual coordinate system. The fiducial marker has square border with high contrast patterns their centres. The colour of area inside the border must be highly contrasted with the border. It can be black and white or coloured. These high contrast features enable the system to track the marker easily. By holding the fiducial