Chapter 60
Collaborative Work and Learning with Large Amount of Graphical Content in a 3D Virtual World Using Texture Generation Model Built on Stream Processors

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ABSTRACT

In this paper, the authors address the challenges of applying three-dimensional virtual worlds for collaborative work and learning, such as steep learning curve and the demands for computational and network resources. We developed a texture generation model utilizing stream processors that allows displaying large amount of meaningful content in virtual worlds, reducing the technical requirements and allowing convenient tools that simplify the use of the technology, and therefore, improve the negative learning curve effect. The authors present original methods of generating images and several tools implemented in vAcademia virtual world. A tool called Sticky Notes is presented in detail as an example. In addition, the authors provide the evaluation of the suggested model and the first result of the user evaluation.

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Three-dimensional Virtual Environments and Social Virtual Worlds (3D VWs) provide both opportunities and challenges for education, and many topics in this area need further research (Burkle & Kinshuk, 2009; Kluge & Riley, 2008). Despite the repeated positive conclusions, 3D VWs have not become widely used, and researchers often report that their studies have experimental nature. The most common problems with applying 3D VWs in the everyday teaching and learning are steep learning curve and demand for computational and network resources (Helmer, 2007; Kumar et al., 2008). While the computers and networks are constantly improving, 3D VWs require significant improvement as well to make them more convenient for educators and to deal with the steep learning curve.

The work presented in this paper is devoted to designing and implementing a method for texture generation of educational content using stream processors. Although image processing and texture generation on stream processors has been used in computer games for several years, we consider textures of educational materials in particular that are characterized by meaningful content aimed by a teacher. In addition, we propose a generalized mathematical model and a programming model for the method. In terms of scientific contribution, this work can be interpreted as solving a new problem using a well-known method.

One of the challenges for applying 3D VWs for learning – steep learning curve is addressed in this paper by enabling collaborative learning scenarios which require large amounts of 2D graphical content displayed. We present the design of a collaborative graphical workspace of vAcademia 3D VW, which is implemented as a set of tools for collaborative work on 2D graphical content. We argue that such a workspace should be specially designed for learning and integrated into the 3D environment. We propose that the integration of such a workspace is of high value, as they ease collaborative process and reduce the necessity for using additional software. Implementing tools that are familiar for learners and educators can facilitate the process of adapting the system into practice.

The other challenge for applying 3D VWs for collaborative work and learning is their demand for computational and network resources. The CPU is constantly loaded with tasks supporting the virtual environment. Therefore, sustaining additional resource-demanding processes with CPU, such as processing large amounts of images, often results in unsatisfactory performance. In the modern systems, many image-processing tasks are not suitable for being calculated on CPU, as it is loaded with other tasks or excessive computation time is required. In addition, processing many tasks using CPU is inefficient, as the source data for the synthesis of images and the data area for the resultant images are in the local memory of other devices. Usually, the data communication between main and device memories is done through the data bus, which has a limited capacity. The data-communication rate limits the performance of the approach significantly.

The described types of tasks include, for example, image processing for subsequent use as textures for rendering 3D scenes in virtual environments. 3D visualization in such applications is hardware-based and conducted on Stream Processors (SPs) – highly-parallel calculation units that are mostly used for 3D graphics rendering (Joao Afonso, Luis Pedro, Pedro Almeida, Fernando Ramos, & Santos, 2009). The source data are in the local memory of the graphics card, and the CPU is heavily loaded with calculations related to the maintenance of the virtual environment.

This implies that processing images using the capabilities of SPs directly can be efficient, especially given the fact that their computing power usually exceeds the capabilities of CPUs tenfold. However, the SPs have some serious hardware limitations due to their architecture. These limitations do not allow using them for implementing most of the classical image-processing algorithms. Some of the image processing tasks require completely new approaches.

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