Abstract – Due to digitalization the use of virtual environments in different products and services has increased in many fields. For decades military and aviation simulators have shown way of utilizing VE’s for training. The increasing need of virtual environments that are based on real environments has been recognized in several areas. For example healthcare, sports and forest industry have woken up to the possibilities to utilize VE’s in their businesses. However, the markets are lacking a solution to generate high quality virtual environments cost-effectively based on different kind of databases from real environments. In this paper we present the software that utilizes data from different sources to generate virtual environments based on real environment cost-efficiently.

Keywords: Virtual environment, digitalization, terrain data, geological data, GPS.

1 Introduction

Brooks [1] defines a virtual reality experience “as any in which the user is effectively immersed in a responsive virtual world”. It is hard to find a difference between terms virtual reality and virtual environment. Virtual environment could be said to be more “concrete” and virtual reality more “abstract”. In this article we define the term virtual environment (VE) as real-looking virtual landscape, which is based on real environment data or on imaginary environment.

For decades military as well as driving and working machine simulator manufacturers have used virtual reality in their training. The expectations of virtual reality have always been enormous, but so far the technology and applications have not made possible the final breakthrough. Digitalization, growth of entertainment business, technology development and more sophisticated tools to create low-cost, but high quality virtual environments may finally open the doors to apply VE’s to new areas in an enormous scale. Oculus Rift and other virtual headsets will have a remarkable role in this revolution. Augmented reality is following quickly due to technological developments and may bring even a bigger revolution than VE’s in the future. Still, it is good to remember the difference of these technologies and that they are not direct competitors with each other. They have their own strengths and will be used in a most of the cases for different purposes.

An increasing need to create high quality virtual environments based on real land areas has been recognized in different businesses. Nevertheless, virtualizing a real land area is time consuming and rather expensive. There are usually many kinds of geological and terrain data available which could be utilized in the creation of virtual environment. For the need to decrease the development costs and time we started to develop ScenicoTool software which will semi-automate the creation of virtual environment. We succeeded to develop software that uses different kind of geological and other data to generate high quality virtual environments in very short time.

2 The use of virtual environments

In the last couple of years the use of virtual environments (VE’s) has expanded to many new fields. Typical applications have been flying and driving training simulators, entertainment (especially games), architecture, education, medicine, healthcare, sports and arts. Usually the purpose of utilizing VE’s to these areas has been to improve safety, skills and/or efficiency and to save time and/or money. Product developers and service providers want to offer close to real-life experiences by using VE’s. For educational purposes VE’s are used especially to achieve more efficient learning results, and entertainment business aims at providing people enjoyment and hooking moments e.g., by playing games. There is lot of scientific evidence of the use of VE’s to e.g., achieve good learning results [2] and increase the physical activity level [3].

Even though virtual environments have been utilized for several fields, it has most likely been just a scratch of the possibilities VE’s provide. It is likely that new innovations that utilize VE’s will be announced in rapidly growing phase in the forthcoming years. Market analysis of the use of virtual environments and augmented reality forecast remarkable growth. The annual growth of these markets is expected to be about 15% in 2013-2018 and reach $1.06 Billion in 2018 [4].

Recently the use of VE’s has increased drastically by game industry due to the enormous growth of the industry. Games such as SimCity and Cities: Skylines are good examples of games that are built to simulate high quality virtual cities and worlds. Construction industry, architecture and environment planning are utilizing VE’s in their planning projects. VE’s have been utilized to present prototypes of the buildings and rooms, but can be utilized also for an iterative, user-informed process throughout the entire design and development cycle [5]. Forest and mining industry have been
utilizing VE’s in their simulators (e.g., companies such as Ponsse, Tenstar and MeVEA). Also driving simulator manufacturers utilize high quality VE’s in their simulators (e.g., Oktal, Realtime Technologies, Eca Faros). Exercising and athlete training have been provided with new innovations [6] in which VE’s provide new tools and motivating content into training [3]. Tourism services are taking advantage of 3D visualizations in their operations and services (e.g., Vatican offers 3D tour in Sistine Chapel). These and many other fields benefit from VE’s that are representing the real environments in high and accurate enough quality.

Due to improvements in technological capabilities of hardware and software, such as continuously growing processing power, image resolution and more powerful graphic cards as well as communication bandwidth, the quality of virtual environments have improved quickly. Also in gaming industry the game engines such as Unity3D and Unreal Engine provide good tools for game developers to create high quality virtual environments. Moreover, a great number of graphic designers provide good quality 3D models, texture packages and virtual environments for reasonable costs.

Despite the above-mentioned improvements in technologies, the development of VE’s based on real land areas is still very challenging. The development requires most often lot of handwork and is very time consuming. There are software that enable creation of virtual environments (e.g., Virtual Terrain Project and WorldComposer) by utilizing different databases (e.g., Open Street Map, point clouds, road data databases). Still, existing software are utilizing only a part of the available data, which could be used to add more details to VE. Also support to import created VE’s to other software, such as simulator software is missing.

3 Landscape data

In the transit of digitalization, huge data masses concerning e.g., geological and forest data are stored in cloud services and other storages. Vast information of landscape data from all over the Globe is available for organizations to build up new services. Some of the data are freely available for research and educational but also for commercial use. On the other hand, some of the data may be rather expensive.

4 The background of the project in Kajaani University of Applied Sciences

During 2010-2012, along with the research and development of driving simulators we learned, for example, how to create high quality virtual environments, how to build and use multiscreen CAVE environment and how to control and fine tune different motion platforms [7]. During the 2013-2014 we have developed a new kind of exergaming simulator for gym training, fitness testing and rehabilitation. The target was to develop a simulator, which integrates different exercising, and rehabilitation devices, immersive virtual environment, games, and advanced motion controllers in order to bring these devices to a new level [6]. During these projects the idea of semi-automatization of virtual environments in a cost-effective way for generating new VE’s was recognized. The development of VE’s has required rather much handwork and it used to be time consuming especially when the virtual environment has been made to be one-to-one copy of the real environment. Much of the development of virtual environments was done manually by graphic designers with help of numerous pictures of the environment and Google Street View.

In discussions with organizations in the municipality of Kainuu and in further Finland, it was recognized that numerous organizations saw benefits of utilizing virtual environments in their services, especially if the VE’s were based on the real environments. However, these (VE’s) should be achieved easily and with reasonable costs and should be able to import different software. As no such software that would enhance the VE creation process were recognized, a software development project was initiated at Kajaani University of Applied Sciences. The objective of the project was to develop a tool for semi-automatic creation of virtual environments. The competent software developers at the University were recruited to work for semi-automating the creation of VE’s with software that use different databases to create the VE based on real terrain and other data.

5 Development team

The R&D team consisted of team lead and software team with three talented developers and two graphic designers. Unity3D game engine was chosen for the platform of development, as it was already familiar to the team and its features suit well also to other operations than game development. It offers lots of ready 3d objects and features for instance for modeling different weather conditions and seasons.

The project was done in collaboration with several organizations that represented different fields, such as sports, forest industry and rehabilitation. In the beginning of the project, reviews of available data and formats as well as possible costs of the data were explored. It was also important to discuss with forest industry experts to understand what kind of data are available for example from forest databases.

6 ScenicoTool software

The developed ScenicoTool software is able to generate quickly virtual forest environments that are based on real Finnish environments. Currently the data provided by National Land Survey of Finland (NLS; freely available data) and by Finnish Forest Centre is used. The terrain is based on the Digital Elevation Models that the NLS provides on the accuracy of two meters. The undergrowth, big rocks, paths and tracks, roads etc. are also captured from the data provided by NLS. The different types of trees are put on their places on 16x16 meter raster’s based on the data from Finnish Forest Centre or respectively, from Metsähallitus, which is a state
enterprise that administers majority of state-owned land and water areas in Finland.

After the first phase of software development was ready, the development of GPS data feature was started. The aim was 1) to use GPS data to generate virtual environments in which the recorded route matches the real world equivalent but all the surrounding nature is based on imaginary environment and 2) to add GPS routes to the VE that is created based on the databases of real environment. The objective for utilizing GPS data was to open new possibilities to create real world routes even there is no other data available. This improvement will open up new possibilities specially to use VE’s e.g., in various simulators and sports.

7 Pilot cases for testing the tool

During the R&D project, ScenicoTool software was tested in several cases, targeted to sectors of forest, sports, and rehabilitation. The pilot cases are presented next.

FOREST. Finnish Forest Center played an important role in the project. Their expertise on forest and GIS data helped to understand how to effectively utilize the forest data. Other partners in this work package represented forest machine simulator manufacturer and forest machine manufacturer, who utilize virtual environments in the training simulators. The game engine enabled exporting the virtual environment that was created with Unity3D to match the requirements of the simulator software.

Specific land area from Kajaani, Finland (Pöllyvaara recreation area), was chosen for pilot testing. After generating the environment, it was tested in Athene Exergaming simulator (Fig.1).

SPORT. The ScenicoTool was used to create virtual Kontiolahti Stadium and skiing tracks, as well as the terrain and forest based on the real Kontiolahti area. The graphic designers modeled the 3d objects such as buildings and other assets. The tracks of Biathlon 2015 World Championships were created in the virtual environment and tested at Vuokatti Testing Center in December 2014. The virtual Kontiolahti was attached with a large treadmill and the athletes were able to walk, run and roller ski through the competition tracks.

Figure 2. Virtual Kontiolahti was developed for Athletes training.

REHABILITATION. The partners in this pilot case represented rehabilitation. These partners saw value in being able to provide virtual environments as part of e.g., physiotherapy with a recumbent bike or a treadmill so that the rehabilitees would exercise in places that are familiar to them. In the project, THERA-Trainer Tigo restorator bike was used with virtual environments in the rehabilitation exercises (Fig.3). Created VE’s were tested with a rehabilitation pilot group with good feedback of the increased motivation and enjoyment for exercising.

Figure 3. Virtual environments were tested for rehabilitation use.

8 Conclusions

The software will be a valuable tool for many purposes. Sports and health care will benefit of getting access to virtual environments that are based on real areas, which is very valuable for instance in preparations and coaching for forthcoming championships, exercise testing, training and rehabilitation. The forest owners and forest machine operators can be provided with a visualization of how the forest property would look like e.g., in the case of logging and also
move in the virtual forest. The virtual environments are useful also for, e.g., forest machine training simulators. For tourism, applications to show the nature could be rather quickly be initiated.

ScenicoTool software development has taken the first steps. As the software is created as a plug-in to Unity3D engine, it is very straightforward to export the created VE’s into various software and products. The next steps will be looking at the data from different countries in order to enhance the software to develop environments from all over the globe, and later on commercialize the software.

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