# DESIGN AND PERFORMANCE EVALUATION OF WINDOWS AND LINUX PLATFORM APPLICABLE IN A VIRTUAL ARCHITECTURAL WALKTHROUGH



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# DESIGN AND PERFORMANCE EVALUATION OF WINDOWS AND LINUX PLATFORM APPLICABLE IN A VIRTUAL ARCHITECTURAL WALKTHROUGH

by

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## LIST OF ABBREVIATIONS

2D-Two Dimensional

3D-Three Dimensional

API-Application Programming Interface

ADDIE-Analyze, Design, Develop, Implement and Evaluate

BSD-Berkeley Software Distribution

CAD-Computer Aided Design

CPU-Central Processing Unit

FPS-Frame per Second

GL-Graphics Library

GLU-OpenGL Utility Library

GLUT-OpenGL Utility Toolkit

GLX-OpenGL Extension to the X Window System

GPU-Graphics Processing Unit

GUI-Graphical User Interface

HCI-Human Computer Interaction

HMD-Head Mounted Display

HTRF-Head Related Transfer Function

IDE-Integrated Development Environment

I/O-Input Output

KDE-K Desktop Environment

LCD-Liquid Crystal Display

LOD-Level of Detail

MS3D-Milkshape 3D

OS-Operating System

POSIX-Portable Operating System Interface

PVS-Potentially Visible Set

SGI-Silicon Graphic Inc

SP2-Service Pack 2

VE-Virtual Environment

VR-Virtual Reality

VRML-Virtual Reality Modeling Language

WGL-Wiggle OpenGL

WINE-Windows Emulator

**REKABENTUK DAN PENILAIAN PRESTASI PELANTAR WINDOWS DAN LINUX DI DALAM APLIKASI SENIBINA TELUSUR MAYA**

## ABSTRAK

Penyelidikan ini berkaitan rekabentuk aplikasi senibina telusur maya yang dibina dan digunakan dalam dua pelantar yang berbeza iaitu Windows dan Linux. Kedua-dua pelantar ini dibandingkan bagi mengukur dan menilai prestasi setiap pelantar bagi pembinaan aplikasi tersebut. Penentuan antara pelantar yang sesuai bagi aplikasi senibina telusur maya merupakan satu keputusan yang sukar untuk dibuat tanpa sebarang fakta dan data. Oleh itu, penyelidikan ini merupakan salah satu langkah bagi mengenalpasti kelebihan menggunakan pelantar Windows dan Linux di dalam aplikasi senibina telusur maya dan bagi mengenalpasti, mana di antara kedua-dua pelantar tersebut yang menunjukkan prestasi terbaik bagi aplikasi ini. Ini bagi memastikan pelantar yang digunakan bagi pembinaan aplikasi berkenaan dapat dibuat pada tahap prestasi yang maksimum. Penyelidikan ini juga penting bagi mengenalpasti pelantar yang menunjukkan prestasi yang lebih baik dari segi kemampuan, kelajuan dan juga memori yang mencukupi bagi menampung aplikasi senibina telusur maya. Bagi mencapai objektif yang ditetapkan dalam penyelidikan ini, beberapa eksperimen telah direkodkan secara terperinci berdasarkan beberapa kriteria yang ditetapkan bagi membuat perbandingan antara kedua-dua pelantar tersebut. Tahap prestasi setiap pelantar diukur berdasarkan empat kriteria utama iaitu kadar bingkai, kualiti imej, penggunaan CPU dan penggunaan memori. Secara keseluruhannya, keputusan menunjukkan kadar bingkai dan penggunaan CPU yang lebih baik di dalam Linux berbanding dengan Windows. Manakala penggunaan memori menunjukkan bacaan yang sebaliknya bagi Windows dan Linux. Penggunaan memori di dalam Linux adalah jauh lebih tinggi berbanding Windows. Bagi kualiti imej pula, Linux mempunyai kemampuan yang lebih baik dari segi mengekalkan kualiti imej berbanding pelantar Windows. Dengan pengunaan perkakasan yang sama, satu sistem pengendalian terserlah berbanding yang lain sebagai asas bagi aplikasi senibina telusur maya. Walaupun sistem pengendalian Linux tidak menguasai keseluruhan ujian dan eksperimen yang dijalankan, adalah sangat ketara keputusan secara menyeluruh lebih menyebelahi Linux berbanding Windows dari segi prestasi. Selain mempunyai prestasi yang cemerlang, Linux mempunyai kelebihan sebagai perisian sumber terbuka. Linux berkemampuan untuk mengurangkan perbelanjaan bagi proses pembangunan disamping mengurangkan kos infrastruktur yang dipercayai boleh memberi keuntungan yang besar kepada pemaju-pemaju VR memandangkan kos pembangunan bagi perisian proprietari adalah jauh lebih mahal berbanding perisian sumber terbuka.

# DESIGN AND PERFORMANCE EVALUATION OF WINDOWS AND LINUX PLATFORM APPLICABLE IN A VIRTUAL ARCHITECTURAL WALKTHROUGH

## ABSTRACT

*This research describes the design of a virtual architectural walkthrough application, developed and run on two different platforms; Windows and Linux operating system. Both platforms are then compared in order to measure and evaluate the performance of each platform used to build the virtual architectural walkthrough. The decision on which platform performs best is difficult to answer without actual facts and data. Therefore, this research is an attempt to quantify the relative merits of the Windows and Linux operating systems as an underlying platform for a virtual architectural walkthrough and to experimentally determine, which either of the two demonstrates superiority for this task. This is to make sure that the base in which the particular application is run at has sufficient help at its maximum performance. This research is also important to show which operating system has better capabilities, speed and ample of memory to sustain a virtual reality application. In pursuit of this goal, several experiments are detailed and recorded, in which key criteria are compared between the two operating systems. The performance of each platform is measured based on four main key criteria's which is frame rate, image quality, CPU usage and memory usage. From the overall experiment, results indicate that the frame rate and CPU usage is much better in Linux compared to Windows platform. Meanwhile the memory usage reading shows otherwise. As for the image quality, Linux has much better capabilities in maintaining its image quality compared to Windows platform. Using completely identical hardware, one operating system stood out from the other as a foundation for a virtual architectural walkthrough application. While Linux did not completely dominate every test, it should be obvious that the vast majority of the results strongly favor a virtual architectural walkthrough on Linux rather than Windows in terms of its performance. Besides having an excellent performance, Linux has the advantage of being open source. It has the capability of minimizing the budget of development and lower the cost of infrastructure which is good for all VR developers since the cost of development is far too expensive when it comes to proprietary software.*

# CHAPTER 1

# INTRODUCTION

## 1.1 Research Background

This research presents a design and performance evaluation of a virtual architectural walkthrough application build on two different platforms, Windows and Linux base operating system. It proposes some qualitative reflections and observations on the nature of Windows and Linux platform in the concept of virtual reality (VR) and on the most popular and important claims associated with the architectural walkthrough approach. The ultimate goal of this research is to measure, evaluate as well as to compare the performance of each platform used to build the virtual architectural walkthrough and develop a proof of concept based on the result obtain through this research. The performance of each platform is measured based on four main criteria which is frame rate, image quality, CPU usage as well as its memory usage.

Virtual reality is the simulation of a real or imagined environment that can be experienced visually in the three dimensions (3D) of width, height, and depth and that may additionally provide an interactive experience visually in full real-time motion with sound and possibly with tactile and other forms of feedback (Latoschik, 2006). Here real time means that the computer is able to detect a user's input and modify the virtual world instantaneously. The real-time aspect of such systems revealed to be very appreciated by the users as it enabled them to show, in much more details and realism, their designs to others (Burdea & Coiffet, 2003). Virtual reality can also be described from the simulation content point of view as unifying realistic (or veridical (Codella et al., 1993)) realities with artificial reality. This is a synthetic environment, for which

there is no real counterpart (or antecedent) (Krueger, 1991). The simplest form of virtual reality is a 3D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out (Latoschik, 2006). VR technologies address a wide range of interaction and immersion capabilities. Interaction varies learner control during the VR experience. Immersion varies from first person, second person, or third person experiences and in physical, perceptual, and psychological options. Often, the term virtual environment (VE) is used instead of just virtual reality to stress that there is no ambition to remodel the universe. VE are realistic representations of some physical basis at all (e.g. 3D databases). It may also be an abstract representation of some physical simulation (e.g. molecular structure) (Sourin, 2005).

VR environments have huge application in visualization industry, starting from simulation to games. One of the most obvious applications of VR was the so familiar architectural walkthrough in which this research is focused on. An architectural walkthrough is a computer-based, interactive system that can simulate the visual experience of moving through a 3D model of a building by displaying rendered images of the model as seen from a hypothetical observer viewpoint under interactive control by the user. It allows user to navigate a virtual architecture as if in the real world. 'Walkthroughs', as they are commonly called, are not only valuable for conveying information about a building, structure or large scale environment, they are also relatively easy for almost anyone to produce at a simplistic or amateur level. Typically in walkthrough animations, structural and environmental objects such as walls, columns, doorways, buildings, and trees remain stationary while the camera moves through the scene. Walkthrough and flythrough differ in technique. A walkthrough is used to show the actual point of view of a person walking through a scene and is

generally shot at or slightly below eye level. Flythrough are not as narrowly structured as walkthroughs and can be made from any point of view desired and at any speed and camera angle (Cory, Meador & Ross, 2001).

Another reason that 3D architectural walkthroughs have come into popular use in business and industry is that they are fairly inexpensive to produce, as well as an excellent way to 'pre-visualize' what a building or environment will 'look like' before it is built. The decision on which platform performs best in VR is difficult to answer without actual data and facts. Therefore this research is done in order to determine and evaluate the performance of Windows and Linux base operating system applicable in a virtual architectural walkthrough. The intended audience for this research is future VR developers and users seeking for an appropriate platform for the implementation of an architectural walkthrough based on the evaluation and result obtain through this research.

## 1.2 Problem Statement

As technology progresses more and more throughout the years, memory and hard disk requires much bigger space to enhance the performance of any software applications such as games or any other graphical related utilities. In saying so, the investigation of various operating systems in terms of its performance and user friendly interfaces rings the necessity. In this research, two different platforms which is Windows and Linux are examined in order to compare and evaluate its performance in terms of frame rate, image quality, CPU usage as well as memory usage. This research is an attempt to quantify the relative merits of the Windows and Linux operating systems as an underlying platform for a virtual architectural walkthrough and to

experimentally determine, which either of the two demonstrates superiority for this task. This is to make sure that the base in which the application is run at, has sufficient help at its maximum performance.

As Windows are the most used operating system in the world today, this does not mean it is the best platform to run any application. Though many applications are made to interface with it, manufacturers fail to determine the area in which this application might perform best such as how much load can the Windows sustain at one go. Linux in the other hand are mostly used as a networking or programming tool rather than a virtual reality platform or any GUI application, although there are a small amount of software utilities provided which is compatible only for Linux. Rarely have one seen application made by software manufacturer that is compatible with both operating systems. This is sometimes problem for both windows and Linux users if certain software is needed in the later operating system or vise versa. Henceforth is this investigation. This research is also important to show which operating system has better performance, speed and ample of memory to sustain a virtual reality application.

The question of which operating system to use for a virtual walkthrough application should not be viewed as a matter of personal preference or in terms of generalities such as “Linux is too hard to understand” or “Windows is slow”, etc. The point of this research is to examine whether there are quantifiable, compelling reasons for using one operating system over the other. It is also important to understand that this study focuses on only the capabilities of the operating systems for running a virtual walkthrough application. This is not a promotion or indictment of a particular operating system, rather an attempt to show which one is most suited for running a virtual walkthrough application.

## 1.3 Aims and Objectives

The objective of this research can be summarized as follows:-

- To design and develop a virtual architectural walkthrough application on Windows and Linux platform.
- To measure and evaluate as well as to compare the performance of each platform used to simulate and run the virtual architectural walkthrough in terms of frame rate, image quality, CPU usage and memory usage.

## 1.4 Scope of Research

The scope of this research involves designing and developing a virtual architectural walkthrough application in two different operating system, Windows and Linux platform. The scope also revolves in determining which operating system platform makes the right choice for a virtual architectural walkthrough. In order for one to distinguish itself from another, the performance of each platform are being measured based on the following key criteria:-

### a) Frame Rate

Frame rate test is certainly one of the main criteria need to be considered when evaluating the performance of a platform in a virtual architectural walkthrough. In order to maximize user performance and comfort, any VR system as well as the platform used to run the system must satisfy the real-time requirement, which means maintaining a constant frame rate that is above a certain threshold. The ability of accelerating the frame rate is certainly one of the most important criteria for evaluating the performance of a platform. Maintaining a constant frame rate is also very important. Especially when

the mean frame-time is high, fluctuations in frame-rate can influence the performance of VR tasks. High and constant frame rates are both important. VR users may feel sick, lose immersive feeling and lose hand-eye coordination during performing a VR task without satisfying either of these two requirements. Therefore, both fast frame-rate and constant frame time management should be considered for any VR system (Yuan & Green, 1997).

**b) Image Quality**

In virtual reality community, when talk about the image quality, it is always referred to 'realistic' as one of the main criteria. In a VR system, the user's perception of engagement and being in a 'real' world should be as natural as possible. It involves how accurate the geometric models and fine textures resemble real objects and how well it captures many of the effects of light interacting with objects (Yuan & Green, 1997). This research is mainly concern on how well does windows and Linux platform preserves image quality.

**c) CPU Usage**

A computer's CPU usage can vary depending on the types of tasks that are being performed by the processor. The percentage of CPU usage indicates how much of the processor's capacity is currently in use by the system. A high CPU usage rate may indicate a poorly tuned or designed application. When the CPU usage reaches 100%, shows that there is no more space capacity to use for running other programs. When the percentage of CPU usage begins to max out at 100%, additional action may need to be

taken. Abnormally high CPU usage by particular task can be an indication that there is something wrong with the computer system.

**d) Memory Usage**

Memory has such an important influence on system performance that monitoring and analyzing memory usage is one of the first step should be taken to measure and evaluate systems performance. The memory counter provides information about how the virtual architectural walkthrough application running on a system makes use of the system cache. Increased memory usage of certain task or process may cause a decrement in the systems performance. This is because increased memory usage not only increases the in-memory footprint of an application but also increases the time spent allocating and manipulating that memory.

## 1.5 Research Overview

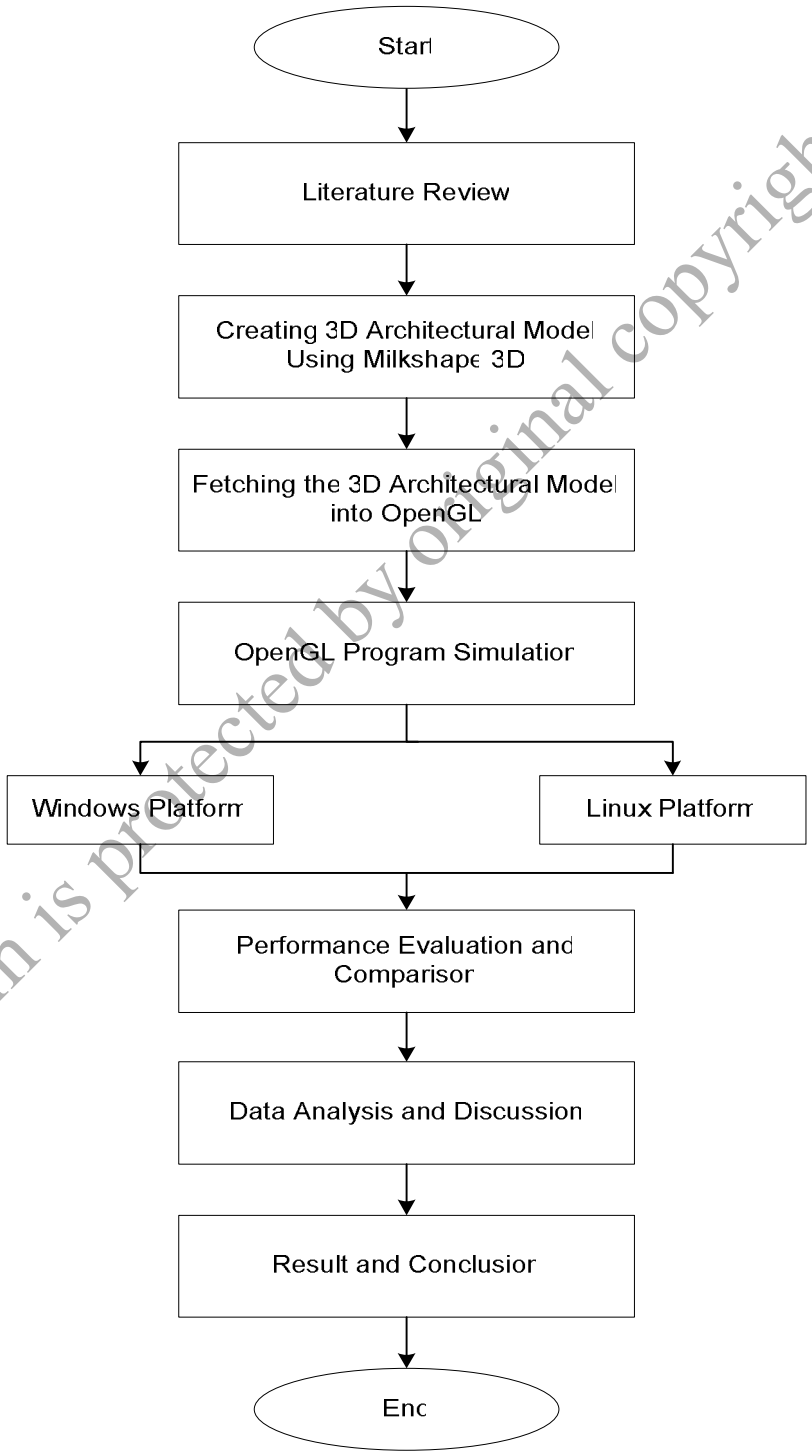


**Figure 1.1: Flow Chart of Research Overview**