UNIVERSITI PUTRA MALAYSIA

VIRTUAL REALITY IN ENHANCING INTERNET-BASED EDUCATION

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VIRTUAL REALITY IN ENHANCING INTERNET-BASED EDUCATION

By

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DEDICATION

To HIM, for HIS love and blessings bring me this far.

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LIST OF ABBREVIATIONS

2-D	-	Two-dimensional.
3-D	-	Three-dimensional.
AWT	-	Abstract Windowing Toolkit.
BOF	-	Birds-Of-a-Feather.
CGI	-	Common Gateway Interface.
COTF	-	Classroom Of The Future.
CSCW	-	Computer-Supported Cooperative Work.
DIS	-	Draft for International Standard.
EAI	-	External Authoring Interface.
FTP	-	File Transfer Protocol.
GUI	-	Graphical User Interface.
HITL	-	Human Interface Technology Lab.
HMD	-	Head Mounted Display.
HTML	-	HyperText Markup Language.
HTTP	-	HyperText Transfer Protocol.
JDK	-	Java Developer's Kit.
JSAI	-	Java Script Authoring Interface.
MOO	-	Multi-User Object-Oriented Environment.
MUD	-	Multi-User Domain.
NASA	-	National Aeronautics and Space Administration.
NCSA	-	National Center for Supercomputer Applications.

RFP	-	Request-For-Proposals.
SDSC	-	San Diego Supercomputer Center.
SGI	-	Silicon Graphics Incorporation.
UI	-	User Interface.
VE	-	Virtual Environment.
VR	-	Virtual Reality.
VRML	-	Virtual Reality Modeling Language.
WAIS	-	Wide Area Information Servers.
WWW/Web	-	World Wide Web.

ABSTRACT

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Master of Science.

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Faculty: Science and Environmental Studies

Until recently, Internet-based education is fundamentally two-dimensional (2-D). This difference from the three-dimensional (3-D) world that human beings experience and learn provokes that 3-D learning environments should be included into the Internet-based education. It is envisaged that Virtual Reality (VR) has the capability to provide for the 3-D learning environments.

The objectives of this study are to investigate the capability of VR in enhancing Internet-based education and to investigate the process of VR model or Virtual Environment (VE) development. As Virtual Reality Modeling language (VRML) is the non-proprietary 3-D format to represent VR on the Internet and its current version (2.0) enables dynamic, interactive models to be developed these

boiled down to investigate the capability of VRML2.0 in enhancing Internet-based education and the process of VR model/VE development using VRML2.0.

A conceptual framework for developing VE on the Web for education purposes is proposed. It describes the various components, which can constitute a VR model and can be used as a guideline in identifying the functionalities that can be included in a VE.

Scene-based VE development approach is proposed and adopted in developing the two VEs in this study. Five distinctive phases are identified for the VE development (Planning, Designing, Building, Programming, Testing and Experiencing) and they fit nicely into this approach. The conceptual framework can be used in the planning and the designing phases of the VE development.

The two VRML models developed i.e. the Architecture of a Typical CPU model and the Virtual Physics Laboratory model show encouraging results despite of certain limitations. They serve as experiential 3-D learning environments because of the direct interaction and the sense of immersion that they provided. Observation from the Virtual Physics Laboratory model shows that VRML2.0 has problems in modelling time-critical educational topics accurately.

Despite the presence of certain limitations in using VRML2.0 to simulate real learning environments, VR models provide alternative learning environments which are interactive and inherently 3-D. By integrating the 3-D VR learning

environment into the existing 2-D environment, learner previous encounters with the 2-D learning environment can be augmented with a whole new experience of interactive 3-D computer-generated worlds. The confluence of the strength of both the environments on the Web produces the synergism that enhances Internet-based education.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

KENYATAAN MAYA DALAM MENINGKATKAN MUTU PENDIDIKAN BERASASKAN INTERNET

Oleh

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Sehingga kini, pendidikan berasaskan Internet adalah pada dasarnya dua dimensi (2-D). Perbezaan ini daripada dunia tiga dimensi (3-D) yang manusia alami dan pelajari menyeru persekitaran pembelajaran 3-D diturutsertakan ke dalam pendidikan berasaskan Internet. Kenyataan Maya (VR) dijangka mempunyai kebolehan untuk menyediakan persekitaran pembelajaran 3-D tersebut.

Objektif kajian ini adalah untuk mengkaji kebolehan VR dalam meningkatkan mutu pendidikan berasaskan Internet dan untuk mengkaji proses pembangunan model VR atau persekitaran maya (VE). Memandangkan *Virtual Reality Modeling Language* (VRML) merupakan format 3-D yang bukan hakmilik mana-mana pihak untuk mewakilkan VR pada Internet and versi terkini iaitu 2.0

membolehkan model yang dinamik dan interaktif dibangunkan, maka skop kajian ini dikecilkan kepada penyelidikan tentang kebolehan VRML2.0 dalam meningkatkan mutu pendidikan berasaskan Internet dan proses pembangunan model VR/VE dengan menggunakan VRML2.0.

Satu rangkakerja konsep untuk membangunkan VE pada *Web* untuk tujuan pendidikan telah dikemukakan. Ia menerangkan tentang pelbagai komponen yang boleh membentuk sesuatu model VR dan boleh digunakan sebagai garis panduan dalam mengenalpasti fungsi-fungsi yang boleh dimasukkan ke dalam sesuatu VE.

Pendekatan *scene-based* dalam pembangunan VE telah dikemukakan dan digunakan dalam membangunkan dua VE untuk kajian ini. Lima fasa yang berlainan telah dikenalpasti terlibat dalam pembangunan VE (Perancangan, Rekabentuk, Pembinaan, Pengaturcaraan, Pengujian dan Pengalaman) dan kesemuanya boleh dipadankan dengan baiknya ke dalam pendekatan ini. Rangkakerja konsep boleh digunakan dalam fasa perancangan dan fasa rekabentuk dalam pembangunan VE.

Dua model yang dibangunkan iaitu model Senibina untuk CPU dan model Makmal Fizik Maya menunjukkan keputusan yang memuaskan walaupun wujud beberapa kekangan. Model-model ini boleh digunakan sebagai persekitaran pembelajaran 3-D experimentasi kerana terdapat interaksi langsung dan suasana penyelaman. Pengamatan daripada model Makmal Fizik Maya menunjukkan

bahawa VRML2.0 mengalami masalah dalam memodelkan secara tepat tajuk pendidikan di mana masa adalah elemen yang kritikal.

Walaupun terdapat batasan dalam menggunakan VRML2.0 untuk mensimulasi persekitaran pembelajaran yang sebenar, model-model VR menyediakan persekitaran pembelajaran alternatif yang interaktif dan 3-D. Dengan mengintegrasikan persekitaran pembelajaran 3-D ke dalam persekitaran 2-D yang sedia wujud, pengalaman lepas pelajar dengan persekitaran pembelajaran 2-D boleh ditambah dengan satu pengalaman baru dunia 3-D interaktif yang dihasilkan oleh computer. Penggabungan kekuatan kedua-dua persekitaran pada *Web* ini, menghasilkan kuasa gabungan yang meningkatkan mutu pendidikan berasaskan Internet.

CHAPTER I

INTRODUCTION

Introduction

The Internet or the Net has long been recognised as a global communication and information distribution channel. Its fundamental nature of connecting network of networks distributed around the globe makes it the largest and most powerful repository of information that man ever had. In June 1997 there is only a handful of countries having no connectivity to the Internet (Landweber, 1997).

The Net is experiencing exponential growth ever since its conception and Comer estimated that the Internet will outpace world-wide production of computers (Comer, 1995). This pattern of growth is attributed to its ability as a communication tool. The Internet offers two modes of communication namely synchronous and asynchronous (McLellan, 1996). Synchronous communication occurs instantaneously in real-time where all the participants are present at their respective locations (for example on-line chat spaces). Contrarily, asynchronous communication is delayed at the receiver's end (for example e-mail). These two modes of communication make the Net extremely powerful in collaborating activities.

In 1989, the growth of Internet was given a further boost by the work led by Tim Berners-Lee at CERN, a particle Physics laboratory in Geneva, Switzerland. They managed to develop the World Wide Web (WWW or Web) (Liu et al., 1994). As the result, more and more functionalities are being added to the Internet continuously. Accessing on-line information which was previously restricted to the academic community is becoming increasingly natural and essential for the global population as a whole as well as in our community. The impact of this situation is beginning to be felt in every facet of our life, i.e. socially, economically and politically.

The Web provides the Internet users with a uniform and convenient means of accessing the vast resources of the Net. Apart from providing HyperText Transfer Protocol (HTTP) the Web also supports other existing forms of information services on the Internet (Lemay, 1995). These include File Transfer Protocol (FTP), Gopher, Usenet news, Wide Area Information Servers (WAIS), telnet and e-mail. Whereas the user once needed a FTP client to access FTP archives, a WAIS client to search WAIS servers and Gopher client to get to the Gopher servers, a Web client/browser provides access to all of these services.

Starting from the release of Mosaic i.e. the world first graphical Web browser, by National Center for Supercomputer Applications (NCSA) at the University of Illinois in 1993 the Web has became the most graphical Internet service (Liu et al., 1994). Other well-known graphical browsers include Netscape Communications Corporation's Navigator (Netscape Communications Corporation, 1998) and Microsoft's Internet Explorer (Microsoft Corporation, 1998). The Web

also has the most powerful linking abilities among all the services provided by the Internet. It enables *hyperlinking* (embedded reference to other information) from any point in a document to any point in the document itself or another document which may exist on any other computer host on the Internet. With a Graphical User Interface (GUI)-based browser, links are followed with the simple action of pointing and clicking with a pointing device. This node-link technique for navigating and finding information on the Web is alluring although larger size of information poses some difficulties (Andrews et al., 1995).

The most prominent feature that contributes to the Web's popularity is: as a hypermedia information system (Lemay, 1995) it provides the ability to link and integrate different media types on the same document thus making representation of information on the Web aesthetically appealing. This coupled with the existence of GUI-based Web browsers enable the distribution of multimedia information on the Internet. To experience the multimedia effects the user's computer must of course be equipped with multimedia capabilities.

Furthermore, publishing information on the Web using the easy-to-learn-and-use HyperText Markup Language (HTML) is trivial and encouraging. However, the quality of the presentation of the information depends very much on the expertise and the creativity of the content providers. Besides that, all forms of previously printed and electronically recorded information can be converted for distribution via the Web. As the information is stored electronically and on-line, updates can be performed regularly and the distribution of information is less costly.

Problem Statement

Despite the ability to produce attractive and beneficial learning environments, the Internet until recently is not capable of providing learning environments which mimic the real learning environments due to the fact that all the information presented are two-dimensional (2-D) even with its most graphical information service i.e. the Web. This disparity from the three-dimensional (3-D) world that human beings experience and thus learn in the daily lives provokes that 3-D learning environments should be included into the Internet-based education together with other existing forms of information. The best tool at hand to simulate the learning environments in 3-D electronic forms undoubtedly points to the technologies of Virtual Reality (VR).

VR refers to the collective technologies which are aim at producing a natural, inherently 3-D, human-conformed computer interface which has the ability to stimulate every aspect of the human senses. This ultimate ambition is still undergoing extensive researches despite of all the hypes produced by the media agencies. However, fiction did actually preceded fact in the evolution of VR technologies. Some novelists (such as William Gibson in his *Neuromancer*, 1984 and Neal Stephenson in his *Snow Crash*, 1992) have the fanciest dream : in the future, humans can plug into an electronic network that spans the globe i.e. *cyberspace* (Rheingold, 1991).

With the advent of computer graphics technologies and the advances in computer hardware plus the explosive growth of Internet specifically the Web the time was ripen to realise the dream of cyberspace. In the first international conference of WWW in Geneva, May 1994 the first effort of incorporating VR into the Internet specifically the WWW appeared in the form of the proposal to establish a logical format for non-proprietary platform-independent VR i.e. Virtual Reality Markup Language (VRML). The "Markup" was later changed to "Modeling" since storing 3-D models was what VRML was all about (Matsuba & Roehl, 1996).

As VR has the ability to simulate the real physical world and also non-existence world the incorporation of VR into the Internet for education purposes helps to create 3-D learning environments that resemble the real learning environments which are lack in the present Internet-based education. By simulating real physical environments which may not be accessible by the learner (because of too distance, too expensive etc.) learner will be provided with alternative learning environments. Non-existence environments can also be modelled using relevant data to give the learner a whole new paradigm and experience in learning.

User's or learner's previous encounters with the passive 2-D documents will be augmented with a whole new experience of interactive 3-D computer-generated worlds. This is achievable using VRML which at its best is a non-proprietary standard and permits the integration of 3-D interactive data into the existing hypermedia environment.