Virtual Reality – Creation, Usage and Education

František Hrozek, Branislav Sobota, Štefan Korečko and Csaba Szabó
Department of Computers and Informatics
Faculty of Electrical Engineering and Informatics, Technical university of Košice
Košice, Slovak Republic
frantisek.hrozek@tuke.sk, branislav.sobota@tuke.sk, stefan.korecko@tuke.sk, csaba.szabo@tuke.sk

Abstract — At Department of computers and informatics, FEEI TU of Košice, students can study problematic of virtual reality technologies. Study is divided into two parts. First part focus on theoretical knowledge and second part focus on practical knowledge. This paper presents practical exercises during which students earn practical experiences about these virtual reality technologies: 3D scanning, position tracking, 3D displays and 3D printing.

Keywords - virtual reality technologies, 3D scanning, position tracking, 3D displays, 3D printing

I. INTRODUCTION

Virtual reality (VR) technologies are increasingly used in everyday life (for example 3D displays are used at homes, 3D scanners and printers are used in building industry, etc.). It is therefore appropriate to teach students about these technologies as much as possible. At Department of computers and informatics, FEEI TU of Košice, students can study virtual reality technologies. This study is focused on the acquirement of theoretical knowledge and practical knowledge about virtual reality, their technologies and 3D computer graphics. On practical exercises students work with the latest virtual reality technologies (such as 3D scanning, position tracking, 3D displays and 3D printing) and create content for them (such as anaglyph pictures and 3D models).

Paper is organized as follows. Section 2 presents these virtual reality technologies: 3D scanning, position tracking, 3D displays and 3D printing. In section 3 is mentioned virtual reality hardware with which students work. Section 4 presents what students learn on practical exercises using virtual reality technologies. Section 5 summarizes information presented in the paper.

II. VIRTUAL REALITY TECHNOLOGIES

A. 3D Scanning

3D scanner is a device that analyzes a real-world object or environment to collect data on its shape and possibly its appearance (i.e. color).

There are several types of 3D scanners, which differ in the technology used for obtaining a data. They can be divided into two main categories: contact and non-contact scanners.

Contact scanners require a physical contact with the object being scanned. Although they are usually very precise, they are also much slower (order of $10^{3}$ Hz) than non-contact scanners (order of $10^{5}$ Hz).

Non-contact scanners use radiation to acquire required information about objects. They are of two basic types: passive and active. The main advantage of passive scanners is that they are cheap as they do not require so specialized hardware to operate. To scan objects, they only use existing radiation in its surroundings (usually visible light). In contrast, active scanners are equipped with their own radiation emitter (usually emitting laser light). While the latter are considerably more expensive, they are also much more accurate and able to scan over much bigger distances (up to few km) [1].

B. Position Tracking

Position tracking serves for sensing user’s position and rotation in 3D space. Position tracking devices are divided into these categories (depending on technology used for position and rotation tracking) [2]:

- Mechanical trackers
- Magnetic trackers
- Ultrasonic trackers
- Optical trackers
- Inertial trackers

Each one tracking technology has its advantages and disadvantages. For example, magnetic trackers do not suffer obscuration problems, but they are sensitive to environmental magnetic fields and ferromagnetic materials in the workspace. Position tracking is also used in other VR technologies such as data gloves and head mounted displays.

C. 3D Displays

3D displays use several technologies to create 3D image. Each technology has its advantages and disadvantages. There are several types of 3D displays [3]:

- Holographic displays
- Volumetric displays
  - Swept-volume displays
  - Static-volume displays
- Stereoscopic displays
D. 3D Printing

3D printing is a form of additive manufacturing technology where a three dimensional object is created by laying down successive layers of material. 3D printers are generally faster, more affordable and easier to use than other manufacturing technologies. 3D printers offer developers the ability to print 3D models for visualization, testing or direct parts creation.

III. VIRTUAL REALITY HARDWARE

A. 3D Scanner

This 3D scanner is Leica ScanStation 2 (Fig. 1) from Leica Geosystems. Scanning method used by this 3D scanner is method called "time of flight". Scanning range is up to 300 m and scanning density is up to 1 mm. More details about Leica ScanStation 2 at manufacturer’s webpage [4].

B. Position Tracking

This position tracking system is InterSence IS-900 SimTracker. This system has 6 degrees of freedom and for tracking position and rotation is used inertial-ultrasonic hybrid tracking technology. Parts of this system: MicroTrax devices (head and hand tracker, wireless transmitter, wand - Fig. 2) and SoniFrame. More details about this tracking system at manufacturer’s webpage [5].

C. 3D Displaying hardware

Students work on practical exercises with stereoscopic displays (displaying systems) that use autostereoscopic and passive (anaglyph, INFITEC) technology.

1) Autostereoscopic 3D display

This autostereoscopic 3D display that students work with is 42” 3D display Philips WOWvx (Fig. 3). Resolution of this display is 1920×1080 but real resolution in 3D is 960×540 and optimal watching distance is 3 m. 3D image is created using 2D-plus-depth method. This method create 3D image using 2D image and depth map. More details about this 3D display and 2D-plus-depth method at manufacturer’s webpage [6].

Figure 1. Leica ScanStation 2

Figure 2. MicroTrax devices (from left to right) – wand, hand tracker, head tracker, wireless transmitter

2) Passive stereoscopic displays (displaying systems)

a) Anaglyph

The anaglyph is a composition of a red channel from the left image and green and blue channels (together creating a "cyan channel") from the right image. 3D image is created when a user looks at the anaglyph through red-cyan glasses (the left eye can only see the red part of the image and the right eye the rest). Advantages of anaglyph images:

- for watching are needed only cheap red-cyan glasses
- anaglyph image can be displayed on standard 2D displays or printed on paper

b) 3D displaying system

This system uses passive stereoscopic technology based on INFITEC technology (more details about INFITEC technology at [7]). Parts of this system are:

- pair of projectors with INFITEC filters and glasses
- special projection screen
- mouse or “space mouse” for navigation in 3D scene
- rendering cluster consisting from three PCs with cluster version of visualization software called SuperEngine

Rendering cluster currently supports scenes rendering up to 5 million polygons. Rendering performance of this cluster can be extended by adding other computers to cluster.
Fig. 4 shows projection screen, glasses and projector pair used in this stereoscopic system.

Figure 4. Parts of stereoscopic system: screen, glasses and projectors

D. 3D Printer

3D printer available for students is ZPrinter 450 (Fig. 5). Maximum dimensions for printed model are 203×254×203 mm with printing resolution is 300×450 DPI and layer thickness between 0.089 - 0.102 mm. More details about ZPrinter 450 at manufacturer’s webpage [8].

Figure 5. ZPrinter 450

IV. 3D MODEL CREATION WITH VR TECHNOLOGIES

Creation of 3D model for visualization needs a lot of effort. Everything begins with collecting of information and analysis (preparing phase). When the data are prepared 3D model creation begins (modeling phase). A check of model for errors comes after 3D digital model creation (verification phase). The visualization of the final model is the last step. This process is depicted in Fig. 6 [9].

Practical exercises are divided into these sections:

- 3D model creation
- 3D scanning
- 3D visualization
- 3D printing

A. 3D Model Creation

In this section students learn how to create 3D models, which are used in 3D visualization (using 3D displays) and in 3D printing. During practical exercises students learn:

- 3D modeling basics
- how to create 3D model using photos, sketches or blueprints
- how to texture created 3D models
- how to set up scene for rendering of single image or entire animation

As 3D modeling applications are used Google SketchUp [10] and Blender [11]. Fig. 7 shows 3D model (TUKE University library) created by student using Google SketchUp.

Figure 7. 3D model created by student using Google SketchUp

B. 3D Scanning

In this section students learn how to manipulate and work with 3D scanner Leica ScanStation 2 - e.g. finding the right scanning position, setting the best parameters for scanning or joining multiple point clouds together. Students also learn how to use scanned data to speedup their 3D model creation. Fig. 8 (left) shows students working with 3D scanner and Fig. 8 (right) shows 3D scan (point cloud) scanned by students.

Figure 8. Students working with 3D scanner (left) and 3D scan created by students (right)
C. 3D Visualization

3D visualization section is divided into three subsections where students work with:

- **Anaglyph images** – this subsection teach students how to correctly create left and right image of selected object (scene) for easy anaglyph creation. Fig. 9 shows student working with anaglyph images.

- **Autostereoscopic 3D display Philips WOWvx** – in this subsection students learn how 2D-plus-depth method works and how to create content (2D image + depth map) for this autostereoscopic 3D display.

- **Virtual reality system** – in this subsection students acquire theoretical and practical knowledge about 3D virtual reality system that combine together 3D displaying system (passive stereoscopic system using INFITEC technology) and position tracking system (InterSence IS-900 SimTracker) to create immersive VR environment. Also students learn how to create content for this VR system with 3D modeling applications and 3D scanning. Fig. 10 shows student working with this VR system.

D. 3D Printing

This section teach students how 3D printing works and how to manipulate with 3D printer ZPrinter 450, how to prepare 3D models for printing and how to finalize printed models.

For printing students use their 3D models which was created in SketchUp or Blender. Fig. 11 shows printed 3D model of University library (3D model used for printing was created in SketchUp – Fig. 7).

V. Conclusion

Knowledge and experiences earned by students about virtual reality technologies during theoretical lessons and practical exercises helps student to find better working position on labor market after university graduating. Also every year increase in students’ interest about virtual reality shows that students want to learn about virtual reality technologies.

Future work will be focused on implementation of other VR technologies into practical exercises (e.g. data gloves and head mounted displays).

ACKNOWLEDGMENT

This work is supported by VEGA grant project No. 1/0646/09: Tasks solution for large graphical data processing in the environment of parallel, distributed and network computer systems.

REFERENCES


