Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

INTERACTIVE GEOMETRY LAB

Bachelor/Master Thesis

3D Modeling in Virtual Reality

Introduction

High-end virtual reality headsets provide a feeling of full immersion in a virtual 3D environment, and enable users to explore and interact with virtual 3D objects by precisely tracking the position and orientation of the user's head and the controller(s) placed in the users' hands. Virtual reality eliminates the cognitively difficult translation between a 2D projection and the actual 3D object that plagues traditional 2D display technology. At the same time, applications must fulfill strict real time requirements in order to avoid motion sickness and other types of discomfort caused by lag. In this thesis we wish to research how various interactive 3D shape modeling and animation algorithms, originally developed for standard display-mouse-keyboard user interface, translate to the virtual reality setting.

Task Description

We will be working with the Oculus Rift VR headset and its touch controllers. All necessary hardware will be made available to the student for the duration of the project. The concrete methodology to explore will be sketch-based modeling (FiberMesh). The challenges in this project are the conversion of the traditional user interface to the VR setting, adaptation of the shape modeling algorithm to work with this new type of input, porting existing geometry processing and modeling code to VR headset, addressing the stringent efficiency requirements, and more.

Here are the suggested steps:

1. Read the FiberMesh paper carefully, and check the papers referenced there as well to make sure everything about the method is clear, discuss with advisor.

2. Implement a functional version of FiberMesh in libigl, targeted at keyboard/mouse or keyboard/stylus interface. The definition of "reasonable" is up for interpretation, but the minimum should be: being able to draw silhouette curves (and inflate), draw/erase additional curves on the surface, grab-and-deform any curve (and the surface shape follows, as described in the paper), smudge/smoothing of curves, extrusion curves. Creating tunnels, sharp features – can be optional although very nice to have. Additional the typical I/O functionality: load/save the created models + curves, and export to common mesh formats.

3. Devise a plan how to port the controls you implemented for desktop/mouse/keyboard into Oculus VR with touch controls, while keeping the same functionality. Try to answer the following questions: How does the UI need to be changed? Can you think of new features or different

features that were not possible or difficult in 2D display mode? Are there things that are harder/unreasonable without a mouse or stylus? Do you need some helper tools/UI in VR, for example a “wallpaper” or “guide” image that you can trace curves from? (this could be useful in 2D as well). Research related literature and ongoing projects in this direction.

4. Port FiberMesh to Oculus VR setup, implementing the UI ideas you developed above. Collaborate with other students working at IGL regarding the interface of libigl and Oculus SDK – by then there should be a reasonable libigl mesh viewer running available.

5. Test your app, invite others to test, think of particular questions/experiments/hypotheses you would like to check.

6. Write thesis and prepare the final presentation (usually takes about 3-4 weeks).

Grading scale

The thesis will be graded using the following scale:

6.0	Work and results are equivalent to publication quality of international workshops/conferences
5.5	Thesis quality significantly exceeds expectations
5.0	Thesis meets expectations
4.5	Thesis partially meets expectations, minor deficits
4.0	Thesis meets minimal quality requirements; it has major deficits and it is clearly below expectations

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