Immersive 3D modeling with Blender and off-the-shelf hardware

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ABSTRACT

We present an immersive 3D modeling application with stereoscopic graphics, head tracking, and 3D input devices. The application was built in three weeks on top of Blender, an open source 3D modeling software, and relies solely on affordable, off-the-shelf hardware like PlayStation Move controllers. Our goal was to create an easy to use 3D modeling environment that employs both 2D and 3D interaction techniques and contains several modeling tools. We conducted a basic user study where novice and professional 3D artists created 3D models with our application. The study participants thought that the application was fun and intuitive to use, but accurate posing of objects was difficult. We also examined the participants' beliefs about future use of immersive technology in 3D modeling. The short implementation time of the application, its many features, and the 3D models created by the study participants set an example of what can be achieved with open source software and off-the-shelf hardware.

Keywords: Natural interaction, 3D modeling, virtual reality, PlayStation Move, 3D user interfaces, stereoscopic 3D

Index Terms: H.5.2 [Information Interfaces and Presentation]: User Interfaces—Input devices and strategies, Interaction Styles

1 INTRODUCTION

Creation of three-dimensional (3D) shapes with 3D input devices in virtual environments goes back over three decades: In 1976 Clark [1] introduced a system where a user could create 3D surfaces with a 3D wand and a head-mounted-display. More recent examples are reviewed by LaViola and Keefe [2], who provide a broad overview of past and present art and design applications that use spatial interfaces.

Despite the long history of immersive 3D modeling systems, a vast majority of 3D artists design and create 3D models using 2D displays and input devices that are constrained on desktops and other planar surfaces. Immersive display technology and spatial 3D input devices have been traditionally expensive, and their use mostly limited to research laboratories and auto industry giants.

In the recent years inexpensive spatial game controllers and affordable 3D displays have become available, lowering the costs of implementing and using immersive 3D software. This opens a possibility for creating a stereoscopic 3D modeling application with a spatial interface, which could be adopted by large population of 3D artists.

Intrigued by the capabilities of modern, affordable hardware and open source software, we implemented an immersive 3D modeling application with a 3D user interface (3DUI). We explored its potential by conducting a user study, the results of which are presented in this paper.

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2 SYSTEM

Our 3D modeling application was implemented in a short time using hardware and software that we had used in past projects.

2.1 Hardware

The application (Figure 1) runs on a standard desktop computer and works on any 3D display that supports side-by-side or top-and-bottom mode. We used a 55" Panasonic TX-L55ET5Y television that could display stereoscopic imagery through passive, circularly polarized stereo-glasses.

For interaction, the user holds a PlayStation (PS) Move controller in one hand and a PS Navigation controller in the other. An additional PS Move controller is strapped to the user's head for head tracking. Input from PS controllers is streamed to the computer via Ethernet from a PS3 console that was equipped with a PS Eye camera.

From the two controllers we used altogether 13 digital buttons, 3 analog buttons, and one analog stick to control the virtual 3D camera and to trigger various actions (e.g. undo, redo, delete object) in our 3D modeling application.

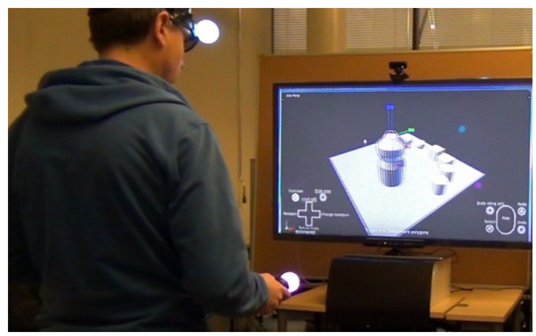

Figure 1: User editing a mesh object in our application

2.2 Software

Our 3D modeling application is built on top of Blender 3D software and RUIS library for Processing [3]. The PS console's Move.me software outputs PS controllers' pose and button data that is received by the computer where RUIS processes it and sends it to Blender via Open Sound Control protocol.

Our design principle when creating our application was to have a powerful set of 3D modeling tools mapped logically to controls (e.g. the button that duplicates in object mode, extrudes in mesh edit mode). We mapped 3D modeling actions directly to PS Move and Navigation buttons so that users would not spend time with menu navigation. To facilitate learning of our interface, we incorporated an interactive heads-up display that shows a picture of the controller buttons and actions currently mapped to them.

Using Python scripting in Blender, we implemented a hybrid UI that combines Blender's standard 2D interaction with custom 3D interaction. The user is presented with a first-person view that he can affect with head movements and by operating the application's virtual camera with PS Navigation controller. The application emulates a 2D mouse by projecting the hand-held PS

Move controller's 3D location on to the display as a 2D cursor, while two buttons of the controller correspond to left and right mouse buttons. This emulated mouse is used for selection and axis-constrained manipulation of objects and their sub-components, as well as projective painting of textures.

The custom 3D interaction that we implemented is based on the six-degrees-of-freedom (3D location and 3D rotation) input from PS Move controller. The user can control a 3D cursor to paint with metaballs in 3D, which is useful for modeling organic shapes. The controller can simultaneously pose the location and rotation of objects and their sub-components, which is used in placing and duplicating objects, and when placing or extruding polygons of a mesh object.

3 User Study

We conducted a user study with 14 participants (12 males, 2 females) whose ages ranged from 23 to 37 with a mean age of 29. Seven of the participants were novices with no experience or limited experience in 3D modeling, while the other seven participants were professional 3D artists who had from 2 to 10 years (mean of 5) experience in 3D modeling. All participants had normal stereoscopic vision – between 30 and 120 arc seconds – as measured with the standard TNO test [4].

The study started with a short pre-questionnaire, after which each participant observed the study organizer to use the application for 5 minutes, demonstrating its features. Then the participant had 10 minutes to practice with the application and get accustomed to its interface. After this the application was restarted and the participant was informed that they had 15 minutes to create Walt Disney World's Cinderella Castle, of which there was an 84 cm by 119 cm poster next to the 3D television. Finally the study participants filled a post-questionnaire about the experience.

3.1 Results

All the participants were able to create a 3D model that bore some resemblance to the Cinderella Castle. During the task they focused on transforming, duplicating, and editing the provided geometry primitives. A video of our application and the participants' 3D models is available online*.

According to the questionnaire answers, the participants felt that their performance with the 3D modeling task was helped by the 3D display but not by the head tracked motion parallax. Six professionals and four novices reported that the 3D display helped their performance, while one professional and one novice said it did not help and two novices did not know. As for the head tracked motion parallax, five professionals and four novices said that it did not help their performance, two professionals and two novices did not know, and one novice said that it had helped.

Our questionnaire had two open-ended questions asking about the good and bad sides of our application. In participants' answers fun and intuitiveness as well as high fatigue and poor accuracy in using the application stands out. Fun was mentioned by five participants as was intuitiveness. Additionally, four professionals said that the application provided a good depth perception. Fatigue was mentioned six times and mostly in context of eye fatigue. Poor accuracy – either in the emulated mouse cursor or posing of objects – was mentioned seven times. During the study we observed that the most common difficulty with our application was related to accurate posing of objects. The participants spent most of their time in trying to place objects where they wanted them to be.

The participants also rated fun, intuitiveness, ease of use, fatigue, and subjective performance of the 3DUI on a seven point Likert scale (where 1 meant strong disagreement and 7 meant strong agreement). Their ratings reflected their answers to open questions, as every rating for fun, intuitiveness, and fatigue was higher than median ratings for ease of use and performance. We applied Mann-Whitney test to find statistically significant differences between ratings of professionals and novices. The only difference was that professionals tended to rate the application's 3DUI more fun than novices ($p < 0.05$).

Participants were asked before and after the modeling task about their beliefs regarding how commonly 3D displays, head tracking, and 3D input devices will be used by professional 3D modelers in the next 10 years. Their answer options for each technology were: 1) Its use will dominate over currently reigning technology; 2) Its use will be common but secondary to currently reigning technology; and 3) Its use will be rare. In display technology 2D displays were pitted against 3D displays, 2D input devices against 3D input devices, and non-head tracked displays against displays that provide motion parallax via head tracking.

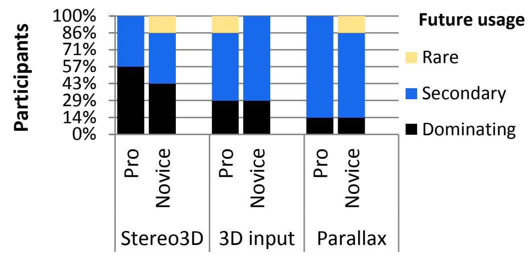

Figure 2: Professional and novice participants' beliefs about future use of immersive technology in 3D modeling

Participants' post-task answers to these questions are presented in Figure 2. After completing the task, three participants changed their beliefs to a more positive one regarding the future of head tracking in 3D modeling applications, and two did the opposite. With regards to 3D displays, two novices adjusted their answers in positive direction after the task.

4 Discussion and Future Work

In its current form, our immersive 3D modeling application is best suited for composing scenes from pre-fabricated objects, and for rough 3D sketching and creation of organic shapes, where the focus is not in accurate alignment of 3D elements. We reckon that our application's posing accuracy issues can be alleviated by fine-tuning the interface and by adding more refined snap features and guides to help in positioning of objects.

We believe that the 3D models created in the study, the short implementation time of three weeks, and the several features of our application present a fine example of what can be achieved with open source software and affordable, off-the-shelf hardware.

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