A GPU-based Real-time Rendering Method for Immersive Stereoscopic Displays

Kensei Jo* Kouta Minamizawa† Hideaki Nii Naoki Kawakami Susumu Tachi
The University of Tokyo

Figure 1: *Left: The appearance of TWISTER IV(Telexistence Wide-angle Immersive STEReoscope model IV). Right: We selected the open source first person shooting game Cube (http://cubeengine.com/) and rendered it by using our method.This figure shows immersive stereoscopic images for left eye (1584×600[pixel]). The method could render stereo images of Cube at 20–30fps.*

1 Introduction

In recent years, a variety of immersive stereoscopic displays that can present highly realistic views to users have been developed. One examples of such displays is the system developed by us, called TWISTER (Telexistence Wide-angle Immersive STEReoscope)[Tachi et al. 1996] , that can show immersive stereoscopic vision without requiring special glasses.

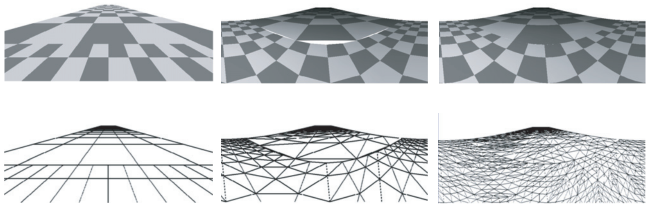
It is difficult to render real-time immersive stereoscopic scenes as natural as experienced in our daily life. In order to display 3D motion pictures in such immersive environments, a concentric mosaic technique[Shum and He 1999] was applied in a previous study. However, it required significant calculations in order to render the surrounding image by synthesizing small strips of images for every view angle. Therefore, few interactive CG environments having a sufficient refresh rate and resolution in such immersive environments have been developed so far.

Thus, the goal of this research is to render all-surrounding stereoscopic images in real time in order to realize interactive CG worlds. We employed a programmable shader technique on a GPU in order to calculate 3D vertix position data more rapidly than conventional techniques.

2 Method

In our proposed method, projection transform function (PTF) is used instead of traditional perspective projection to relocate vertices to their corresponding positions in the display. PTF is defined as a function whose input is a set of vertex positions in the world coordinate, and output is a set of corresponding vertex positions on the rendering surface. The PTF can be calculated in advance because the geometry of the display is usually known and the origin of the viewer is static in our cylindrical immersive environments.

The algorithm of this method can be divided into two parts. First, the polygon vertices are moved to their corresponding locations by using the PTF with a vertex shader. However, the distortion occurs within the large polygon because PTF is a nonlinear function. Therefore, we subdivided the polygons by using the geometry shader in order to reduce the distortions observed above in the second stage. Polygons are subdivided according to their size in order to reduce the amount of subdivision for all polygons. One simple example is shown in Fig. 2(c), where our proposed method is applied for original image (a). For comparison, a simple vertex shader technique is also shown, where degraded rendering was observed (b). As a result, we have successfully realized GPU-based real-time rendering that automatically transforms normal polygon data to an image for an immersive stereoscopic image.



(a) (b) (c)

Figure 2: *The process of applying our proposed method to original image (a). First polygon vertices are relocated to their corresponding positions (b). Next, polygons are subdivided according to their size in order to reduce the distortion using geometry shader (c).*

This method can be utilized not only for TWISTER but also for displays that have non-planar geometries if the origin of viewer is determined in advance. Our proposed method enables the high-speed rendering of the interactive contents that require real-time performance, which is not achieved by the conventional distortion correction methods. This method allows CG creators to create the contents using typical 3D CG APIs without considering the display's geometries because our method is applied on a GPU.

References

SHUM, H.-Y., AND HE, L.-W. 1999. Rendering with concentric mosaics. In *SIGGRAPH 1999, Computer Graphics Proceedings, Annual Conference Series*, ACM Press / ACM, 299–306.

TACHI, S., MAEDA, T., YANAGIDA, Y., KOYANAGI, M., AND YOKOYAMA, H. 1996. A method of mutual tele-existence in a virtual environment. In *Proceedings of The 6th International Conference on Artificial Reality and Tele-Existence*, 9–18.

*e-mail:kensei_jo@ipc.i.u-tokyo.ac.jp
†e-mail:kouta_minamizawa@ipc.i.u-tokyo.ac.jp

SIGGRAPH 2008, Los Angeles, California, August 11–15, 2008.
ISBN 978-1-60558-466-9/08/0008