

Interactive Sculpting of 3D Computer Graphics Models 9809-MIT01

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Abstract

The past thirty years have seen significant progress in the field of computer graphics, particularly in the area of rendering. However, the creation of realistic models is nearly as tedious today as it was 30 years ago, and many types of complex materials simply cannot be represented with today's graphics systems. To address these problems, we are developing a new 3D modeling system based on the metaphor of sculpting real materials. We believe that by combining haptic output devices, stereoscopic displays, physically-based surface models, and newly developed surface representations it will be possible to approach the feel, naturalness, and flexibility of interacting with materials such as marble, wood, metals, and paints. This research will also serve as a platform for studying the next generation of user interfaces, sensory fusion, and material representations. This work should find application in a variety of fields ranging from computer-aided design to the movies.

Project Overview

Highly detailed geometric models are necessary to satisfy a growing expectation for realism in computer graphics. Within traditional modeling systems, complex models are created by applying a variety of modeling operations such as CSG and freeform deformations to a vast array of geometric primitives. Intricate meshes are also obtained by scanning physical objects using range scanning systems. A notable property of the new acquisition techniques is their ability to capture fine surface detail. These developments have made multi-million polygon models widely available and offer new opportunities to modelers and animators in the CAD and entertainment industries.

The goal of this work is to develop a new data structure, the volumetric surface, which captures attractive properties of both surfaces and volumes, and offers a convenient way of representing material properties of complex models. More specifically, the new approach retains the efficient sampling offered by surfaces, but also supports powerful volumetric operators, such as interactive operations for adding and removing material. Properties of materials, such as brittleness and distance to the surface, control the way materials respond to these operators, providing a higher level alternative to existing

material descriptions in interactive modeling systems. Finally, a haptic interface provides a natural way to interact with these material representations.

Progress Through December 1998

In the first few months of the project, we designed and implemented the volumetric surface data structure. To facilitate interactive rendering and sculpting, we adopted a multiresolution version of this data structure.

We also experimented with several different types of materials, including stone, brick, and plaster, both individually and as composites. We have also developed a number of interactive sculpting tools for editing complex 3D models.

Finally, we began experimenting with a PHANTOM, a force feedback device, to enable tactile feedback during the sculpting process.

Plans for the Next Six Months

In the next six months, we plan to attack several problems. First, we will develop a richer collection of materials and sculpting tools. We will also explore optimizations to make interactive rendering and editing faster. Last, we will also integrate the haptic interface with a head tracked stereo display.