COMPUTER-AIDED AND VIRTUAL REALITY TECHNIQUES FOR GRAPHICAL ARTWORKS

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Abstract: Recent advances in computer graphics and 3D interaction devices raise new possibilities for artworks. However, extended analyses of the underlying technology as well as usability experiments have to be carried out. Moreover, 3D interaction techniques have to be proposed and evaluated. Another important aspect concerns the way computer technology may assist or support artistic creation. The objective of the work presented in this paper is to propose both a theoretical framework for the analysis of computer-aided artistic creation and 3D interaction techniques allowing user-centered artworks. Two immersive configurations along with 3D interaction techniques are proposed and analyzed. These interaction techniques are based on infrared cameras and 3D interaction devices such as a data-glove or the Nintendo Wiimote™.

1 INTRODUCTION

Art has entered in a new phase of experimentation, reinforced by the creation and the implementation of complex models. The process of artistic creation has evolved since its origins in terms of tools, forms, styles and contents. This evolution is undergoing an important step through the opportunities offered by computing technology (Couchot et al., 1988), (Jaspart et al., 2001), (Benayoun, 1998), (Chevalier, 2010) (Bilda et al., 2005), (Bird et al., 2007), (De Gotzen et al., 2008), (Candy et al., 2002), (Saunders et al., 2002), (Costello et al., 2005). 3D interactive environments and virtual reality (VR) technology participate to this evolution in an original and consistent manner.

With the continuous improvements in computer technology, it is now possible to develop 3D artworks with standard high-end personal computers and low-cost interaction devices such as the Nintendo Wiimote™. However, extended analyses of the underlying technology as well as usability experiments have to be carried out. Moreover, 3D interaction techniques have to be proposed and evaluated. Another important aspect concerns the way computer technology may assist or support artistic creation.

In this paper, we propose a framework for the analysis of computer-aided artistic creation and new 3D interaction techniques allowing user-centered artworks. Two immersive configurations along with interaction techniques are proposed and analyzed. They are based on projection displays and propose 3D interaction techniques based on infrared cameras and 3D interaction devices such as a data-glove or the Nintendo Wiimote™.

In the next section we present the proposed theoretical framework for the description, classification and analysis of computer-aided graphical artwork. In section 3, we describe the proposed configurations and interactions techniques. The paper ends by a conclusion and proposes some tracks for future works.

2 THEORETICAL FRAMEWORK

Our theoretical approach was guided by the AIP cube (Autonomy-Interaction-Presence) proposed by Zeltzer to describe and analyze VR systems (Zeltzer, 1991). We propose a framework to describe, classify and analyze computer-aided environment for artistic creation. This framework (the CIA cube) illustrated in Fig. 1, has three independent components: creativity, immersion, and autonomy.

In the proposed framework, the creativity axis is related to the user's creativity, i.e. what he/she could imagine and create without the assistance of the

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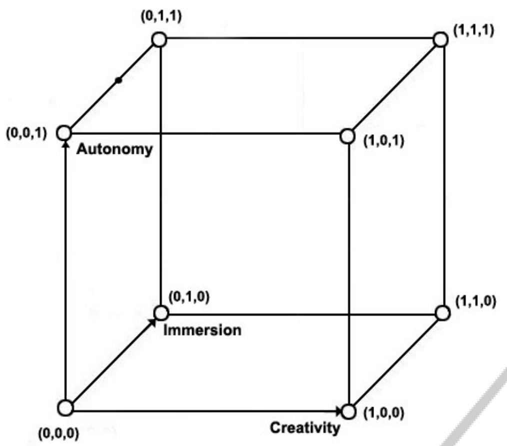

Figure 1: The CIA (Creativity, Immersion, Autonomy) cube.

computer. Some examples of software are Paint, Illustrator, or Photoshop. Autonomy is the related to the automatic generation of 2D or 3D artworks based on complex algorithms, iterated function systems, etc... Immersion refers to the immersive aspect of the working environment and the underlying possibility for the user to be immersed and observe his/her own creation from different viewpoints. Immersion could be achieved through the use of a head-mounted display (full immersion), or a single large back-project stereoscopic display (partial immersion).

3 CONFIGURATIONS AND INTERACTION TECHNIQUES

In order to study computer-aided artistic creativity, we have developed 3D interaction techniques and real-time applications in which the user may perform some graphical artworks using dynamic gestures. We therefore focus on the following point: C=1, I=0.5, A=0 and C=1. In this case, the computer is only used for basic features such as 3D gestures acquisition and graphical rendering. The user is partially immersed in the working environment.

3.1 Immersive Configuration using a Data-glove

3.1.1 Interaction Technique

Sturman has shown that the hand can be used as a sophisticated computer input device, and allows real-time realization of complex tasks requiring several degrees of freedom (Sturman, 1992). Thus, we developed an immersive configuration allowing the user to realize 3D graphical artwork using a 5DT data-glove. User's movements and dynamic gestures are tracked in a large workspace using a motion capture system based on two infrared cameras (Fig. 2). The data-glove has been therefore equipped with a infrared reflector placed in the palm (Fig. 3).

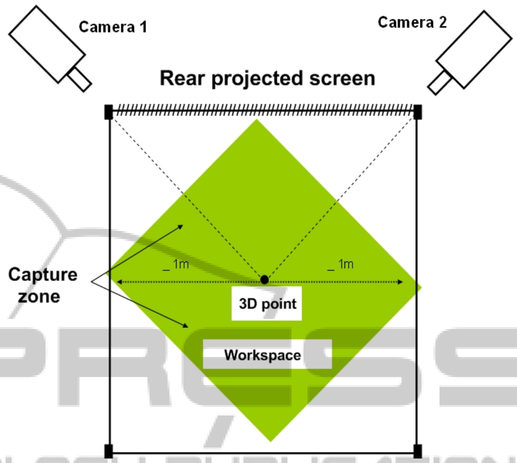

Figure 2: Top view of the system: rear projected screen, infrared (IR) cameras and workspace.

Knowing the specific parameters of the infrared cameras (intrinsic parameters) and the relative positioning of these cameras (extrinsic parameters) it is possible to calculate the position of any 3D points within the workspace.

The glove-based interaction technique allows the user to perform graphical artwork such as 3D drawing. Dynamic gestures are used to control the color of the lines or curves during hand movement in space, and for specific action such as erase the drawing, stop and start to draw. A primary RGB color has been assigned to each finger. Thus, the thumb finger controls the red (R) component, the index finger controls the green component (G), and the middle finger controls the blue component (B). Therefore, simultaneous bending of the three fingers results in black color. Flexion of the ring finger reduces the size of the drawn lines or curves, as flexion of the little finger increases it. A flat hand is used stop drawing. A fist gesture (all fingers fully flexed) erases the whole drawing.

The immersive platform is equipped with a large rear projection display (2 m x 2.5) that allows stereoscopic viewing using passive (polarized glasses). The platform is based on a single HP Workstation WX6400 composed of a dual processor

Figure 3: A user performing 3D graphical artworks using the 5dt glove-based interaction technique.

Intel Xeon 5130 (2 GHz) and a MSI 8800 GTX graphics card with 768 MB of memory. This workstation is connected to two Barco IQ R300 projectors. Each projector is equipped with a polarizing filter (circular).

3.1.2 Analysis and Limits

We measured the absolute error of mocap system along the x (depth), y (width) and z (height) direction. The results revealed that the system accuracy was good and relatively consistent throughout the whole workspace. However, the configuration requires a calibration session (for both the IR mocap system and the glove). Indeed, if one of the IR reflectors is not visible, the drawing is interrupted, resulting in unexpected straight lines as illustrated in Fig.3. Thus, although very interesting and exciting, the overall system was judged relatively difficult to use. Indeed, the few users that performed 3D artworks using this technique reported some difficulties concerning the control of color. The mocap system was judged quite efficient and accurate.

3.2 Immersive Configuration using the Wiimote^{tm}

3.2.1 Interaction Technique

In order to overcome the above cited drawbacks and the overall cost of the system, we proposed a bimanual interaction technique based on the Nintendo wiimote^{TM}. This technique has been developed on a large-scale rear-projected stereoscopic display, but can be used with any projected display or large LCD or OLED TV screen. A single optitrack^{TM} infrared camera is used to track the user's movements (dominant hand and the Wiimote^{TM}) in 3D space. The movements of the user's dominant hand (right hand in fig. 4) are used to draw 3D continuous or dashed lines. The user may also select other primitives such as cubes, spheres (solid or wire), or other predefined form or patterns using the Wiimote^{TM}. This device is equipped with a IR reflector and is moved by the users' non-dominant hand (left hand in fig. 4) within a colorimetric RGB cube used to control the color or the drawing.

3.2.2 Analysis and Limits

As for the previous systems, we measured the accuracy and also the available workspace of the infrared Optitrack^{TM} camera. The selected Optitrack^{TM} camera is the one with the wider field of view (three possible lens are available for the same product). As for the STT IR camera, we observed that the accuracy is relatively good and does not vary within the workspace. Results also showed that the user have to be quite far from the camera if he/she want to work in a large workspace and thus decrease the system accuracy and reliability. The solution is to increase the size of the reflective markers.

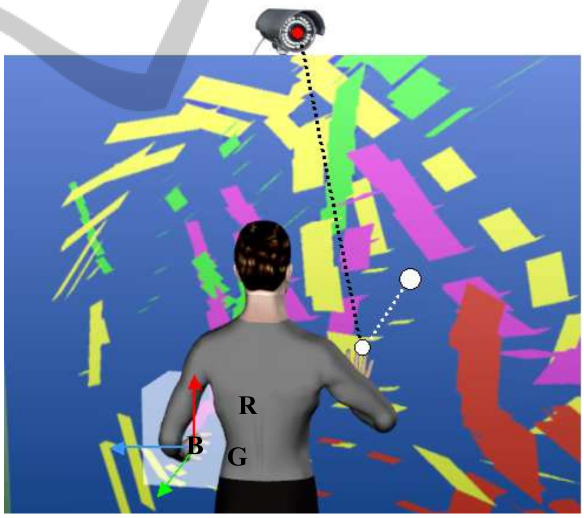

Figure 4: Illustration of the bimanual interaction technique.

In order to evaluate the usability of the proposed bimanual interaction technique, we carried out a non-formal experiment. Five students were asked to perform artworks during 30 minutes and were interviewed. Some best results are shown in Fig. 5, 6, 7, 8, 9. We observed that the students needed some time to understand and use efficiently the interaction techniques. They reported that it was quite difficult and not very intuitive to select a color within the RGB cube. Moreover, they reported that fixed position of the cube in space constrained the movements of their dominant hand.

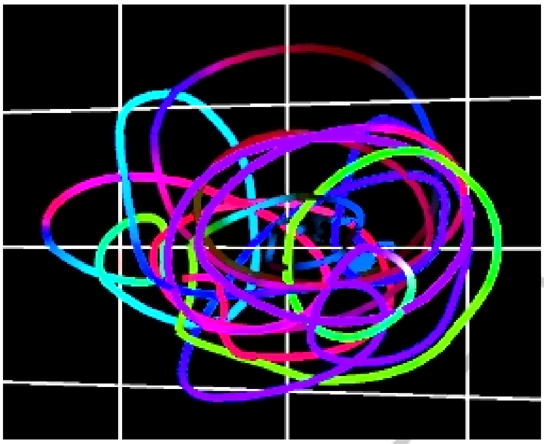

Figure 5: Graphical artworks realized using the bimanual interaction technique (line primitive).

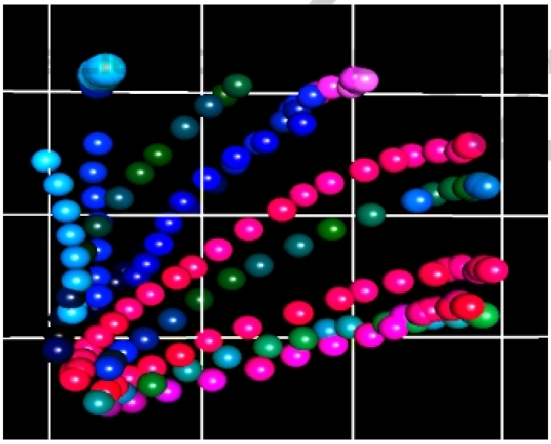

Figure 6: Graphical artworks realized using the bimanual interaction technique (sphere primitive).

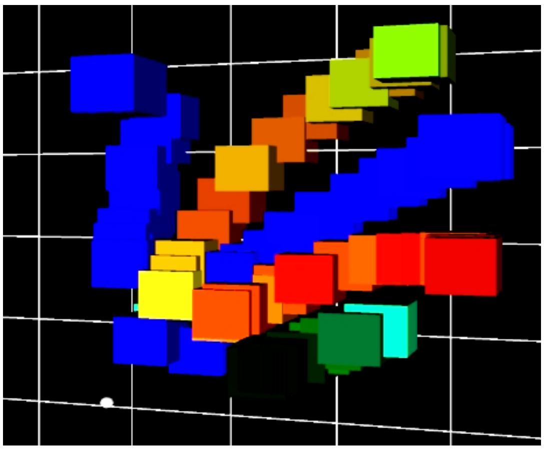

Figure 7: Graphical artworks realized using the bimanual interaction technique (solid cube primitive).

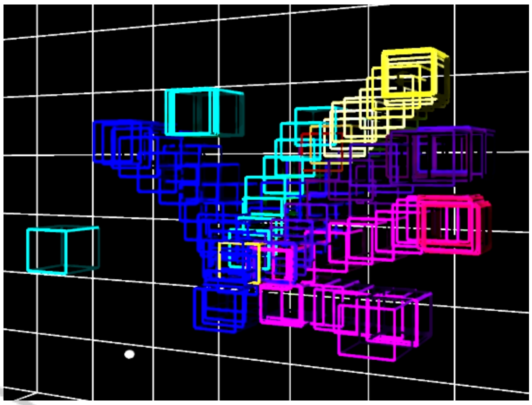

Figure 8: Graphical artworks realized using the bimanual interaction technique (wire cube primitive).

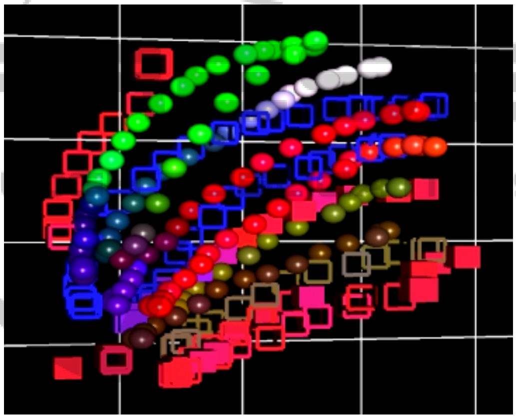

Figure 9: Graphical artworks realized using the bimanual interaction technique (multiple primitives).

4 CONCLUSIONS AND FUTURE WORK

In this paper, we proposed both a theoretical framework for the description, classification and analysis of computer-aided artistic creation. Two immersive configurations along with new interaction techniques have been proposed. They are based on large back-projected displays, infrared cameras and 3D interaction devices such as the 5dt data-glove and the Nintendo Wiimote™. Preliminary experiments have been carried out using short number of subjects. Results and observations revealed that the proposed configuration and interaction techniques required some training. However, after being acquainted with the interaction techniques, the subjects were able to perform and enjoy some interesting 3D graphical artworks. In the future we will investigate other possible 3D artwork applications defined by our theoretical framework and will focus on the integration of complex algorithms to assist the user.

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