Immersive Virtual Reality Course at the Digital Production Studies

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Immersive Virtual Reality course is, in addition to Basics of Virtual Reality, one of the two courses in applied 3D visualisation offered at the Faculty of Digital Production at the Educons University in Sremska Kamenica, Serbia. The purpose of this course is two-fold: to provide students with a profound understanding of the fundamentals of Virtual Reality and to gain practical experience. The students attending this course learnt about the latest technology of Virtual Reality using the virtual reality headset - Oculus Rift. This paper presents the structure of the Immersive Virtual Reality course, which provides the students of technical orientation with a connection to the state of the art visualisation aspect of digital production. The outcome of the course is the final project, done by each individual student, which involves the implementation of a VR system that students are able to use. The results achieved in the course are displayed and analysed in this paper.

Keywords: *virtual reality, digital production studies, visualisation, 3D visualisation, oculus rift*

1. INTRODUCTION

Virtual reality (VR) technology can be described as a technology that adds the dimensions of immersion and interactivity to 3D computer generated models and offers an exploration that is not possible with the traditional forms of representation [1]. Virtual reality is also an interactive and immersive experience (with the feeling of presence) in a simulated (autonomous) world [2]. The technology was developed in the 1960s and 1970s, but in scientific research, the 1990s were the decade when the largest number of papers concerning this topic was published. The interest in VR decreased because the cost of the necessary equipment was high, and the graphic capabilities of computers were not on the level necessary to present a realistic virtual world. The attempts at bringing VR hardware to the customer market have fallen short of commercial success. However, in the last few years, virtual reality is a stimulating technology in areas such as visualisation, software engineering, animation and game development. In recent years industry leaders such as Facebook, with their VR hardware - Oculus Rift, Google's project Glass for augmented and virtual reality, Sony, Valve and Microsoft all have once again begun to capture the public's imagination. Now, with the required level of hardware power and software services available to include in consumer devices for near-photorealistic experience, it is time for VR to make a splash in the world of computing.

Virtual reality in education is still in the early stage of adoption, offering the potential that has not been realised yet [3, 4]. In this context, we feel that virtual reality should have a much bigger role in education programmes orientated around areas such as design and product creation, architecture, television and film production, the computer games industry, interior design, animation, urban planning, exhibition design and web design. This trend has been adopted by many high ranking technical universities such as ETH in Zurich [5], Ecole Polytechnique Fédérale de Lausanne [6] and Stanford University [7]. This paper presents a newly designed course on Virtual Reality. It is one of the two courses for applied 3D visualisation offered at the Faculty of Digital Production at the Educons University in Sremska Kamenica, Serbia.

2. COURSE STRUCTURE

Immersive Virtual Reality (IVR) is an obligatory course, offered during the sixth semester of the undergraduate academic studies at the Faculty of Digital Production at the Educons University in Sremska Kamenica, Serbia and takes the form of two hours of lectures, and two hours of practical exercises a week. The aim of this course is to introduce the students to the theoretical principles of VR technology as well as to its practical use.

The lectures are organized in a way that provides an insight into the theoretical framework and historical context of virtual reality with key points in time and an emphasis on the up-to-date development of technology. The exercise classes are organized towards the practical use of VR. The hardware that is available to students is Oculus Rift DK2 headset and a computer with the hardware and software capable of rendering VR experience. The lectures and exercises are coordinated, but also adapted for optimized results considering the time given to students. The lectures are orientated toward the implementation of VR technology that is

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universal and not specifically defined by the present capabilities of contemporary hardware and software whereas the exercises are structured around the current usage of software and hardware for optimal price of equipment, time for learning, and performance.

The lectures are divided into several subsets: advanced 3D computer graphics; development of VR technology before and after 1990s; development of new VR techniques; physical based simulation; human factors and human interaction; rendering; equipment for virtual reality; display technologies; tracking systems; controllers and gloves in VR; navigation and interaction in virtual environment; collision detection; VR applications in industry; technical possibilities for practical use in personal work; relation between VR and augmented reality. We are aware of the fact that the literature about VR available in Serbian is mainly theoretically oriented, does not cover the new developments in this area, and lacks the practical knowledge that our students need. For that reason, all the information from the lectures including the guidelines for the practical software application is made available for students in the form of PowerPoint presentation in Serbian language and is updated annually. Moreover, students are encouraged to use literature in English as additional material.

The exercises are structured around the optimal practical application of VR, but also in relation to other courses in the Faculty of Digital Production. The students are introduced to different sets of computer skills before attending the IVR course. They have completed different courses that are orientated towards basic 3D modelling, image and film processing, sound editing, basic key frame 2D animation and programming among other skills. The course IVR relies on the basic understanding of the principles learnt in those earlier courses.

The software that the students are introduced to during the IVR course includes Trimble SketchUp [8], Autodesk 3ds Max [9] and Unity 3D [10]. All of these are frequently used in industry and are free of charge in education packages. SketchUp is a program for 3D modelling that is easy to use and has the biggest collection of free 3D models on the internet. 3ds Max is chosen because it is one of the most used software packages for 3D geometry creation, modification, visualisation and animation in industry. Unity 3D is a software that is free of charge for personal use and it is often used for visualisation purposes such is VR.

The framework of the IVR course is shown in table 1. This approach to the course on virtual reality in education is not new [11], but IVR is one of the rare courses developed in this way in our region. The students are also given a set of video tutorials, purposely made for them in order to provide a practical reminder of the tools that have been introduced in the exercises.

The students are not obligated to work using only the three software packages that are described above, however, they can use other software only if they have enough practical knowledge of it. The aim of this course is not to fully understand all of the features of the software mentioned, instead, only specific tools that can be universally used to create virtual environments are the focus of the IVR course. The goal of the exercises is to make each student individually capable of developing an executable programme for VR visualisation of the 3D environment. This can be measured by their final project. More on the subject of the project and the results is written in the next chapter.

Table 1. Exercises dynamics and structure

Week	Programme	Software	Overview
1st	Introduction to SketchUp software	SketchUp	Interface. Basic commands and tools. Comparative analysis with another software that is familiar to students.
2nd	Basic modelling techniques	SketchUp	Drawing 2D shapes, and forming 3D objects from them. Precision drawing techniques.
3rd	Advanced modelling techniques	SketchUp	Advanced tools for geometry creation (components, morph options, Boolean operations).
4th	Advanced options	SketchUp	Scenes management, visualisation, texture tools.
5th	Working with 3D components	SketchUp	Recapitulation and work with 3D components that are freely available. Setting a scene.
6th	Introduction to 3ds Max	3ds Max	Geometry creation and modification
7th	Texturing, animation, export of geometry	3ds Max	Texturing techniques, basic 3D animation, preparation of 3D model for export into Unity 3D software.
8th	Introduction to Unity 3D software	Unity 3D	Interface. Basic tools. Import of objects from SketchUp and 3ds Max
9th	Basic geometry and orientation	Unity 3D	Geometry manipulation and first person camera and controller setting
10th	Texturing and animation	Unity 3D	Advanced techniques for texturing and animation
11th	Audio effects	Unity 3D	Implementation of music and sound effects.
12th	Basic principles of coding in Unity	Unity 3D	Introduction into basic Java programming with MonoDevelop software
13th	Optimization of model	SketchUp, 3ds Max, Unity 3D	Adaption and optimization of 3D model for best VR performance
14th and 15th	Consultations	SketchUp, 3ds Max, Unity 3D	Recapitulation and working on individual 3D models and environments.

3. RESULTS

The students are graded based on their final exam and their skills and success on the course can be evaluated through it. The final project is individually done by all students and it takes the form of a final product that can be experienced through Virtual reality headset Oculus Rift. An executable file that is developed with Unity 3D using 3D modelling program is the final product. On the exam, the program is checked and graded.

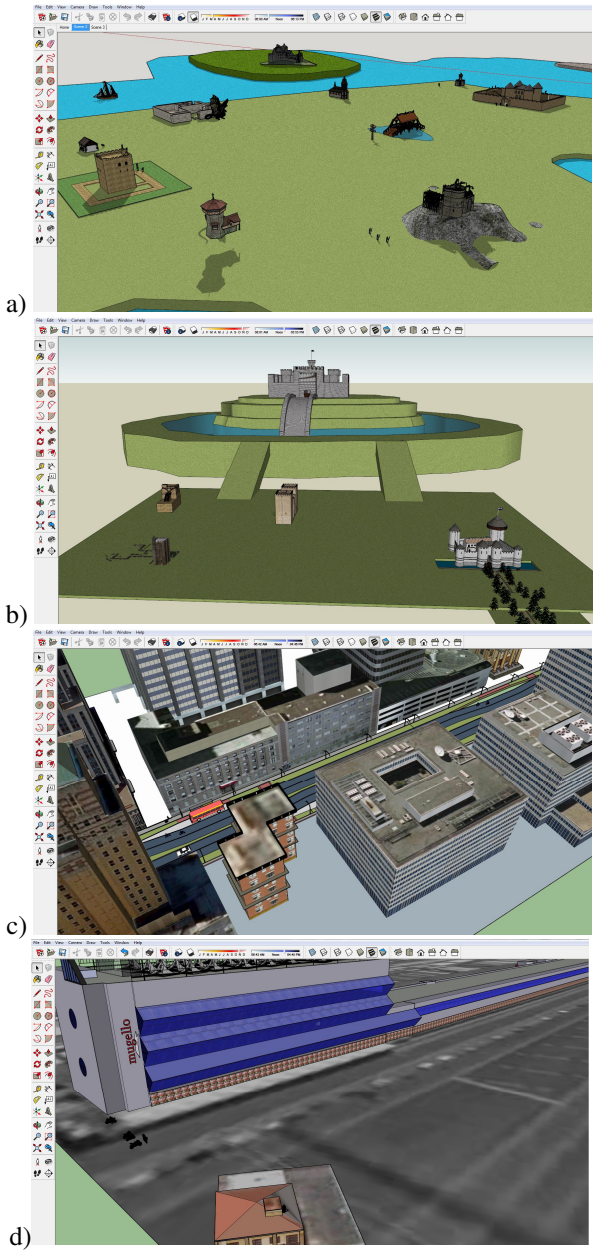


Figure 1. Student's work before consultation (a) Virtual model of a medieval village, (b) Virtual model of a medieval castle, (c) Virtual model of an urban environment, (d) Virtual model of racing track

Only four students have attended this course because only one generation of students has completed the sixth semester at the time when this paper is written.

All the students have successfully passed the exam at the end of the course. During the last weeks of the course, they brought in their unfinished work for final consultations and corrections. Figure 1 presents a student's work in this period. Geometry is based on the environment theme that they chose. The environments (a) and (b) have medieval themes, (c) has a modern theme of an urban block and (d) of racing track . The students were encouraged to develop and adapt other effects in accordance to the theme that they had chosen.

The students then corrected their work and finished the VR application. Two out of four projects are presented in this paper, based on their quality. The first presents a medieval village (figure 1 (a) and figure 2) where the project was improved by the student from the working file to the final product in order to make it better for VR application. Different components were moved in order to be closer to the camera. Also, a number of figures had to be removed so that VR could be able to show a stable frame rate. The second project presents an urban street (figure 1 (c) and figure 3) and the environment here was changed from the working file to the final product in order to present it as part of a larger city. Cubes that can be read as buildings in the distance were added. Also, a ramp was added on one of the buildings that can be used in VR application to climb on a higher point on the scene.

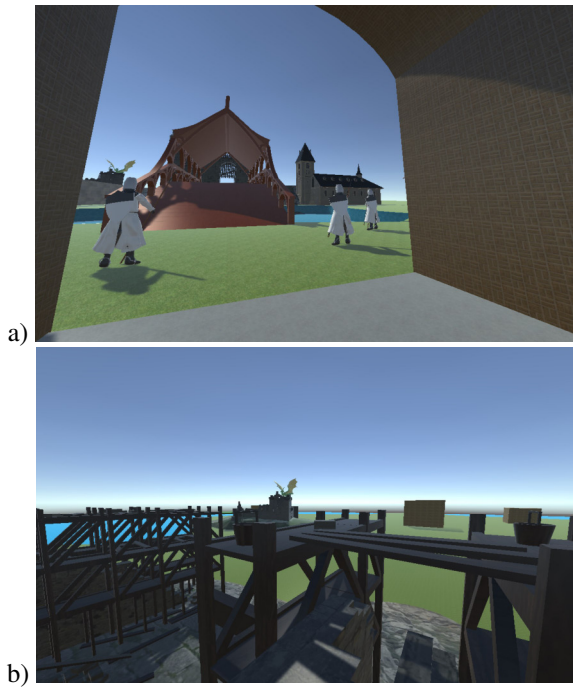
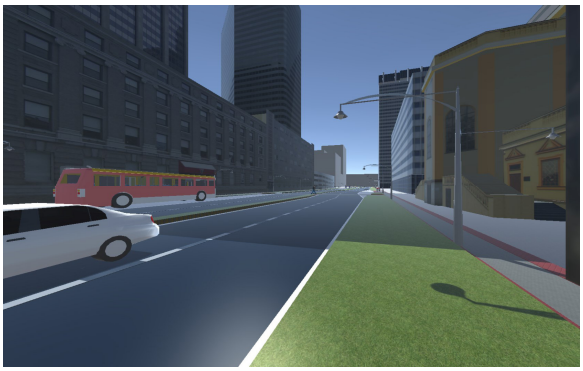


Figure 2. Final project of the medieval village; Scene rendered in Unity 3D (a) Entry point, and (b) Scene from a high point.

Our general impression is positive. The students' projects contained all the necessary elements that were stressed as important throughout the exercises, but some new opportunities for improving the course structure have been acknowledged. For example, the students did not have enough time for further elaboration of their work after they had been introduced to all the features contained in the three software packages. The animation and interaction have not been successfully incorporated into all four projects. Also, the students spent most of the time on 3D modelling of the environment, although they had attended a course of 3D modelling in the third semester. Based on this experience some changes have been made on the course. The next generation of students will be introduced to the components that make

the first part of the IVR course already in the third semester, so that in the sixth semester more attention can be directed towards good visualisation, animation application, and interaction.

a)



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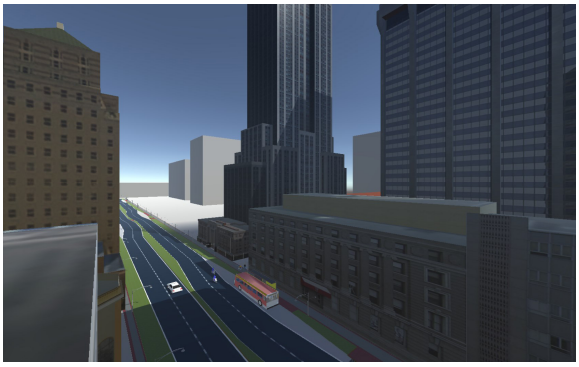

Figure 3. Final project of the urban environment; Scene rendered in Unity 3D (a) Entry point, and (b) Scene from a high point.

4. CONCLUSION

Virtual reality presents an important factor in the education of students orientated towards the field of visualisation. The educational approach chosen in this course is valid because it has enabled students that attended it to acquire the skills for VR application development. The number of students who have completed this course is small, but their results have shown that the main goal of the course was successfully reached. Some adjustments will be made in the course structure, and the information gathered through the analysis of the final project of the first generation has proved to be valuable in that respect.

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КУРС ИМЕРЗИВНЕ ВИРТУЕЛНЕ РЕАЛНОСТИ У СТУДИРАЊУ ДИГИТАЛНЕ ПРОДУКЦИЈЕ

П. Шиђанин, М. Лазић, Р. Обрадовић

Курс имерзивне виртуелне реалности је, као додатак основним студијама виртуелне реалности, један од два курса у примењеној 3Д визуализацији на Факултету дигиталне продукције Универзитета Едуконс, у Сремској Каменици, Србија. Сврха овог курса је двојака: да омогући студентима дубоко разумевање суштине виртуелне реалности и да прошири њихово практично искуство. Похађајући овај курс студенти уче најновије технологије виртуелне реалности коришћењем наочара за виртуелну реалност „Oculus Rift“. Овај рад презентира структуру курса виртуелне реалности, који повезује студентима техничке оријентације са аспектом уметничке визуализације у дигиталној продукцији.

Исход курса је финални пројекат, урађен од стране сваког појединог студента, који обухвата имплементацију ВР система кога су студенти способни да користе. Постигнути резултати курса су приказани и анализирани у овом раду.