VIRTUAL REALITY TECHNOLOGY ENHANCED LEARNING

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Abstract

In this work, we will share our efforts in Singapore on the research and development of immersive and interactive technology for learning and teaching in secondary, tertiary and special schools. The VR classrooms/labs will be introduced as the first example with the presentations of the FutureSchool@Hwa Chong Institution, two other schools. In the second example, a new project to develop immersive and interactive technology for tertiary Engineering Education at Nanyang Technological University will be presented. A VR game is discussed as the third example for the purpose to assist children with autism in their learning of living skills.

Keywords: Technology-enhanced Learning, VR.

1 INTRODUCTION

Virtual Reality (VR) is not new. Back in the 1960s, Dr. Ivan Sutherland, the inventor of the first VR Head Mounted Display (HMD), described [12][13] "The screen is a window through which one sees a virtual world. The challenge is to make that world look real, act real, sound real, feel real". Typically, VR consists of four major enabling technologies such as fidelity modeling, immersive visualization, real-time interaction, and natural user interface [2].

Among countless industries clamored involving with VR, especially in the last two years, the education sector is becoming the new frontier of VR applications. Google initiated the Cardboard for Education project (https://plus.google.com/communities/10307326999809122127). Microsoft (https://youtu.be/6eHG6reQhq0) and Facebook (https://youtu.be/YuIgyKLPt3s) also invested heavily on their education uses of augmented reality (AR) and VR technology. Back in 1990s, Pantelidis [7] investigated the benefits of VR in the classroom. Roussos et al. [9] looked into learning and building together in an immersive virtual world. Virtual realities were discussed for educational communications and technology by McLellan [6]. The design, development and evaluation of a virtual reality based learning environment were studied by Chen [5]. Over the past decade, we have been actively doing VR research and development focusing on VR technology enhanced Learning [1][2][3][4].

Singapore's Ministry of Education (MOE) introduced several schemes including "Teach Less, Learn More" to promote innovative learning. In 2008, MOE and Infocomm Development Authority (IDA), Singapore initiated the FutureSchools@Singapore (FS@SG) program (https://www.moe.gov.sg/media/press/files/2012/11/annex-1-factsheet-on-futureschools.pdf) as part of the MOE's Third Master plan for ICT in Education (2009–2014). The FS@SG projects explore expanding learning possibilities with virtual learning environments and other education technology that allow teacher–student interaction, online assessments, and monitoring of students’ progress.

In this work, we will share our efforts in Singapore on the research and development of immersive and interactive technology for learning and teaching in secondary, tertiary and special needs educations. The VR classrooms/labs for secondary education will be first introduced. Next, a new project to develop immersive and interactive technology for tertiary engineering education will be presented. Finally, we will discuss the VR enhanced technology to assist the living skill learning for children with autism in a special school.

2 VR TECHNOLOGY ENHANCED LEARNING

VR has been found in many applications such as engineering and medicine. In this work, we are keen to investigate the use of VR technology for education applications including STEM learning in secondary schools, engineering learning in tertiary institutions as well as life skill learning in special needs education.
2.1 VR TEL in Secondary Schools

Figure 1 (Upper-Left) shows the VR Lab at Hwa Chong Institution (HCI) as part of the FutureSchool@HCI project. The VR Lab serves as a new venue for HCI students to learn Science and Mathematics. For Biology, they do immersive and interactive learning of proteins and DNA in the VR Lab. Similarly for Mathematics, they learn trigonometry, vectors, and distance in an immersive and interactive fashion in the VR Lab.

Figure 1 (Upper-Right) shows the VR Classroom at River Valley High School (RVHS). The VR technology aids RVHS students to visualize virus structure. Currently, we are working with Riverside Secondary School to develop a VR Learning Wall (Figure 1(Bottom)) aiming to assist students better understand the differences of plant cells and animal cells.

![Figure 1](image)

2.2 VR TEL in Nanyang Technological University (NTU)

Aerospace engineering is an important part of NTU curriculum. Due to its complexity, turbine engine is among several difficult topics for engineering students. Turbine engines, or turbojet engines extract thrust solely from the heated gas expansion through the turbine and nozzle, while for bypass turbojet engines, or turbofan engines, its thrust comes both from the bypass air and the hot gas expansion [8]. Although the large mass flow of bypass air receives less energy than that goes through the core engine, it still provides a good amount of thrust by getting compressed through the inlet fan and thus creating a large momentum difference [10]. It is clear that turbofan engine is a fuel-efficient yet powerful type of engine and is economical for cruising. Therefore, most commercial passenger
aircrafts are equipped with turbofan engines. The functional structure of turbofan engines consists of common elements: inlet fan, compressor, combustion chamber, turbine and nozzle.

At Nanyang Technological University, engineering students are doing immersive and interactive learning of mechanical and aerospace subjects. Figure 2 shows a student doing disassembly of a turbine engine. In this way, students will get themselves familiar with the turbine concepts before they actually do hands-on with real engines.

2.3 VR TEL in Special Education

Autism is a spectrum disorder. There is a wide degree of variation in the way it affects children with autism. Every child on the autism spectrum has unique abilities, symptoms, and challenges. Often, they have difficulties to gain living skills. A virtual environment is an ideal way of imparting skills necessary for independence, which most of us take for granted, before encouraging children with autism to try these out in the real world. Dorothy Strickland et al [11] did a study to assess the effectiveness of VR as a learning tool to engage children with autism.

Over the years, we have been developing VR technology to assist children with autism in their learning and communication. Our recent interest is to design and develop VR technology to enhance the learning of living skills by children with autism. Figure 3 shows children from a special school playing the virtual showering game to learn body clean.
3 CONCLUSIONS

In this work, we reported our efforts in design and development of VR technology for education uses including VR technology enhance learning in secondary schools, tertiary institutions and special schools. Both technology innovation and content development play a significant role in this work. Due its interdisciplinary nature, we have been collaborating with colleagues from schools and education research institutes.

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