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ON THE ROLE OF AUDIO EFFECTS IN REALISM OF VIRTUAL REALITY SYSTEMS

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Abstract: *The aim of this article is to consider contribution of audio effects in increasing realism of virtual reality systems. This is done using example of car driving simulator, which is under development at University Metropolitan. Analysis include contribution of particular details as well as complete audio environment. Sound is recorded on the car in motion using mobile recording system and music is composed by iPad device with appropriate tools. Car driving simulator is multi PC platform equipped with low cost gaming hardware, developed using standard game development technology, as a part of education process at Belgrade Metropolitan University.*

Keywords: *E-Learning, Educational systems, Virtual reality, Simulation, Audio effects*

1. INTRODUCTION

Learning by reading is one of unavoidable methods in all schools. On the other hand, acc to Dale's cone of experience [6] learner retain twice more information of what they HEAR, five times more of what they SEE and HEAR, and nine times of what they DO. That is why a student is put into improvised "real" environment (a kind of laboratory and/or equipment) whenever is possible and asked to perform the task or activity, which is a learning objective.

The advent of computers and specially PCs and computer graphics enabled computer assisted illusion of reality called virtual reality (VR), which is exploited everywhere - from engineering and production, to everyday life, art and entertainment. Usually virtual reality is primarily experienced through two of the five senses: sight and sound, but may also include touch feel. The simplest form of virtual reality is a 3-D image that can be explored interactively at a computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. More sophisticated VR involve wrap-around display screens, actual rooms augmented with wearable computers, and haptic devices that let you feel the display images.

Low cost VR systems are very attractive to be used in education. They are also known as serious games or educational games (wihch are similar but nort quite identic concepts).

There is an increased interest among young population in South-East Europe for new media, virtual reality and game based technologies. In spite of lack of official university programs, young people from the region often participate into various student competitions, frequently with significant success (for example, Imagine Cup). As a result, various educational courses were open, among them computer game design course at BMU (Belgrade Metropolitan University), and the promising experiences are reported in [1-5].

This part of article presents experience in teaching of Computer games and associated educational virtual reality systems at Belgrade Metropolitan University (BMU), where bachelor, master and doctoral levels of study are available. Thus during the studies a student is focused on basic techniques, as well as on more advanced ones, which usually make part of research work.

Special class of VR systems are educational VR systems, example of which is training simulation device. The aim of this article is to describe some of the results in teaching and development of VR educational systems at BMU. A car driving simulator is developed and used in teaching of techniques how to build VR educational system. Specifically, increasing of audio fidelity of simulation device is described in this paper. The technique applied is suitable both for subjective and objective evaluation of simulating device.

The paper is organized as follows:

Next section discusses some basic facts of the computer games education as well as VR systems.

Section 3 presents teaching of design and development of computer game course and VR systems at BMU.

Several student projects, described in section 4, illustrate teaching results and relative success.

2. STUDIES AT BMU OF COMPUTER GAMES

Virtual reality systems offer favourable possibilities for education since they give feeling of being immersed in synthetic world, enabling a student a safe way to learn, even in adverse weather conditions and independent of geographic location or historic period. The computer game technology and specially class of serious games offers low-cost VR systems which may be applied even in schools with low budget.

At BMU 3D graphics and VR systems is central area of two curriculums:

- Interactive media at FDA (Faculty of Digital Arts)
- Computer Games at FIT (Faculty of Informatics Technologies), at bachelor level [1].

Master and doctoral level studies contain several courses (like design of virtual reality systems, serious games, real time simulations) as a part their curriculum.

Interactive media is artistic oriented curriculum, with the primary goal to learn how to create and animate in 3D objects and virtual worlds. Thus, techniques learned are based on using drawing and modelling tools (e.g. Photoshop and Maya) to produce 2D and 3D artefacts, as well as easy to use game engines (e.g. Game Maker Studio and Unity 3D). After finishing studies at bachelor level students are able to create their own simple games or similar interactive graphical applications using easy to use game engines.

Computer Games curriculum at FIT is considered as a part of Computer Science and Software Engineering with primary aim to create software for real time graphical-based applications and computer games. Goal of these studies is to learn basic 2D and 3D programming techniques, how to optimize computer resources to enable efficient real-time rendering and how to attribute physically realistic and intelligent behaviour to virtual worlds.

After finishing studies at bachelor level students are able to create their own simple game or similar interactive graphical application using programming language (e.g. C++ C#, or other).

Master and doctoral level of studies are also available at BMU, both at FDA and FIT and more advanced 3D modelling and rendering techniques make part of it.

Virtual Reality systems are studied at FDA going beyond traditional artistic limits - study includes also programing aspects of creating VR worlds. On the other hand, studies at FIT, although primarily oriented towards programing virtual worlds and real time simulation, include also modeling techniques in order to produce simple 2D and 3D assets for virtual worlds.

More details on curriculums implementation at BMU may be found in references [1-5].

3. COMPUTER GAMES AND VR AT BMU

Master studies at BMU are focused on low cost virtual reality systems and real time simulations, which largely coincide with so-called serious games.

Unlike traditional games designed primarily for entertainment, serious games have additional purpose (usually education or training). In fact, serious games attempt to serve as low cost version of more complex (and expensive) virtual reality based training and simulation systems (that's why are often called „light-weight simulators“). In other words, serious games exploit well developed game technology to solve (some of) the tasks in simulation and training, but also to preserve challenges and attractiveness of entertainment games.

In serious game context virtual (or game) world should be more close to real world. It is also useful if this closeness could be objectively evaluated. Especially a class of simulation games used for training purposes should possess not only high visual realism but also realistic time behaviour of virtual world.

For this reason design of serious games often goes beyond basic game implementation techniques and requires more efficient and improved solutions. In the following text some of the results will be presented, obtained by students at doctoral, master and bachelor level, to illustrate both the study content and challenges in extended game application area.

4. EXAMPLES OF STUDENTS WORK AT BMU

Team projects

Teaching of games and virtual reality systems are centered around practical work and producing functional outcomes. This means that in the scope of concrete course student should realize functional game or similar VR application featuring properties specific to course goals. By default at BMU, student fulfils this task through individual student project, which is supposed to take 40 to 60 hours of one semester.

Due to complexity of VR systems and computer games, requiring several (experienced) man months even for relatively simpler systems, there is a risk in education to reduce student projects to trivial examples, far from real-life projects.

For this reason the students are organized in development teams, working on common project which may be more complex and realistic. In fact, the team project is composed from individual student projects thus preserving compatibility with educational model established at BMU. Grading of every student is individual, but usually there is an interest to go beyond individual task and realize final goal (objective of team project) which is more challenging and motivating.

This approach also permits to compose teams from students of various levels of education. As an example is the project of audio effects of low cost driving simulator (serious game) described in this paper. The team was composed of one doctoral student, one master student and three bachelor students. Project duration was spring semester 2015.

From global point of view, one project may be spread over several years and generations of students, exploiting classical spiral model of system (or software) development or modern agile methodology.

This allows making student projects more close to one in industrial environments, especially with respect to advances in technology. Also, this permits to make academic projects more advanced in technology than industrial projects, usually constrained to strong deadlines and financial results closely related to concrete project requirements.

Serious game

One of the group projects associated with serious games and virtual reality study is car driving simulation game. It is planned as student project whose activities are split in series of homework and student individual or team projects, and series of iterations which will lead to realistic training environment. Each homework should contribute to the current version of simulator (in some aspects like study of alternative solutions), and each student's project should result in new working prototype.

Figure 1 shows screenshot of simulator with interior of a cockpit of a car in urban traffic environment.

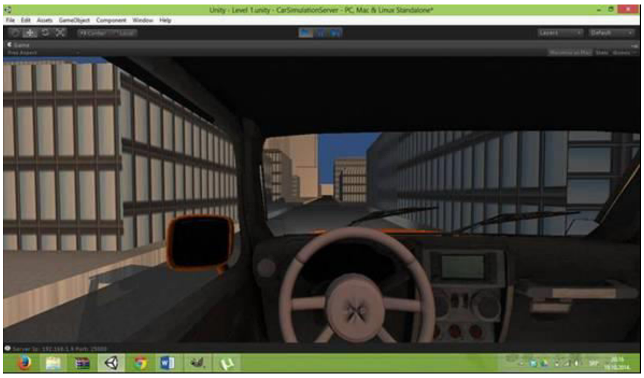

Figure 1. Car driving simulator – serious game

Car driving simulator

This is of one of educational projects at BMU. Brief history of the project is as follows.

First version of car driving simulator, named SimAuto was done by student V. Petković in 2013. The cockpit of a car and urban scene was modeled in Maya, imported in Unity 3D. With a camera attached at driver eye position and simple script, this game-like simulator enabled exploring scene using WASD style controls. Fig 1 represents screenshot taken from SimAuto.

Next version of SimAuto was multi PC implementation using networking concepts avelable in Unity 3D, which was elaborated in two independent individual student projects (D. Manesku and M. Šarac). Both of them investigated various networking options and specificities of multitasking simulator implementation, proposing their own choice. All other functional fetures of first SimAuto version was retained (the original 3D model of the scene and car interior as well as WASD controls).

The result of these projects was distributed architecture of simulator on several computers, shown in fig. 2.

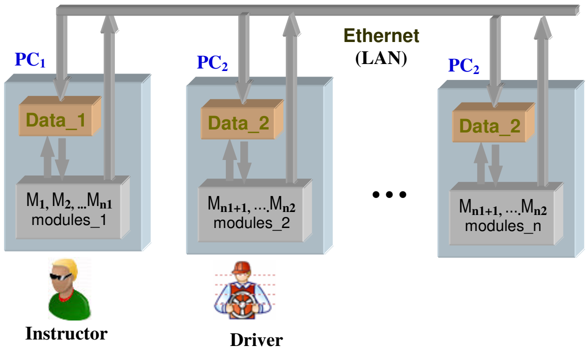

Figure 2. Distributed architecture of simulator

Third version od SimAuto was based on the previous works and represented the shift toward simulator-like VR system, possessing the following features.

The driver field of view vas spread to a wide angle of view using several monitors, i.e multichannel visual system. Each monitor generates part of field of view (approximately 40 deg in actual implementation) enabling visual scene generation up to 360 deg. Each monitor is driven by its separate PC hosted module, communicating with other simulator modules by network.

Figure3 4 screen SimAuto version

The virtual car was controlled using driving wheel and pedals – one from collection of low cost gaming hardware available on the market. This, as well as better visual driver communication with environment created more realistic experience while driving virtual vehicle.

Finally, last bat not least, this simulator version uses more realistic car dynamic model, tuned to represent vehicle Opel Corsa 1000. More details on mathematical relations and procedure of tuning th model are given in reference [5].

The third SimAUto version was developed an tested by student M. Tanić, as a part of his bachelor thesis in computer games at BMU.

Figure Simulator-driver interaction

Last version of SimAuto was developed during the spring semester in 2015 by the project team of BMU students: Ćeranić N. -doctoral student, Sabo I. – master student, Dragojević S, Redić M., Parapid A. –all bachelor students.

The objective was to improve some important simulation features which remained unchanged since the original version of SimAuto.

The visual scene is more careful modeled to represent urban traffic environment i.e streets with traffic signalization, buildings and trees with more realistic representation. Also, the area of visual scene is extended, adding additional suburbs with different traffic conditions. This may enable training of driver for different kind of tasks.

Figure Screenshot of SimAuto last version

The other vehicles are added to simulation base. This enables change of driven car model and population of traffic situation with different cars controlled by virtual drivers (not implemented yet).

Figure SimAuto features various vehicles

Finally, the audio driver – VR environment interaction were added to the simulation, the last missing component of previous SimAuto versions necessary to be more close to industrial simulator devices. This activity was not just adding a sound effects like completing the list of necessary items.

The several records are taken on real cars during drive in urban environment. The reords are carefully analised to extract contribution of various internal sources (engine sound, horn, directional signalization, radio etc.) as well as external sources, specific to urban environment.

Extrated sound sequences are filtered an then (after comparison with original record) included in simulation. This approach is suitable for subjective as well as objective simulator audio evaluation, necessary for device certification procedure.

Since objective of each student was to finalize his own individual project, integration of all contributions in final simulator configuration was not perfect. However, better integration of all components as well as optimization of simulator may be done in the next student-project phase.

5. CONCLUSION

Our practice shows that the students need to be taught basic principles of their professional disciplines, and if properly motivated, they can master the tools themselves and be quite creative with them – from using many features of the tools, to enhancing and optimizing the tools themselves. Moreover, as 3D modeling and rendering in real time (virtual reality and games context) should be performed taking into account functional properties of the application in order to efficiently utilize computer resources.
New university course in computer game development, opened at Belgrade Metropolitan University, in a few years give good results, promising to further enhance this process. Part of this success is due to applying an untraditional concepts of Gamification and Problem Based Learning in teaching the students how to create modern computer games.

The paper reports the approach used in teaching of educational serious games, also known as educational virtual reality systems. The obtained results shows increased interest in completing his individual projects as well as even tendency to go beyond the scope of curriculum covered by lessons.

Present study at BMU gives encouraging results not only in teaching students how to create games and VR applications, but also shows that the students can contribute to development of low cost Virtual Reality technologies in South-East Europe.

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