OPTIMIZING COLOUR RESOLUSION IN 3D MODEL AND ANIMATION FOR FAST RENDERING TIME BETWEEN PC AND MACINTOSH

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Dedicated to my lovely mum Wan Khadijah Wan Ibrahim
and my wife Norzelawati Asmuin.

Declarations

I hereby declare that this project is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that is has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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(AZIZAN BIN ISMAIL)

Date : 23.10.2003

Approval Sheet

This report is submitted to the Faculty of Computer Science and Information Technology, Universiti Putra Malaysia and was accepted as fulfillment of the requirement for the degree of Master of Science.

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Abstracts

This project studied whether the optimizing of colour resolution for the non-photorealistic 3D model and animation can make the rendering process becomes faster than before. 130 frames of short and simple 3D animation were tested. Four types of colour resolution in three categories of screen resolution was applied to the 3D animation, and the result shows that the screen resolution give more impact to the rendering process time compare to the colour resolution. This project also present a comparative study between PC-based and Macintosh-based in the 3D model and animation rendering process. The same 3D animation was tested through the two different platforms which has quitesimilar in terms of performance and the result shows that Macintosh-based perform better that PC-based in all rendering processes.

MENGOPTIMAKAN WARNA DALAM MODEL 3D DAN ANIMASI UNTUK MENDAPATKAN MASA TERPANTAS DALAM PROSES RENDER MENGGUNAKAN PLATFORM KOMPUTER DAN MACINTOSH

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Abstrak

Projek ini ialah kajian bagi mengealpasti tahap optima resolusi warna untuk model 3D dan animasi yang tidak photorealistik. Ini bagi membolehkan proses render menjadi lebih cepat berbanding sebelumnya. Animasi 3D yang pendek iaitu sebanyak 130 frame telah diuji. 4 jenis resolusi warna yang terdapat dalam 3 kategori resolusi paparan telah di aplikasikan kepada animasi 3D tersebut. Keputusan yang diperolehi menunjukkkan resolusi paparan memberikan lebih impak terhadap masa proses render berbanding resolusi warna. Perbandingan antara 2 platform iaitu komputer peribadi dan Macintosh dalam proses render animasi 3D juga telah dilakukan di dalam projek ini. Animasi 3D yang sama telah diuji menerusi 2 platform tersebut di mana ke dua-duanya mempunyai keupayaan memproses yang hampir sama. Hasil kajian menunjukkan platform Macintosh memperlihatkan keupayaan yang lebih tinggi berbanding komputer peribadi dalam kesemua proses render.

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CHAPTER 1

INTRODUCTION

1.0 Introduction

Science fiction, cartoon and action movies today cannot avoid from using computer graphic especially 3 Dimensional (3D) models and animation as part of their features. When talk about 3D models and animation, terms like modeling, animation, rendering, wire frame, texture, photorealistic and non-photorealistic and color resolution need to be understand.

Definition for 2D is like square drawn by tracing vertices of a line as it moves perpendicularly to itself. In other words, a 2D graphic is a graphic that has height and width but no depth. Definition for 3D is like cube drawn by tracing paths of vertices of a square as it moves perpendicularly to itself. In other words, is a 3D graphic is a graphic that has or appears to have height, width and depths. Figure 1.0 show the different between 2D and 3D.

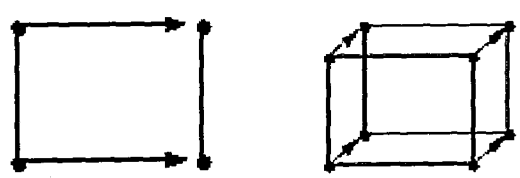

Figure 1.0 Illustrations of 2D square and 3D box

When take a look at 3D graphical image on our computer monitor, images made up of a variety of shapes, although most of them are made up of straight lines. There are squares, rectangles, parallelograms, circles and rhomboids, but most of all are triangles. However, in order to build images that look as though its have the smooth curves often found in nature, some of the shapes must be very small, and a complex image like a human body that might require thousands of these shapes to be put together into a structure called a wire frame. The wire frame has to be given a surface.

From the surface in the real world, there are information about it in two ways either look it in different angle or touch it whether it's soft or hard. Texture can explain the things whether it smooth, or does it have lines, bumps, craters or some other irregularity on their surface.

Rendering is the process of converting 3D geometric descriptions of graphical objects into 2D image plane representations that look real. Rendering can simulate the appearance of real-world textures, colors, surface shadows, highlights and reflections.

Non-photorealistic 3D models are objects being created by modeler using computer graphic. The models are not realistic such as cartoon, robot, human, and furniture, animal and so on. Photorealistic 3D models are also object being created by modeler using computer graphic but it is more realistic in terms of colour, texture and reflectance when compare to the real object. Photorealistic 3D models used millions of different colors for the pixels making up an image to get the realistic color. Variety in texture comes both from mathematical models for surfaces to stored "texture maps" that are applied to surfaces. The qualities that we can't see also very important to make the model look realistic such as soft, hard, warm, and cold, with particular combinations of color, texture and reflectance. If one of them is wrong, the illusion of reality is shattered.

1.1 Problem Statement

Previously, three ways of rendering techniques had been used in computer graphic. The rendering techniques were empirical simulation, ray tracing and radiosity. The main problem for all these three techniques were took long period of rendering time. This was due mainly because of colour resolution, graphics hardware and quality in terms of application and content to be executed by the machine (PC-based or Macintosh-based). Therefore a study needs to be done in each of the main factor. However this project will concentrates only on the usage of colour resolution and comparison between two different platforms in the rendering process of 3D animations.

1.2 Project objectives

Based on the problem statements, the objectives of this project are:

i. To identify the appropriate colour resolution for the 3D models and their animation for fast rendering time.

ii. To identify which platform are suitable to render the selected 3D models and their animation.

1.3 Scope of research

The scope of this project will focus on two major categories. The first category includes the optimization of colour resolution for the 3D non-photorealistic models to reduce the rendering process in terms of duration.

The second part of the project is the comparison of rendering process between two different platforms which is PC-based and Macintosh-based for the same 3D model and animation.

1.4 Significance of The Project

3D modeling and animation has a very tight relationship with colour resolution, computer platform and rendering time. The higher resolution for 3D model the higher image quality can be produce and the more time needed for the rendering process. Due to this, the project is to find an appropriate color resolution for 3D model and animation and to find out which platform is suitable for non-photorealistic rendering process.

1.5 Organization of the Thesis

In chapter two, the literature review will discuss about the previous work done in the rendering techniques, rendering techniques for non-photorealistic model and the current techniques which used by the Lightwave 3D as a standard 3D software in this project. In chapter three, the topic is the methodology that used in this project. It will discuss about the comparative study that was choose as the methodology in this project. It also explain briefly about the overview of the experiment; how the experiment done, how to collect the data and how to analysis the data and come out with the conclusion. In chapter four, the topic experiment, which is explain in detail about the experiment plan, design, and the procedures to make sure of the data validity. In chapter five, the topic is the result and analysis. This chapter will explain about the data collection, data analysis, result and interpretation of the data. Finally in chapter six, is the conclusion. The conclusion from this project is the finding for the best colour resolution and the best platform which produce the fastest time for rendering 3D model and animation.

CHAPTER 2

LITERATURE REVIEW

2.0 Previous Works

Traditional animation applies 2D images by creating the movements according to the right timing and follows some fundamental principles like squash and stretch, anticipation and follow through (Thomas 1981).When animator started using computer for their works, they gained advantages in modeling, animation and rendering of animation. Rendering is the process of converting three-dimensional geometric descriptions of graphical objects into two-dimensional image plane representations that look real. Many researches have been done in rendering techniques to stimulate the styles of artist. There are many rendering techniques that are now firmly established: counter rendering, empirical simulation, ray tracing, radiosity,

Contour line or image is one of the techniques of rendering that used traditional way or by computer rendering and ray tracing (Christ 1999). Contour lines are an important part of the styles of comics and cartoons. The animator makes counter line drawings for the animated character, counter drawings of the frame in between and finally color is painted in the spaces between the counter lines. When animator starts using the computer in modeling, animation and rendering animation, it is easily viewed the 3D model from all directions. For rendering, the painting of each frame is done automatically. In computer generated contour rendering, there are some practical issues. Some surface should not have contours between them but have been modeled between them. Therefore, it is necessary to specify pairs of surfaces that should not have contour between them. Contour also can be on top of each other in image space. Therefore contours need to be composite in the rendering process and need a good strategy to apply on it.

Empirical simulation of light-object interaction in conjunction with polygon mesh objects was the first and most common used by Gouraud (1971) and Phong (1975). In fact an object considered to exist in isolation with a light source. It is a common phenomenon when an object hit by the light source, the reflection and shadow exist. However this technique does not cater for the light interaction between the object and ignore originates of the light source. In other words, empirical simulation technique had limitation on the object light reflecting. To overcome the limitation of the empirical simulation; ray tracing and radiocity techniques have been introduce for the illumination model.

Ray tracing technique simulates global interaction by tracking thin beams or ray of light as they travel through a scene from object to object (Cook 1984). It deals with specular interaction and suitable for scenes consisting of shiny and mutually reflective objects. However, ray tracing cannot simulate diffuse interaction and very expensive than polygon mesh rendering.

On the other hand, radiosity technique particular on the light reflecting in all direction, from the surface of the object to another as a function of the geomatric relationship among surface. It deals with diffuse or dull surfaces and mostly used to simulate interiors of rooms (Alan 1996). However rediosity techniques cannot cope with specular interaction. Both techniques have their own limitation therefore effort for the research to incorporate specular interaction in the radiosity techniques.

2.1 Rendering Technique for Non-photorealistic Model and Animations

Non-photorealistic rendering (NPR) method has found a variety of techniques to simulate the styles of artist such as particle system, pen-and-ink illustration, cartoon shading, pencil sketching, stylistic rendering and silhouette edge detection.

New technique for non-photorealistic rendered have been proposed based on artistic effects using an interactively editable particle system by Matthew (1999). This technique maintained interframe coherence by geomatric graftal objects to represent graftal textures and have shown it can generalize many other artistic effects. The system rendered at fast rates of frame on the low end workstation but it depends on the complexity of the scene.

New real-time algorithm for cartoon shading, pencil sketching and silhouette edge detection and new technique for generating motion lines to emphasize motion in 3D cartoon rendering had been introduced by Adam (2000). However this new technique only required per-vertex positions, material properties, texture coordinates and connectivity information. For cartoon shading, this new algorithm can make 3D model drawn like 2D cartoon and viewed interactively. This technique relies on texture mapping and the mathematics of diffuse lighting.

Stylistic rendering is the combination of multi-pass rendering and image processing technique used by Adam (2000) thresholding of surface color via the value of *n-l*. He present standard rendering equations to achieved cartoon shading that was presented by Gooch (1999) which creates a warm-to-cool transition for technical illustrations. NPR for rendering freeform design in modeling system had been applied by Zele (1996) and Igar (1999). Animated models rendered in a cartoon style by Meta (1999) but Adam (2000) used in multiple styles and is integrated with multi-resolution mesh system that improves scalability.

Silhouette edges detection (SED) technique has been used in NPR and illustration for many years. Hidden line algorithm has been used to provide a real-time rendering SED implement by Mark (1997). Silhouette with polygons similar as background colored suitable for rendered models which used by Adam (2000).

2.2 Rendering techniques in Lightwave 3D

Lightwave 3D used many of rendering technique to give more feature to the user. Illustration is one of the techniques which particularly in the technical diagrams, benefit from a simplification of visual detail which emphasizes the salient part of the image. Gooch (1999) provides with an algorithm for rendering objects with shading in cool to warm tones with about the same luminance. The algorithm blends between cool and warm colors using the overlap of the lighting direction with the surface normal, (the cosine of the angle of the light with the normal). This shading parameter is available in LightWave 3D through the Light Incidence type Input Parameter in the surface texture Gradient Editor.

In LightWave 3D, edge lines can rendered automatically be on an object-by-object basis. Typically they should be turned on for Silhouette Edges, Unshared Edges, Sharp Creases, and Surface Borders. For Silhouette Edges, apply the medium line and small lines for all others.

Applying the Shrink Edges with distance option enhances depth cues, and can also be used to generally attenuate the line thickness. Lines should be drawn in the default black.

When deal with the metal parts, appearance of fine milling groves on the surface are important. Such an 'anisotropic' or directional surface is often represented in illustrations by a series of light and dark bands running parallel to the long (minimum curvature) axis of the object. This effect can again be achieved in LightWave 3D version 6 and above by using gradients. For a cylindrical shape, the axis of maximum curvature goes around the cylinder. It happens to correspond to the U coordinate in a cylindrical UV mapping projection.

There are several ways to render this appearance. The simplest would be to replace the shading with a striped gradient based on the light incidence. Unfortunately, this surface is not working well on the faces away from the light. In addition, basing the stripe positions on the incidence angle is not faithful to the algorithm, because the stripes are not continuous along the surface, but shift based on the angle of the surface. If the vertical component of the lighting direction were ignored, this would be more correct.

The author will use the Lightwave 3D version 7.0 as a standard 3D software for both platform; PB-based and Macintosh-based. The main reason why the author choose it as a standard software because only