VirtWall: A Concept of Low-Cost Virtual Wall for Immersion in Virtual Reality

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Abstract. *Immersive systems allow a high degree of involvement for the users and they can offer wide visual field and stereoscopic visualization for multiple users. This paper presents the VirtWall, a concept that uses a single fast processor and a dual-head video card to produces immersive stereo graphics for virtual reality applications at low-cost. The main goal is to disseminate the use of VR systems for educational purposes.*

1. Introduction

Virtual reality systems use computational platforms and devices to create virtual environments for simulations and interactive visualization. These systems can be classified as immersive and non-immersive according to user's involvement with the application [Netto02]. The immersive systems allow a high degree of involvement for the users and they can offer wide visual field and stereoscopic visualization for multiple users besides the interaction. Examples of immersive systems are the Virtual Walls [Czernuszenko97] and the CAVE systems [Cruz-Neira93] which one or more large dimension screens are used for stereoscopic projection of images. Both systems present high cost and can reach to a million of dollars. However, the possibilities of use of that technology are countless and its use is already verified in different applications.

Nowadays, examples of applications for these systems can be found in Brazil, as in the case of EMBRAER – Brazilian airplane industry – that uses virtual walls to prototype its airplanes [Toledo01], the General Motors automotive industry that uses CAVEs in its design projects [GM02] and Petrobrás – Brazilian petroleum industry – that accomplishes simulations of petroleum sheets by the use of immersive systems of the same nature [Bezerra02]. The main advantage in the use of those systems is to minimize costs in some stages of researches for the obtaining of new productive processes or even new products. As features those systems present: possibility of visualization for multiple users, full or partial immersion, high dependence of specific computational platforms (high performance graphic stations), high cost and no-mobility. Additionally, those systems require specialized workers for their assembly in a definitive place. Due to these reasons and the high cost involved, those systems become unviable to be widely used in Brazilian small and medium companies and universities.

The present paper shows how to solve the problems related to the cost and mobility of immersive systems presenting an accessible solution for Brazilian companies and universities for several applications. This solution offers a system for immersive and interactive visualization for multiple users and allows the diffusion and popularization of low cost technologies for immersive

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virtual reality systems. It is based on domestic computational components and public domain software. Special attention was dispensed to do not allow the lost of performance or graphical quality.

2. The VirtWall

The virtual wall technology can be a low-cost option against the CAVE technology. The applications of both systems are similar, but the degree of user's immersion can present differences depending the number of virtual walls used. However, virtual walls have some advantages over the CAVE systems: the computational system is less expensive, the screens require less space and it is more practical for a large number of simultaneous users. The main advantage resides in the fact that this kind of low cost system helps to expand the use of immersive Virtual Reality environments for public and educational institutions as such as all the society.

It is known that domestic computational systems already possess capability of data and video processing and that they are capable to offer technological solutions for immersive virtual reality [Zuffo01]. In the literature, there are several attempts to reduce high costs of CAVE and virtual wall systems. Pair et al. [Pair00] designed a triple-screen, four Intel PC-driven and passive stereo display system to generate and synchronize graphics, which are displayed using stereoscopic projectors. Their CAVE like system was built at total price less than US$ 60,000. Studies and experiences of Bennett et al. [Bennett00] and Pape et al. [Pape02] based on Intel processor PC platforms and accelerated graphics cards obtained good results with a virtual wall using passive stereo. Belleman et al. [Belleman01] designed a single-screen active stereo system called Linux Immersive Environment (LIE). LIE uses a single Linux PC with a video sync-doubler to generate active stereoscopic images.

In Brazil, studies about the use of domestic computational systems for immersive virtual reality can be found in the VR group at USP. They are building a cluster of dual processor PC's to the development of platforms for full immersion [Zuffo01]. We do not have notice from any another Brazilian research group about development of a low-cost virtual wall.

The VirtWall system is a concept that uses a single fast processor and a dual-head video card to produces immersive stereo graphics for virtual reality applications. Using those components and based on that concept, we build a virtual wall: a single AMD PC based running operating system Linux and tools of public domain. That computer has some special features related to the amount of RAM memory and to the video card. Because the processing of the images is made by software and it is done twice to generate the stereo effect [Bennett00], the CPU speed was an item of attention.

In our implementation of the VirtWall concept, we use two Sony multimedia projectors with high intensity of light, which we can be used in illuminated rooms, as for example, classrooms. These projectors are found in the national market and they present costs very lower if compared to stereo projectors used for applications in virtual reality. Even so, those projectors possess resolution features and illumination intensity that allow a clear and comfortable visualization. The choice of the projectors observed the necessary optical properties for the good operation of the system without distortions, what could compromise the stereo effect. This stereo effect is obtained adjusting a pair of polarized filters in front of the projectors lenses.

The programming tools used were C/C++ languages, OpenGL graphics libraries and VRJuggler developing package. These tools provide the development of reliable and high performance systems for Virtual Reality, comparable to commercial systems of high cost. Despite of the technological advances, the main conceptual similarities among the Bennett et al. [Bennett00], Pape et al. [Pape02] and VirtWall are: use of PCs to building virtual reality systems; commercial multimedia projectors and passive stereo. The main differences are related to the number of PCs − we used a single PC with a reasonable quantity of memory − and related to the graphic card − we used one which driver is

compatible with Linux/Xfree86. The use of a free accelerated drive provided by Nvidia for GeForce 4 graphics cards determined the choice Nvidia/GeForce 4 set. We also used a 120 inch silver screen made in Brazil and it presented good quality for polarized stereo projection

The VirtWall can support applications that involve several kinds of applications in the university community providing immediate benefits. The benefits can also be extended to all society providing facilities to works at costs lower than the current ones using commercial platforms. Nowadays, some applications are already running and others are under development in our implementation of the VirtWall concept: the virtual human body atlas, a system to help teaching image classification and a virtual reality system to help teaching geographical information systems (GIS). Other application under development is the visualization system of multidimensional and multivariate statistical data.

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