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Sub-theme: ICT in Higher Education

APPLICATIONS OF VIRTUAL REALITY TECHNOLOGY IN EDUCATION: FOCUSING ON TEACHING AND LEARNING

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ABSTRACT

Virtual reality (VR) which in its infancy was applied in the military domain has now emerged its applications to other domain such as manufacturing, construction, medicine, business, tourism, filming, architectural design, and education. In education especially related to teaching and learning process, a difficult concept in any subject can be described to students in detail with aid from VR technology. In this paper, the definition and history of VR, some applications of VR technology, hardware and software related to education especially teaching and learning applications in subjects of history, chemistry, physics, mathematics and others are thoroughly discussed.

INTRODUCTION

Emergent technologies and the current process of teaching and learning have somehow changed each and every inch of our life. The way we interact, work and live is being influenced by new technology. In computer graphics, the static two-dimensional (2D) images have now become three-dimensional (3D) objects that can be interactive. If in early stage, the World Wide Web (WWW) uses 2D format in Hypertext Markup Language (HTML), now the format has moved towards interactive 3D worlds in the hands of Virtual Reality Modelling Language (VRML). The static 3D specification of VRML1.0 in 1995 has been modified to VRML2.0 in 1997 to improve 3D worlds so that it can have characteristics such as interactivity, animation, and support early prototype development stage for 3D objects.

The advent of high resolution digital camera has produced attractive, sharp, high resolution images. This brings positive impacts to VR technology advancement especially those related to panoramic image display. With rapid advances in information and communication technology (ICT), the applications of VR technology in education can help in the process of teaching and learning because of the following:
   a) The reducing cost in computer hardware and software.
   b) The increasing power of computer processors.
These eventually influence teaching and learning process as well as the education advancement on individuals and to whom involved in this domain.

MULTIMEDIA AND CREATIVE MULTIMEDIA

The domain of creative multimedia is focusing on content development, content creation, production and broadcasting of flagship applications, televisions and movies, online multimedia, advertising, publishing, interactive software, training, as well as education. In general, many industries use and display moving images, computer graphics, texts and sound as basic components to convey information.

The importance of creative multimedia domain can be observed from the total expenditure of the industry worldwide as indicated as follows:
   1999 – USD71.7 billion
   2000 – USD81.7 billion
   2005 – USD149.2 billion
Meanwhile, the biggest and major focus areas are as follows:
   • Multimedia
   • Graphics Arts
   • Animation and Arts

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- Computer-Aided Design and Manufacturing (CAD/CAM)
- Scientific Visualisation

From the above list, it is stated that animation is the most dynamic sector in computer graphics industry.

VIRTUAL REALITY TECHNOLOGY

Definitions of Virtual Reality
Virtual reality is a method where human is able to interact with computer visually and manipulating as well as interacting with virtual objects in virtual worlds (Aukstakalnis & Blatner, 1992). Lanier (1992) suggests that virtual reality is a simulator for general use in which its user can navigate into artificial worlds in a computer where the worlds are somehow similar to the real world. On the other hand, Briken (1992) defines virtual reality as an experience in 3D and sharing between computer and human and where it has its own capability to deliver the interaction process. From these definitions, it is concluded that virtual reality is a method to display, move, and interact with computer and complex data.

Virtual Reality Technology
The capabilities of techniques use in virtual reality technology have been increased especially in education domain. This is proven by the increasing number of local and foreign universities offering virtual reality courses inclusive of 3D graphics integration, interactive and real environment as well as 3D concepts in the Internet. Besides software that relates to panoramic images, there are also other software that can be taken into account such as AutoCAD, 3D Studio Max, VRML (Cosmo World and Cosmo Player), and Sense8 (WorldUp, World2World, and World Toolkit). The applications that have been developed for virtual reality are numerous ranging from computer games, business, engineering, architectural design, defense, medical, manufacturing until education domain. Virtual reality centers have also been setup by some renowned automotive industries. Examples include Mercedes in Sindelfingen, Germany, Volvo in Gothenburg, Sweden, and Toyota in Japan.

In Malaysia, an oil company Shell based in Sarawak establishes its own virtual reality center known as Advanced Collaborative Environment Virtual Reality Center (ACE) in Lutong, Miri, Sarawak. This center is one of five similar centers owned by Shell Groups worldwide, which are in Houston, United States of America, in Woodside, Australia, as well as in Rijswick and NAM, Netherlands. ACE has three main systems which are visual computers, high resolution projection display system, and 28-feet curve screen for receiving clear effects. The center costs RM6.7 million in total.

A good example of virtual reality applications is a virtual campus tour developed by University Florida as shown in Figure 1 which eventually can accommodate the needs of prospect visitors.
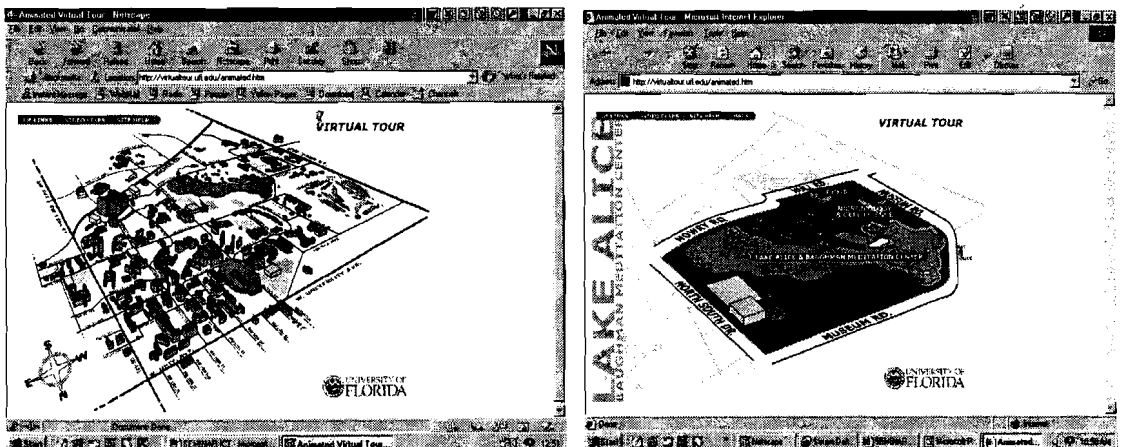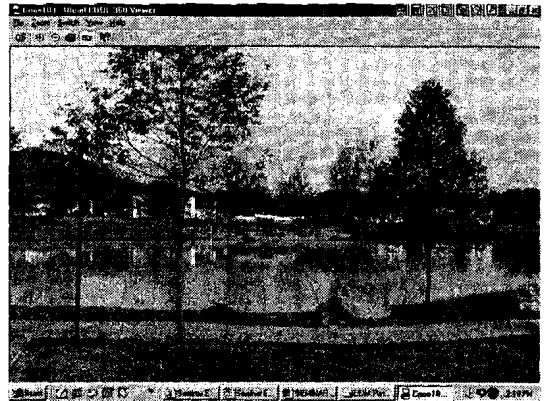

Figure 1: *Screen snapshots of University of Florida virtual tour*

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The same method may also be applied to display the local campus in Malaysia such as Universiti Utara Malaysia campus in the northern region as shown in Figure 2(a) and also the facilities available in the campus such as golf course and recreational lake as shown in Figure 2(b) and 2(c).

(a) Outside the Chancellery building

(b) Recreational lake

(c) Golf course

Figure 2: *Screen snapshots of Universiti Utara Malaysia campus*

APPLICATIONS OF VIRTUAL REALITY TECHNOLOGY IN TEACHING AND LEARNING PROCESS

Virtual reality has been used as materials or intermediaries or medium for teaching and learning purposes. Online learning or e-learning programs or also called virtual education now have been offered by Universiti Tun Abdul Razak (UNITAR) and Open University Malaysia (OUM). Besides text form, teaching materials can also be in visual form.

There are two major technologies that do not involve huge amount of cost and at the same time are widely used in developing a virtual reality application. These are Virtual Reality Modelling Language (VRML) read as "Vermal" and 360^0 Panoramic Display that can be used with Quicktime VR from Apple Computer, Inc.

VRML Applications in Teaching and Learning Process
In 1995, VRML was born as a standard language for producing 2D and 3D objects for the Internet display. VRML is at first used to display a simple 3D objects and limited in terms of size and complexity. For example, in teaching Chemistry subject, teachers can easily develop a diagram of atoms using VRML as shown in Figure 3.

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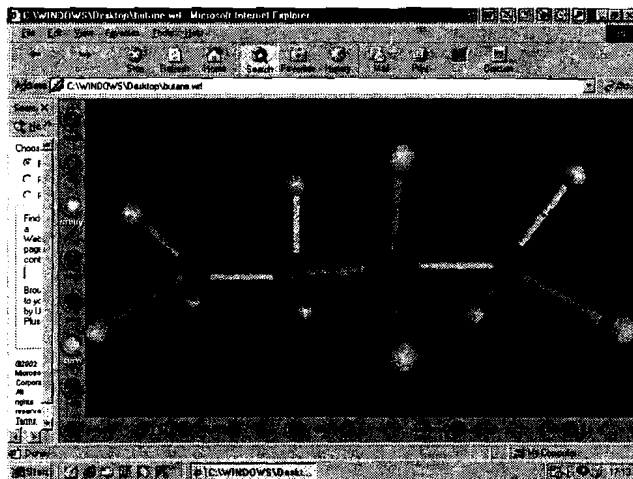
Figure 3: A screen snapshots of atoms.

Applications of 360⁰ Panoramic Display in Teaching and Learning Process

The 360^0 panoramic display technology uses clear images that can be obtained from any types of digital camera. Images are captured in spherical form with a total view of 360^0. All captured images are then stitched to produce a panoramic display in 360^0. Users may view a panoramic display whether in a direct position of 180^0 or in spherical form of 360^0.

In geography subject, the 360^0 panoramic display technology can be used to describe in detail the location of a city. Alor Star in Kedah, Malaysia, for example, uses this technology as shown in Figure 4 to give a clear picture of that particular city to students without being physically there (Junaiza Jarjis, 2001).
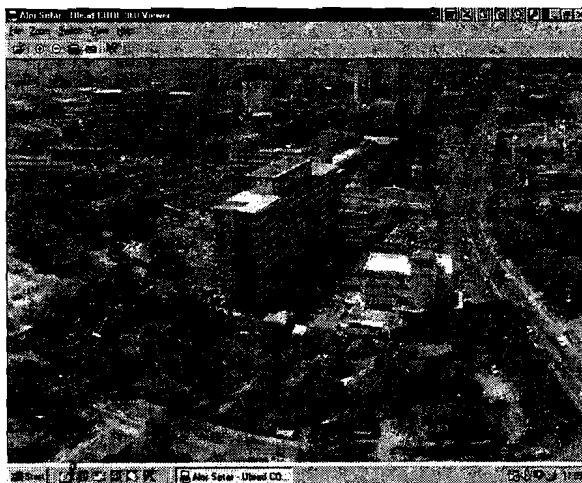
Figure 4: A screen snapshot of Alor Star city.

The struggle of Parti Komunis Malaya (PKM) at the mountain of Khao Nam Kang which is near the border of Malaysia-Thailand is now memorised as among the unique historical artifact in History subject. Khao Nam Kang once becomes a tourist and historian attraction can now be clearly shown with the use of virtual reality technology. The technology enables students and historian see for themselves the location where PKM operated. With the availability of this technology, students and historian from all over Malaysia do not need to physically visit Khao Nam Kang in Thailand but somehow or rather enough to look at 360^0 panoramic display as illustrated in Figure 5.

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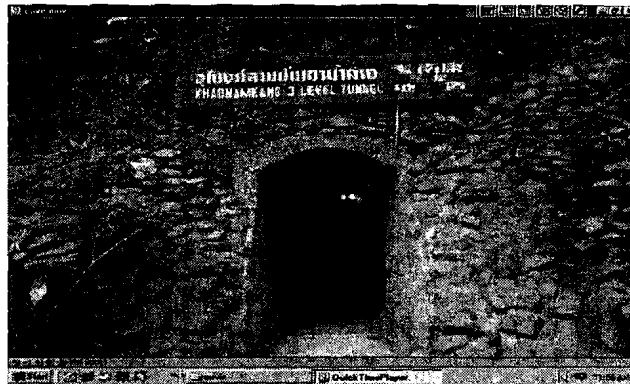
Figure 5: *A screen snapshot of Khao Nam Kang tunnel.*

Applications of 3D Modeller in Teaching and Learning Process

The advent of 3D modeller software also puts some influence in the way 3D models can be produced. With the use of 3D modeller such as 3D Studio Max R3.1, the movement of atoms can be illustrated as in Figure 6.
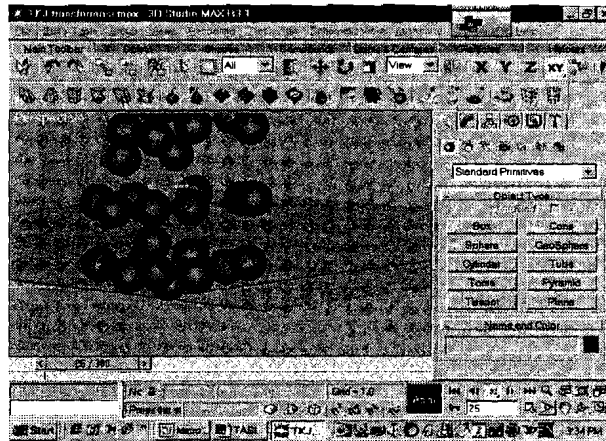

Figure 6: *Movement of atoms in a 3D modeler*

In Physics subject, principles and rules of Archimedes may easily be explained with the use of virtual reality technology as illustrated in Figure 7.
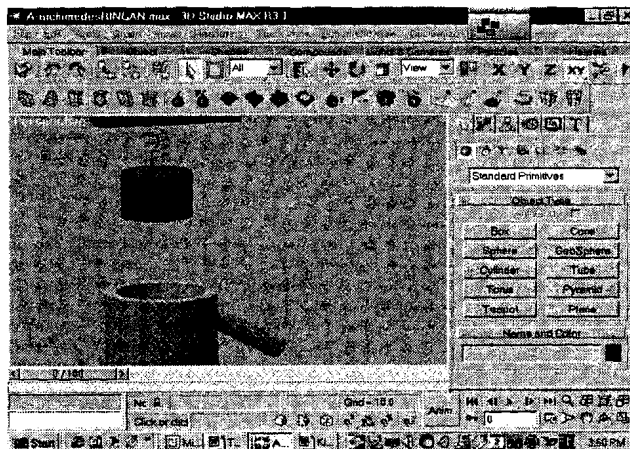
Figure 7: *Principles and rules of Archimedes in a 3D modeler.*

Students in Architecture or Housing Design domain may use virtual reality technology to build a housing prototype based on client's request and desire. The color, furnishing of furniture and floor tiles and et cetera may be produced with the use of suitable virtual reality software as illustrated in Figure 8.
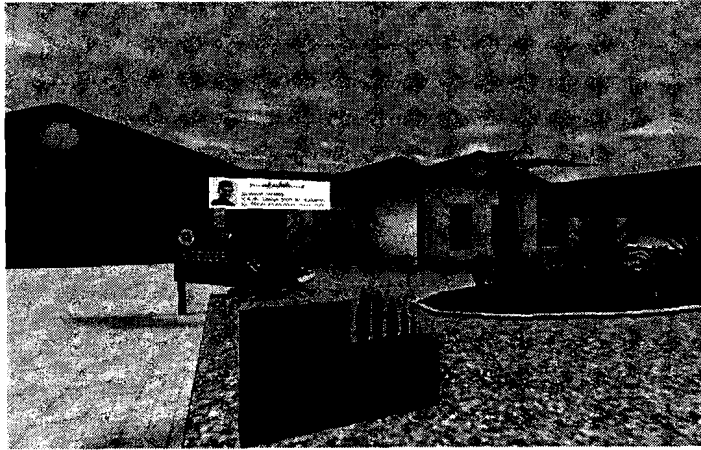

Figure 8: *Housing prototype model*

ONLINE MATERIALS FOR TEACHING AND LEARNING PROCESS

The Internet advances help educators share teaching materials across the boundaries. In Physics subject, for example, a method of describing a pendulum concept and a simple calculation involving time, T and distance, L is illustrated in Figure 9.
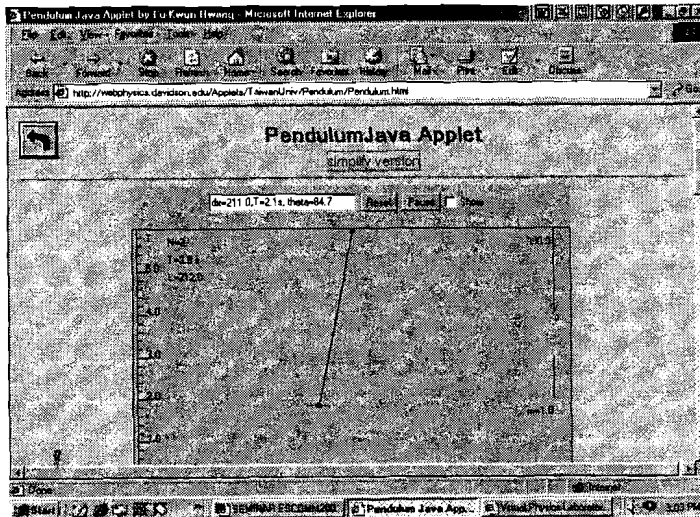

Figure 9: *A simple pendulum calculations in the Internet*

Another example is in Mathematics subject whereby a Pythagoras' Theorem concept can be demonstrated with the help of 3D model as illustrated in Figure 10.
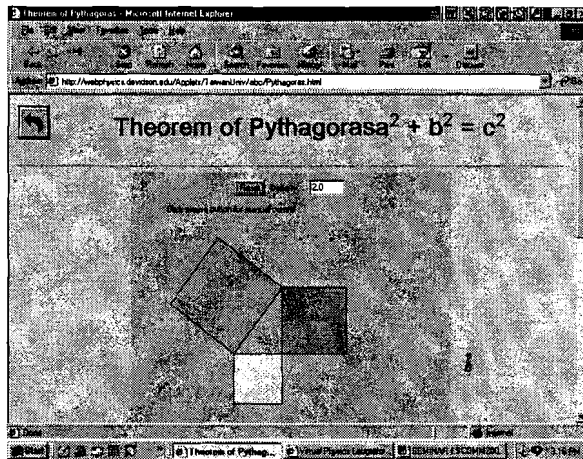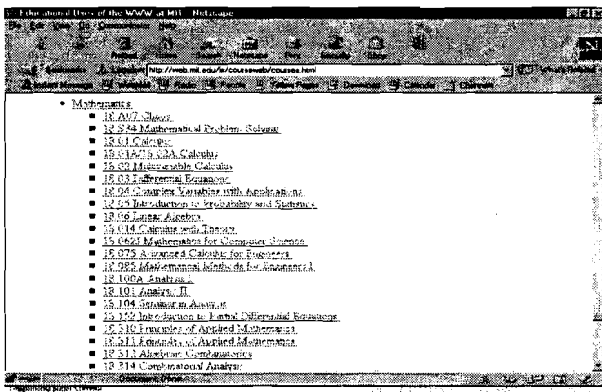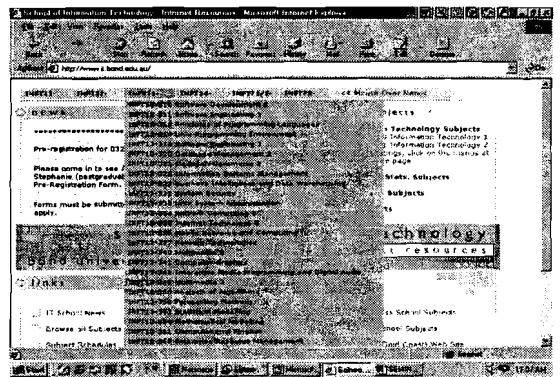
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Figure 10: *A Pythagoras' Theorem concept in the Internet*

Samples of online course materials are obtainable from several renowned universities' Web sites. These includes online materials from World Lecture Hall, Massachusetts Institute of Technology (MIT), USA as depicted in Figure 11(a) and Faculty of Information Technology, Bond University, Australia as in Figure 11(b).

(a) World Lecture Hall from MIT

(b) Online materials from Bond University

Figure 11: *Online course materials available in the Internet*

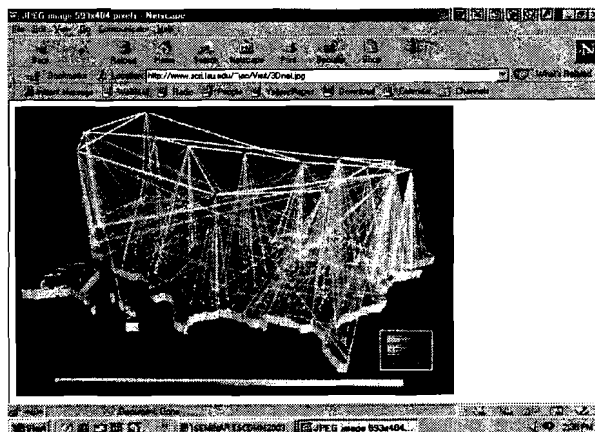The location of the Internet can also be illustrated in 3D as shown in Figure 12.

Figure 12: *Location of the Internet in 3D*