AN INTERACTIVE INTERIOR DESIGN SYSTEM USING DESKTOP VIRTUAL REALITY TECHNOLOGY

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ABSTRACT

AN INTERACTIVE INTERIOR DESIGN SYSTEM USING DESKTOP VIRTUAL REALITY TECHNOLOGY

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In the design plan of a living room, a 3D simulation can provide a much better sense of what and how the living room would look like. This 3D simulation can provide better perception of the living room plan rather than simply sketches, drawings, or catalogues. Generally, the objective of this project is to design and develop a virtual interior design of a living room which allows the users to visualize and also change some of the attributes of the living room using the VR system to their own preferences. For this project, two virtual living rooms with two different sets of interior design were constructed. The virtual living room was constructed using VRML text editor as well as 3ds Max 7 software. Software such as Adobe Photoshop CS and Microsoft Visual Basic 6.0 has been chosen as the tools for designing and developing the interface of the virtual living room control panel. The system developed enables the user to change the color and texture of some of the furnishing attributes as well as being able to switch the lamps on or off. The system's usability is evaluated using the Cooperative Evaluation Technique that brings together designer and user in a cooperative context. With the VR system that is able to navigate, define and modify the living room virtually, this system can play an important role as a user interface system for virtual experience.

ABSTRAK

SISTEM HIASAN DALAMAN BERSIFAT INTERAKTIF MENGGUNAKAN TEKNOLOGI MEJA REALITI MAYA

Jenthi a/p Krishna Radha

Dalam merancang hiasan dalaman sebuah ruang tamu, simulasi tiga dimensi dapat memberikan gambaran yg lebih jelas tentang apakah dan bagaimanakah keadaan ruang tamu akan kelihatan. Simulasi tiga dimensi ini mampu memberikan persepsi hiasan dalaman yang lebih jelas berbanding lakaran, lukisan atau katalog. Secara amnya, kajian ini bermatlamat untuk mereka bentuk dan membangunkan sebuah sistem hiasan dalaman untuk ruang tamu bersifat maya yang membolehkan pengguna untuk melihat secara maya serta menggunakan sistem realiti maya tersebut untuk menukar beberapa sifat ruang tamu itu mengikut kehendak masing-masing. Bagi tujuan kajian ini, dua buah ruang tamu maya dengan dua set hiasan dalaman yang berbeza telah dibangunkan. Ruang tamu maya ini telah dibangunkan menggunakan teks editor VRML serta perisian 3ds Max 7. Perisian seperti Adobe Photoshop CS dan Microsoft Visual Basic 6.0 dipilih untuk mereka bentuk dan membina antaramuka bagi papan kawalan ruang tamu maya tersebut. Sistem yang telah dibina ini membenarkan pengguna untuk menukar warna dan tekstur beberapa perabot ruang tamu serta menyalakan atau mematikan lampu untuk ruang tamu. Kebolehgunaan sistem ini dinilai menggunakan teknik Penilaian Koperatif dengan membawa pereka bentuk dan pengguna bersama-sama untuk bekerjasama menilai sistem tersebut. Dengan adanya suatu sistem realiti maya yang boleh meneroka dan menukar ciri-ciri hiasan dalaman secara maya, ia boleh memainkan peranan penting sebagai sistem antaramuka untuk tujuan melihat dari sudut maya.

CHAPTER 1
INTRODUCTION

1.0 Introduction

Through advanced animation and film technologies, Roger Rabbit hopped into our world and today, with the aid of computer-related technologies, we can enter his sort of world. Virtual reality is neither intimidating nor the exclusive domain of arcade rats and techies (Larigani, 1993). Neither are its applications restricted to the purely technical or purely scientific. It is a creative interactive medium for everyone. It influences how we design things and run our businesses, or how we teach our children and treat illnesses as well as how we spend our leisure time.

1.1 Background of the Study

The changing needs and values of today's consumer have had a significant impact on the sales and manufacturing process. However, when then goods desired by many consumers are diversified, the manufacturer has a difficult time coping with the increased workload. Changing the production system alone cannot cope entirely with the situation. In fact, corresponding sales system, including marketing, distribution, and information services, must also be improved.

Nowadays, computer technology is advancing at a rapid rate. The development of a total production system incorporating CAD, CAM, and CAE is new possible (Fukuda et al, 1997). More according to Fukuda et al (1997), this technology permits movement from mass production to the production of a variety of goods in small quantities. At present, however, most computer-aided manufacturing is geared towards mass production and therefore are unable to handle one-of-a kind products. Thus, the specifications of these products should be easily changed to accommodate individual customer's needs. To execute this concept, virtual reality (VR) technology can be used.

VR technology has been applied for marketing and product presentation for quite some time now. VR system allows customers to look at a design and make changes at an early stage in the process. Presenting designs in VR is also entertaining, since the design can be embedded in a lively environment where it is rendered in real-time and interaction becomes a key element. For most product representation nowadays, we use the Internet like we did with brochures in the past, where everything is two-dimensional (2D), flat, and static.

As stated by Kalawsky (as cited in Chen, 2000), virtual reality systems can be divided into two types: immersive and non-immersive virtual reality. Immersive virtual reality system uses devices such as the Head Mounted Displays (HMD), spaceball, stereo glasses and so on. These devices can give the user better stereo feeling than non-immersive system. However, these systems are too expensive for normal people to afford. This weakness really limits the development of immersive virtual reality technology. On the other hand, non-immersive virtual reality system, sometimes known as desktop virtual reality uses the screen of PC or station to display, which make this kind of system cheap and easy to construct.

With the living room interior design as a showcase, this project had designed and developed a non-immersive, VRML based system that allows the users of this system to have a pseudo-experience of their virtual living room, to modify the object attributes such as color and texture and to make decisions by being provided with a good idea of their potential purchase.

1.2 Problem Statement

Taking a closer look at today's living room interior designs compared to the past leads to an important chic: the amount of variations has risen. Color, shapes, accessories and many other attributes must be adjusted in order to match the user's demands. The interior design representation methods have to be adjusted to these trends. The large amount of variants, which should actually serve as an advantage, can swing to other extreme: the potential buyer may not be able to perceive the variety and the complexity of the object (Dauner et al, 1998), to mentally construct the space allocation and to look for good ergonomic yet aesthetic design.

The interior design of a living room is best viewed in three-dimensional (3D) compared to conventional methods which are normally viewed in two-dimensional (2D). Conventional methods such as the use of paper sketches and drawings demands a cognitive load to both the designer and the potential users because it requires them to mentally construct the 3D shape from the 2D sections. Using an interactive virtual reality system, it allows the user to wander through the living room before it was even built so that the user can visualize the final result from various viewpoints.

Other than that, if the user wants to make any adjustment, then the designer has to revamp the design. The virtual living room can cut down the time consumed to redesign the attributes of the living room because potential users can interactively change some of the attributes in real-time by simply clicking on the mouse. This experimental method can avoid users from making mistakes when choosing suitable furnishing attributes for their living room that could cost them dearly.

1.3 Project Objectives

Generally, the objective of this project is to design and develop a virtual interior design of a living room which allows the users to visualize and change the attributes of the living room using the VR system. Specifically, this project aims to:

- Support an interactive walkthrough VR system which allows user to interactively modify some of the attributes in the virtual living room.
- Study the basic concepts of a living room interior design, such as the stages involved in planning, designing, and furnishing of the living room.
- Recommend a desktop VR system that supports the interactive interior design system.
- Design and develop a system which allows user to view, walk through, define, and interact with the interior design of a living room using a collection of tools such as VRML 2.0 and Microsoft Visual Basic 6.0.
- Evaluate the system's usability using the Cooperative Evaluation technique.

1.4 Definition of Terms

To allow better understanding of this study, some terms need to be clarified as described in the section below. The terms are defined conceptually and operationally. Conceptual definition refers to the general definition of the term whereas the operational definition refers to the definition of term in the context of this study.

1.4.1 Interactive

Conceptual Definition

Computing that allows information to be passed continuously and in both directions between a computer and the person who uses it as a medium of communication (Hornby, 2000).

Operational Definition

In this study, interactive refers to the interaction that the user can experience when using the interactive interior design system in which the user is able to navigate in the virtual living room, change the colors and textures as well as switching on or off the lamp lights in the virtual living room by simply clicking on a few buttons.

1.4.2 Control Panel

Conceptual Definition

Typically it consists of a collection of controls and displays in an assembly that shows the user the state of some object or object of interest, and allows parameters to be altered interactively (Preece et al, 1994).

Operational Definition

In this study, control panel refers to an interface of the interactive interior design control panel, which consists of a collection of controls and displays.

1.4.3 Interface

Conceptual Definition

The way a computer program presents information to a user or receives information from a user, in particular the layout of the screen and the menus (Hornby, 2000).

Operational Definition

In this study, interface refers to the interactive interior design control panel, which consists of label, illustration, check boxes, on-screen buttons, VRML scene, and any other graphic elements that allows the user to interact with the computer.

1.4.4 Usability

Conceptual Definition

A measure of the ease with which a system can be learned or used, its safety, effectiveness and efficiency, and attitude of its users towards it (Preece et al, 1994).

Operational Definition

In this study, usability deals with how easy the user finds to use the interactive interior design system and how well the system fits the physical related characteristics, psychological and physiological capabilities of the user. The effectiveness refers to a specified level of user performance. Meanwhile, the efficiency refers to a specified level of subjective assessment.

1.5 Scope

The scope of this project was to develop a prototype system which demonstrates the construction of a virtual living room interior design using VRML and Visual Basic. Therefore, this project emphasized on the language functionality and does not attempt to build a comprehensive living room.

1.6 Significance of the Study

Fukuda et al (1997) mentioned that most computer-aided product presentation is geared towards large production, unable to handle one-of-a-kind products. Nevertheless, according to Dauner et al (1998), for product presentation nowadays we use the Internet mostly like what we did with brochures in the past where everything is flat and static. These two arguments show that there is a demand for virtual reality system that is capable of one-of-a-kind products.

When you are planning to design the attributes of your living room, a simulated tour can give you a much better sense of what and how you will

experience the environment, much better than simply sketches or drawings, or even the 2D, non-interactive pictures provided in catalogues or web pages.

The design process itself is already an intense process, so changing or modifying the attributes will be even more costly because it consumes more time and budget. As for the VR system, the design concepts of the perfect living room can be experimented and modified to the liking of the user.

Interactive VR System can also improve the design process. It allows the user to wander or walk through the living room even before it was built. This sanctions the user to get some feel of the space, and thus allowing the 3D visualization from various view point. It improves the design process in such a way that it can give more details about the interior design of the living room than pencil and paper drawings presentation used in conventional methods can.

The marketability of the final product of the living room interior design depends on the satisfaction of the customer. With the VR system, the customer's needs could be fulfilled because they are involved in the design process that can help them make the correct choice by modifying the living room to their own preferences. Therefore, it can give satisfaction to the customer before they proceed to develop the living room. Obviously, this is better than the conventional method of presenting the interior design because catalogues, brochures and web pages cannot provide more than just reading and imagining how the living room might look like.

1.7 Limitations

For this project, the users are only able to change/modify the colors of the floor, carpet, ceiling, walls, curtains, and furniture. The virtual living room interior design is a pre-design room, therefore the users are not able to add in their own furniture.

1.8 Summary

This chapter had discussed about the background of study, statement of problem, objective of this study, definition of terms, scope, significance and limitations of this study. The next chapter will review the prior research, which has been done by researchers in the past that will be used as references in this study.

CHAPTER 2
LITERATURE REVIEW

2.0 Introduction

This chapter will present an overview of the literatures related to this project. First of all, the chapter will touch on the definition and application of virtual reality. An introduction to VRML will be included as well as the advantages and disadvantages of using VRML to create the world. The Cooperative Evaluation technique will also be introduced in this chapter.

2.1 Definition of Virtual Reality

A combination of sophisticated, high-speed computer power with images, sound and other effects, virtual reality (VR) has been defined alternately as

- a computer-synthesizes, three-dimensional (3D) environment in which plurality of human participants, appropriately interfaced, may engage and manipulate simulated physical elements in the environment and, in some forms, may engage and interact with representations of other humans, past, present or fictional, or with invented creatures (Nugent, 1991).

or

- an interactive computer system so fast and intuitive that *the computer disappears from the mind of the user*, leaving the computer-generated environment as the reality (Goldfarb, 1991).

2.2 Evolution of Virtual Reality

As early as in 1965, Sutherland spoke fondly of tantalizing virtual worlds and in 1966, conducted preliminary 3D display experiments at M.I.T. Three years later, Sutherland demonstrated the first system developed to surround people in 3D displays of information (Sutherland, 1968).

The VR paradigm and technology were then all but lost, bouncing around the United States, with few takers other than the military. There, in the military, millions were spent on developing virtual reality displays as flight simulators, and for decades, the applications of virtual reality to real problems were monopolized (Larigani, 1993). Until the late 1980s, other countries showed little or no interest in the technology.

The situation has since changed as technologies advances made its debut which included great improvements in three areas that are particularly critical to independent virtual reality research:

- Cathode Ray Tube (CRT) and Liquid Crystal Display (LCD) display devices;
- Image-generation systems;
- Tracking systems

These three technologies converged and became available on relatively affordable systems, allowing researchers to finally transfer and apply the technology in areas other than military and in places other than the United States – notably in Japan, Germany and France (Larigani, 1993).

2.3 Reviews of Related Work on Virtual Designs

According to Chen (2000), VR applications in architecture mainly involve visualization of buildings and walk through of cities. These types of applications are merely representation of design, whereas the use of VR applications in interior design is used as an interactive planning tool that supports decision-making. VR applications in interior design are capable of interactivity such as changing the color and defining light source. Compared with the traditional two-dimensional (2D) plan that is often misinterpreted by the contractor, this 3D design can be better visualized and hence, will help eliminate the chance of errors or misunderstanding in the production of a new interior (Chen, 2000).

The prospect of VR in interior design had grown in these few couple of years. There had been quite a number of companies that have developed both immersive and non-immersive VR systems for this purpose. In 1990, ViVA (Virtual Reality for Vivid A & I space system) was developed by Matsushita Electric Works Ltd to allow customers to pseudo-experience their custom kitchen (Nomura et al, 1992). The user interacts with the virtual world through EyePhones and a DataGlove. Cabinets can be opened, dishes moved, and 3D spatial sounds can be heard. VIVA had been in practical use in Matsushita's Shinjuku Showroom in Tokyo from 1991 until 1994. The customers only need to bring their architectural plans to the Matsushita store, and a virtual copy of their home kitchen is programmed into the computer system. Customers can then get to see their complete kitchen by mixing and matching the appliances, cabinets, colors, or sizes. With this system, customers were able to choose from over 30,000 kitchen unit products (Fukuda et al, 1997).

In 1994, Fraunhofer IA0 and the British software company Division presented the Cooperative-Interactive Application Tool (CIA-Tool) (Bauer, 1993). The CIA-Tools consist of a VR based system for immersive placement and surface adjustment of interior design objects in offices. The user can navigate through the room by using the Head-Mounted Display (HMD). The interaction takes place through gestures controlled by a dataglove. With a certain gesture, a 3D menu pops up offering access to the furniture database or tools for

manipulating the objects. Both projects showed the potential of VR for dynamic room furnishing. But it turned out that the crucial part of these VR tools is the interaction.

At the IAA motorshow in Frankfurt, Germany, in 1997, Mercedes-Benz came up with the “Virtual Car” Simulator (as cited in Dauner et al, 1998). This is a high-end application where users hold a screen in their hands that displays the 3D model of Mercedes-Benz’ new A-class model and make selections for colors etc. In some sense, this application could serve as a model for post-VRML 2.0 applications, that if, Internet access was provided.

All the systems described above are intended mainly for the use of professional designers rather than for domestic use. These systems are both too expensive and too complex for domestic use. In the case for low cost domestic use, designs should be made available by using packages like CD-ROM and so on.

2.4 Description of VRML

VRML stands for “Virtual Reality Modeling Language". It allows specifying dynamic 3D scenes through which users can navigate with the help of a VRML browser (Schneider, 1998). VRML scenes can be distributed over the World-Wide Web and browsed with special VRML browsers, most of which are plug-ins for Netscape or Internet Explorer. When a VRML-enabled browser contacts the file extension of .wrl, it displays the world that is described by the file on the screen. Often, VRML is pronounced as “vurh-mal” not as “V-R-M-L”.

VRML is not a general purpose programming language like C++, a script language like JavaScript or a markup language like HTML. It is a modeling language (scene description language) that demonstrates the geometry and behavior of a 3-D scene.

A VRML file does not have to be compiled from source code, linked into an object module, and then run. Instead, VRML files are parsed, rendered, and finally displayed by a web browser. A VRML file is a plain ASCII text file. It can

be created, viewed, and edited in any plain text editor such as Notepad. A VRML file always starts with the header:

#VRML V2.0 utf8

The identifier "utf8" which appears on the header is to allow the use of international characters in the VRML models. Comments start with #, all characters until the end of the line being ignored.

2.5 Characteristics of VRML worlds

Whether the product is educational, commercial, or technical, most VRML worlds have certain characteristics in common (Ramirez & Rivera, n.d.):

- *Immersive*. The user enters this 3D world on the computer screen and explores it as he or she would explore part of the real world. Each user can take a different tour of the world.
- *User-control*. The user controls the experience. The local browser allows the user to explore the VRML world in any way he or she decides. The computer doesn't provide a fixed set of choices to follow, although the VRML author can suggest possible paths through the world.
- *Interactivity*. A VRML world is interactive. Objects in the world respond to one another and to events caused by the user.
- *Blending*. A VRML world blends two- and three-dimensional objects, animation, and multimedia effects.

2.6 VRML 1.0 to VRML 97

The need of a more realistic data representation motivated the creation of a Virtual Reality Modeling Language (VRML). This standard establishes a language that describes and specifies virtual three dimensional worlds. There are two versions of this standard, VRML 1.0 and VRML 97.

VRML 1.0 was designed to meet the following requirements: platform independence, extensibility and ability to work well over low-bandwidth connections (Ramirez & Rivera, n.d.). This format supports complete descriptions

of 3D scenes with polygonal rendered objects, lighting, materials, networking, ambient properties and realism effects. Objects are defined as nodes. However, VRML 1.0 only allows specifying static scenes.

The current standard is VRML 97, which in its draft phase was known as VRML 2.0. VRML 97 contains many changes to the VRML 1.0 language. It adds audio, interactive objects, behavior and scripting among other things. In this sense, VRML 97 is far more complex than VRML 1.0 (Schneider, 1998).

2.7 Applications of VRML

VRML is intended to provide a rich, stimulating and interactive user experience. Its applications are stressed more on the area of data visualization, where the user needs to perceive the data and/or interact with it.

The low cost of software supporting VRML plus the facility to browse models with this technology is causing the engineering community to consider VRML for access to public and private engineering data (Ramirez & Rivera, n.d.). Ramirez and Rivera (n.d) also mentioned that one of the advantages of the 3D VRML is that the users do not need to know the names of equipment nor the names of any data files. As simple as it is, instead of labeling a danger zone with text, we can use red colors to visualize it. With this approach, the user can actually see where the danger zone is located.

In the medical field, VRML can be used to show different parts of the body. This can help the people that work and study medicine to have a better idea of what they'll do. Software based on VRML that enables the shared viewing and manipulation of three-dimensional (3D) computer models of human anatomy on two networks was recently developed. This software was named Networked Virtual Reality Medical Tutor (NVRMT). This software can also improve the quality of education in anatomy, physiology and medical trauma in a number of difference ways.

The creation of networked virtual environments is also made easier with VRML. This type of environment is called Distributed Virtual Environment (DVE). DVE allows a group of geographically separate users to interact in real-