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Sketch Based Construction and Rendering of Implicit Models

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Abstract

We present an implicit modeling system as a tool for creating a wide range of aesthetic models. Because of their ability to form blends and produce both organic shapes as well as man-made objects, implicit surfaces are a good medium for artists seeking new ways to experiment with 3D modeling. Implicit models can be created using our sketch-based modeling tool Shapeshop *and also by using a procedural interface. Further, we exploit the differential properties of implicit surfaces to explore new techniques for rendering hierarchical, skeletal implicit models in several pen and ink styles. Our method extracts and stylizes silhouette strokes, lines following local shape features, such as those caused by CSG junctions and abrupt blends, and short interior marks to reveal basic form. In this approach we use a particle system as a basis for the stroke extraction method.*

Categories and Subject Descriptors (according to ACM CCS): I.3.3 [Computer Graphics]: Line and Curve Generation, I.3.5 [Computer Graphics]: Curve, surface, solid, and object representations

1. Introduction

The aim of this research is to provide artists and designers with new tools for building and rendering interesting models in an artistic fashion. In this paper we describe some of the interactive and procedural methods we have developed to provide these tools in an implicit modeling system. Our approach is based on a hierarchical implicit modeling system, the *BlobTree* [WGG99]. Models can be built interactively (Shapeshop), or with the Python language to enable the manipulation of a wide variety of implicit primitives. The nodes in the *BlobTree* represent a large number of operations including different types of blends, CSG operations and warps. Besides conventional rendering techniques, we have also designed algorithms for portraying features of complex hierarchical implicit models as strokes, which produces an aesthetic rendering of those models. NPR rendering can be used to produce pleasing images, and the system includes a number of parameters to allow fine control over the resulting image. We take advantage of functionally defined implicit surfaces to produce pen and ink style renderings. The renderer's view is very general since it uses black box functions to decide on the placement of strokes in regions representing surface features. Furthermore the type of each stroke can be guided by the surface geometry. The black box approach enables the development of the rendering software to be independent of the *BlobTree* , making it possible to use other implicit formulations. Implicit surfaces enjoy many advantages over other modeling techniques, particularly in applications requiring a wide range of topologies and blends. Indeed, we exploit these features in artistic rendering. In fact the *BlobTree* has a number of features that make it very useful for creating aesthetic models as detailed below. Implicit modeling techniques lend themselves to representing both man made (figure 1) and natural objects (figure 4) and with pen and ink rendering styles they provide artists with useful tools for producing aesthetically pleasing models and images.

The methods presented in this research allow users to exploit the hierarchical features of the *BlobTree* to encode model complexity. They can construct a *BlobTree* from predefined parts, procedurally defined models via a Python interface or models generated from sketch input. Unlike other sketch–based approaches, our models can be separated into animatable parts as the *BlobTree* is also a scene graph [WGG99].

The benefits of the system are that through the interactive interface we provide artists with a means to exploit blending and other features of implicit modeling. Moreover, the procedural interface allows users to create aesthetic models and