COLLISION DETECTION HANDLING FOR COMPUTER GRAPHIC SIMULATION IN VIRTUAL ENVIRONMENT APPLICATION

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For my parents and family. Also, my dearies friends and lecturers.

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ABSTRACT

Collision detection in a virtual environment of computer graphic research has become an important research area in computer graphics due to the need to visualise virtual environment as realistic as possible. Virtual environment also known as an immersive environment consists of elements such as culling, lighting, shadows, collision detection and others that will determine the realism level of simulation. One of the key components that need further consideration is to equip the synthetic world with fast and efficient collision detection approach so that virtual simulation can be done realistically. In general, detecting the collision in a virtual environment for the object is an essential element in many three-dimensional (3D) application areas such as virtual reality, animation, simulation, game and robotics. Thus, collision detection has become one of the important elements that bring virtual world to imitate the realism of a real world. Hence, many issues involving collision detection have been investigated. The purpose of this research is to study the handling process and the traversal approach used in the hierarchical representation that can intensify and boost up performance of the collision detection scheme in virtual reality simulation. Handling collision detection in a virtual environment is a very technical issue because it need special techniques to handle it. The technique applied is related to the physical law, mathematic application, graphic designer and the computer programming language

ABSTRAK

Pengesanan perlanggaran dalam persekitaran maya computer pada penyelidikan grafik telah menjadi kawasan penyelidikan penting dalam grafik komputer disebabkan oleh keperluan untuk menggambarkan persekitaran maya sebagai realistik yang mungkin. Persekitaran maya juga dikenali sebagai persekitaran mendalam terdiri daripada elemen-elemen seperti memusnahkan haiwan ternakan , lampu, bayang-bayang, pengesanan perlanggaran dan lain-lain yang akan menentukan tahap realisme simulasi. Salah satu komponen utama yang perlu dipertimbangkan adalah untuk melengkapkan dunia sintetik dengan pendekatan pengesanan perlanggaran cepat dan cekap supaya simulasi maya boleh dilakukan secara realistik . Secara umum , mengesan perlanggaran dalam persekitaran maya untuk objek itu elemen penting dalam banyak tiga dimensi (3D) kawasan permohonan seperti realiti maya , animasi , simulasi , permainan dan robotik. Oleh itu, pengesanan perlanggaran telah menjadi salah satu elemen penting yang membawa dunia maya untuk meniru realisme dunia yang sebenar . Oleh itu, banyak isu-isu yang melibatkan pengesanan perlanggaran telah disiasat . Tujuan kajian ini adalah untuk mengkaji proses pengendalian dan pendekatan traversal yang digunakan dalam perwakilan hierarki yang boleh meningkatkan dan meningkatkan prestasi skim pengesanan perlanggaran dalam simulasi realiti maya. Pengendalian pengesanan perlanggaran dalam persekitaran maya adalah isu yang amat teknikal kerana ia memerlukan teknik khas untuk mengendalikannya. Teknik digunakan adalah berkaitan dengan hukum fizik , aplikasi matematik , rekaan grafik dan bahasa pengaturcaraan computer.

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ABBREVIATIONS

VR	Virtual Reality
CD	Collision Detection
VE	Virtual Environment
3D	Three-dimension
2D	Two-dimension
FPS	Frame per-second
Min	Minimum
Max	Maximum
EEPROM	Electrical Erasable Programmable Read Only Memory
RAM	Random Access Memory
CW	Clockwise
GB	Gigabyte (1,000,000,000 Byte)
PSM	Projek Sarjana Muda
CDD	Continuos Collision Detection
TOI	Time of Impact
CSCW	Computer Supported Collobrative Work
DVE	Distributed Virtual Environment

CHAPTER I

INTRODUCTION

1.1 Project Overview

Collision detection is a fundamental problem in computer animation, computer graphics, physically-based modelling, and robotics. For applications and simulations in these domains to be convincing, they need to not only render realistic images, but also precisely model object interactions in the simulated environments. The interactions may involve objects in the environment, pushing, striking or deforming other objects. Detecting collisions and determining contact points is of fundamental importance to portray these interactions accurately. Although the collision detection problem has been well-studied in the literature, building a general-purpose robust collision detection system remains an outstanding research challenge.

Computer graphic is the graphic that generate by using the computer. The computer graphic basically is interaction between the software and hardware. Both are the specialize combination. The development of computer graphic is really important because the technology nowadays develops very rapidly and it needs to move with the technology. Computer graphic is very important because more advance the graphic will make the technology nowadays look more sophisticated. Computer graphic technology is very widespread. Computer graphic can be found on television, hospitality equipment and military. Other than that, the computer is the base element of the computer animation.

Computer animation is the process used for generating animated images by using computer graphics. Modern computer animation usually uses three dimensions (3D) computer graphics, although two dimensions (2D) computer graphics are still used for stylistic, low bandwidth, and faster real time renderings. Computer animation is essentially a digital successor to the stop motion techniques used in traditional animation with 3D models and frame by frame animation of 2D illustrations. Computer generated animations are more controllable than other more physically based processes, such as constructing miniatures for effects shots or hiring extras for crowd scenes, and because it allows the creation of images that would not be feasible using any other technology [1]. It can also allow a single graphic artist to produce such content without the use of actors, expensive set pieces, or props.

1.2 Problem Statement

In this modern life, technology of computer graphic also become complicated and more sophisticated. When improving of the technology may cause the problem happened. For the collision detection in computer graphic typically refers to the computational problem of detecting the intersection of two or more objects. While the topic is most often associated with its use in video games and other physical simulations, it also has applications in robotics.

In addition to determining whether two objects have collided, collision detection systems may also calculate the time of impact (TOI), and report a contact manifold. Collision response deals with simulated what happens when a collision is detected. The collision occurs may relate to the physical phenomena like acceleration, inertia and project title. Solving collision detection problems requires extensive use of concepts from linear algebra and computational geometry

The obvious approaches to collision detection for multiple objects are very slow. Checking every object against every other object will work, but is too inefficient to be

used when the number of objects is at all large. Checking objects with complex geometry against each other in the obvious way, by checking each face against each other face, is itself quite slow. Thus, considerable research has been applied to speeding up the problem.

1.3 Objectives

The project aims to achieve the following objectives:

1. To study the hierarchical representation of collision detection handling in 3D virtual environment.
2. To handling the accuracy of the collision detection for computer graphic in a virtual environment
3. To develop a prototype of 3D viewer simulation.

1.4 Scope of The Project

This project is separate to the four levels of the hierarchy that are firstly this research are going deep in studying on collision detection fundamental geometric problem that arises in virtual reality. Virtual reality could recreate sensory experiences, including virtual taste, sight, smell, smell, sound, touch. Sometimes referred to as immersive multimedia, is a computer simulated environment that can simulate the physical presence in places in the real world or imagined worlds [2]. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic display, but some simulations include additional sensory information, such as sound through speakers or headphones. It focusing studies on computer graphic and animation in term of collision detection that referred as immersive multimedia. Then, the next scoop is about the collision detection that occur in the virtual environment for 2D and 3D. 2D Mostly applying on the polygon shape (circle, line, rectangle and convex polygon). Easy to implant on convex

shape, but for concave shape it needs critical mathematic calculation to perform that. 3D Basically, applying on the 3D shape (cube, sphere, and cube). In addition, Applying physic are really important, like acceleration, gravity and bounding effect. Implementing the collision detection in 2D and 3D virtual environment [17]. After that, the scope continues about the reaction after the collision occurred in virtual environments. This will prove that the collision have been occurring and what is the effect after the collision occur. After the collision occurs the important thing are what will happen after the object was called. The behaviour of the object need to configure to make it look like the real world. Applying physic and mathematic law are very important here. This project handles the collision detection by using C++ and Java programming language. Unity 3D and 3ds MAX are software used for creating the virtual environment for 3D virtual environment collision.

1.5 Thesis Organization

This thesis comprises five chapters: Introduction, Literature Review, Project Methodology, Result and Discussion, and Conclusion and Future Work. The introduction of the project has been given in this chapter where it specifically explains the background of the project for further understanding of the thesis.

Chapter 2, the Literature Review, reviews the theory on collision detection in a virtual environment. Every facts and information which found through journals or other references will be compared and the better methods have been chosen for the project. Beside that, this chapter also includes the concept and fundamental of the handling the collision detection from the collision occur until the response from the collision in virtual environments.

Chapter 3 is regarding the project methodology that consists of four phases which are pre-phase, phase one, phase two and phase three. The pre-phase are about start the literature review until the methodology construction. For the phase one, the collision detection start to be handled using OpenGL and the result was debugging and analysis for future research. The phase two is about the implementation collision

detection on the 2D and 3D virtual environment. It also verifies the occur of collision and the response from the collision. The last phase focusing on analysis in 2D and 3D virtual environment. Then, went for conclusion and report.

Chapters 4 covers all data and analysis results from the simulation prototype. The experiments included in this chapter put in forms of table, figure and discussions. Finally, the thesis ends with Chapter 5 which concludes the overall project followed by a number of recommendations for future work and research.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

This chapter covers about the literature review on topic start from collision detection of fundamental geometric problem that arises in virtual reality. Then cover the collision detection in 2D and 3D virtual environment. It also cover in response after the collision happened and handle the collision using C++ and JAVA programming language with 3D engine software.

2.2 Virtual Reality (VR)

Virtual reality also known as immersive multimedia, is a computer simulated environment that can simulate the physical presence in places in the real world or imagined worlds. Virtual reality could recreate sensory experiences, including virtual taste, sight, smell, sound, and touch. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some

advanced, haptic systems now include tactile information, generally known as force feedback in medical, gaming and military applications [18].

Furthermore, virtual reality covers remote communication environments which provide virtual presence of users with the concepts of Telepresence and telexistence or a virtual artefact either through the use of standard input devices such as a keyboard and mouse. The simulated environment can be similar to the real world in order to create a real life experience. Flight simulation is the one of the example environment that look like real life. In practice, it is currently very difficult to create a high fidelity virtual reality experience, because of technical limitations on processing power, image resolution, and communication bandwidth. However, the technology's proponents hope that such limitations will be overcome as processor, imaging, and data communication technologies become more powerful and cost effective over time.

Virtual reality is often used to describe a wide variety of applications commonly associated with impressive and highly visual 3D environments. The development of CAD software, graphics hardware acceleration, head mounted displays, data gloves, and miniaturization have helped popularize the motion. People often identify VR with head mounted displays and data suits. The possibility exists to have films and television programmes which are watched with a head mounted display and computer control of the image so that the viewer appears to be inside the scene with the action going all round. The computer presents the view which corresponds to the direction the viewer is facing, through a system of head tracking. This would give the viewers the feeling that they are actually going to the scene in person instead of looking at pictures on a screen [3].

2.3 The 2D virtual environment for computer graphic

2D computer graphics is the computer based generation of digital images mostly from 2D models (2D geometric models, text, and digital images) and by