

Virtual Environment of Real Sport Hall and Analyzing Rendering Quality

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Abstract - Here is presented virtual environment of a real sport hall created in Quest3D VR Edition. All analyzes of the rendering quality, techniques of interaction and performance of the system in real time are presented. We made critical analysis on all of these techniques on different machines and have excellent results.

Keywords - Virtual reality, Virtual environments, Scientific visualization, Computer design, Techniques of interaction.

1. Introduction

"Scientific visualization is the use of computer graphics to create visual images which aid in the understanding of complex, often massive numerical representations of scientific concepts or results (McCormick, 1987)."[1]

Visualization is essential in interpreting data for many scientific problems. It transforms numerical data into a visual representation which is much easier to understand for humans. [2]

The process of data visualization can be described as a sequence of fundamental processing steps:

- Simulation: results of numerical simulations (or data sensing / measurement) are the input of the visualization pipeline.
- Data selection & filtering: relevant regions of the raw data are selected, then filtered and enhanced. Techniques such as for example: enrichment & enhancement, data cropping, down-sizing, noise filtering, segmentation and feature extraction can be used.
- Visualization mapping: the processed data have to be mapped / transformed into graphical primitives such as points, lines, planes / surfaces (triangle meshes), or icons, and their properties such as color, texture or opacity.

- Rendering: finally, the graphical primitives are rendered as images, which are then displayed on the screen.

Virtual reality can be defined in many ways, which all come down to the definition of a significant relationship between human and computer. It can be described as a simulation that computer graphics applies for creating a world with realistic view and that synthetic world is not static, but responds in some way to the reaction of the user and modify the environment in real time. Interactivity and its effect contributes to a strong sense of Immersion - including in the environment in which is the user. He can see and manipulate with graphical objects on the screen, but also could touch and feel. Studies go in that direction to make sensors for hearing, taste and smell.[3]

In this paper, we refer to the concept of immersive Virtual Reality, which gives the user the psycho-physical experience of being present in a virtual environment consisting of interactive (virtual) objects. This experience is achieved by a proper integration of VR hardware (3D displays and spatial interaction devices) with a responsive computer-generated 3D environment.

Feeling of space and depth is essential for every VR system. The human visual system interprets the depth in sensed images using both physiological and psychophysical cues. Through the use of artificial depth cues in computer graphics, these spatial sensations can be simulated. In Immersive Virtual Reality, stereo display and head tracking are used to provide the binocular parallax and motion parallax, respectively.[4]

Visualization in a technology of virtual reality is a graphic representation of the virtual environment in the form of images or animation and can be displayed with various output devices such as monitors, LCD projectors, TVs and similar devices that can display three-dimensional world.

2. Visualization of Sport Hall

For making 3D model it is necessary to collect all information, dimensions, colors, etc. Next step is creating textures for a given model. Each required texture is processed in Adobe Photoshop and then imported into software for virtual reality. For this research we used real model, a sports hall with dimensions 40m x 20 m with capacity for 500 peoples and its environment.

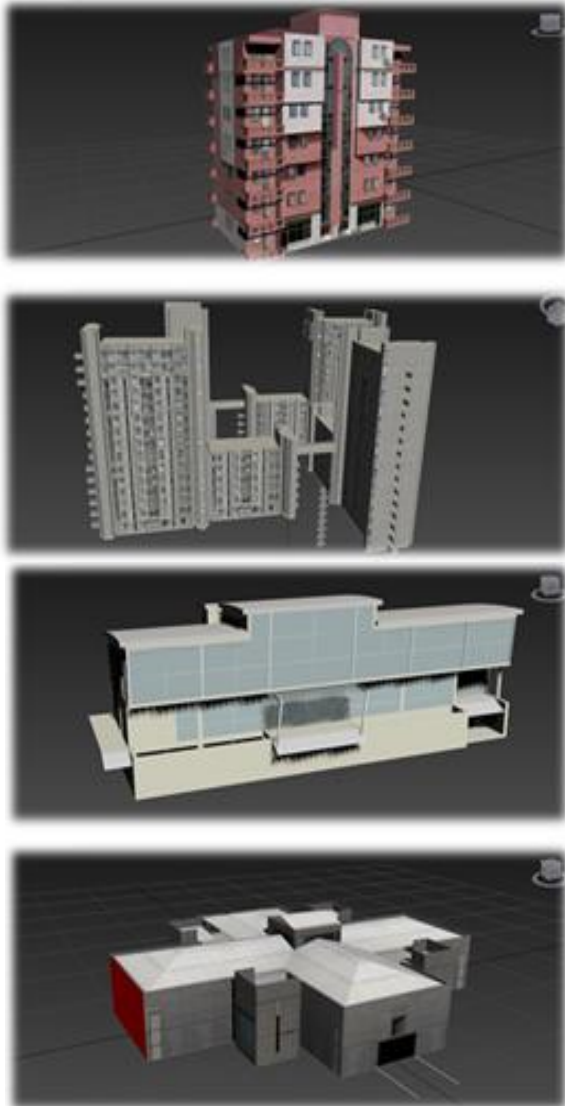


Figure 1. 3D Studio max model

Then we prepared all of these objects for entry into Quest3D.



Figure 2. Virtual environment of sport hall

On next figure we made comparison of 3D models in both softwares, 3D Studio Max and Quest3D VR. From it can be seen the difference of graphic quality on the same computer system. The quality of rendering in Quest3D is much better, with stronger colors and tones and much more realistic look. With that feeling, the user has a better sense of comfort and immersion in virtual world.[5]

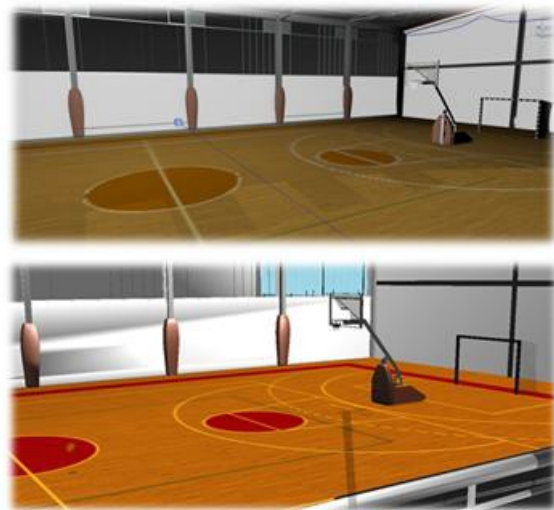


Figure 3. Comparison in both softwares

After that we made comparison on the virtual environment in Quest3D, on different computer systems with different configurations. This comparison shows us the dependence of application of computer components, especially graphics card. Figures and specification of the system show that the difference in quality of rendering is very small. HP Workstation computer system rendered with slightly greater speed and quality versus computer system Toshiba Sattelite A660. It has better graphics card, faster processor and better screen resolution of 1920x1200pixels.

However, rendering on computer system Toshiba Satellite A660 has excellent quality and speed. On both computers the whole process was in real time.

Table 1. Specification on different computers

Category	Toshiba Satellite A660	HP Z210 Workstation
CPU	Intel Core I5 2.27GHz	Intel Core I7 3.2GHz
RAM memory	4GB	8GB
Graphic cards	NVIDIA GeForce GT 330M, 1GB DDR3 memory	AMD Firepro V5900, 2GB GDDR5 memory
Resolution	1366x768, 60Hz	1920x1200, 60Hz
Hard Disk Space	640GB	1TB
Operating System	Windows 7 64 Bit	Windows 7 64 Bit
Quest 3D VR	Ver. 4.3.2	Ver. 4.3.2
3D Studio Max	2013	2013
Photoshop	CS5	CS5

3. Interactions in Virtual Environment

Interaction is an essential characteristic of virtual environments. [6] Much has been published about interaction techniques in VR but the quest for truly intuitive and natural interaction techniques is still going on. Interaction between users and virtual environments is complex. Users must be able to navigate through 3D space, manipulate with virtual objects or control parameters of a simulation, and interact with the 3D GUI inside the virtual environment in a user-friendly way. [7]

In our virtual environment interaction between the objects gives a sense of freedom and reality. It relates to the interaction on shadows of the objects and their movement are in real time. With every movement of the sun light, shadows move together with ball under physical laws. Movements are in real time so the user feels comfortable and real in our virtual environment.

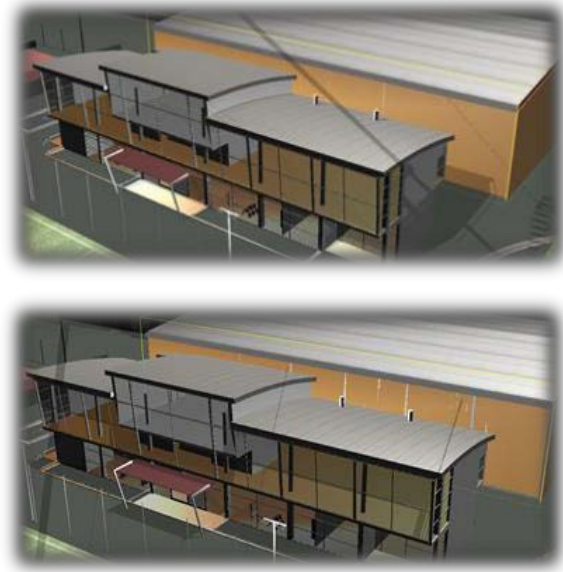


Figure 4. Interactions in real time

One important characteristic in virtual reality are interactions with environment.[8] In our case it relates to the falling of sunlight on objects and sport hall and motion of their shadows, depending on the light source. With reducing the intensity of sunlight, decline the strength of a shadows. When sun move from east to west, movements of a shadows are opposite of the light source.

4. Conclusion

Our comparison gives some great results in the field of virtual reality .Performance of the system is very important characteristic when rendering is in real time. If system displays minimum 10 f/s, it is considered that it is in real time. Our 3D model displayed 25 f/s. and can speed up to 60 f/s. This means that user can feel natural in our virtual world. From the performed comparison on different computer systems we concluded that walking in virtual environment in real-time, computer system should have minimum 1GB RAM and a graphics card that supports DirectX 9. Graphic cards that we used in our research were good and with extra performance and we haven't any problems. System speed should be at least 1GHz minimum, but our systems were stronger than that.

Table 2. Analysis of the results

Category	Toshiba Satellite A660	HP Z210 Workstation
Rendering Quality	Good	Excellent
Rendering Speed	excellent	excellent
Real Time Rendering	Yes, with 25 frames/sec.	Yes, with 25 frames/sec.
Interactions between objects in Real Time	Yes	Yes
Interactions with environment	Yes	Yes
Minimum performance of computer system for Real Time rendering	CPU Speed - 1GH System memory – 1GB Graphic card with DirectX 9	CPU Speed - 1GH System memory – 1GB Graphic card with DirectX 9

At our Graphic department in our faculty, we developed a model for interactive scientific visualization that is based on the following principles:

- User friendly interface;
- Using open source libraries;
- Using computer monitor or LED TV;
- Inexpensive accessories needed for virtual navigation (HMD, virtual stick).
- Will cost under 1000 EUR.

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