Texturing Implicit Surfaces with Particle Systems

Introduction

We describe an intuitive yet effective method to apply bidimensional textures onto implicit surfaces. The main idea is to simulate the motion of particles starting on the surface and moving along the gradient vector field, until the particles reach a support surface, where a texture is defined. This approach is a good alternative to the use of solid texture, allowing effective application of arbitrary 2D image textures onto implicit surfaces. Moreover, our method is enhanced by a set of tools for controlling how the texture is mapped.

The Method

The method is based on inherent properties of implicit models. Let S be an implicit surface defined by a function $F: \mathbf{R}^3 \rightarrow \mathbf{R}$, i.e., $S = F^{-1}(0)$. We interpret the gradient vector field ∇F as a force field defined in the ambient space, and we use it to guide the particles that are initially at rest on S. The motion of a particle is governed by the differential equation $\frac{d^2x}{dt^2} + \gamma\frac{dx}{dt} + \nabla F = 0$, where γ is a viscosity constant. This particle system establishes a correspondence between points on the implicit surface and points on a support surface T, where the texture is defined: the texture attribute for each point on the surface is "read" at the intersection of the corresponding particle trajectory with T. The support surface T should be simple enough so that it is very easy to define texture coordinates on it (e.g. cylinder, sphere etc.).

Computation

We start the simulation with particles placed at the vertices of a simplicial approximation of the implicit surface. Next, particle trajectories are generated by numeric integration of the motion equation. At each integration step, we test whether a particle trajectory has crossed the support surface. If it has, then we obtain the texture coordinate for the corresponding point on the implicit surface from the intersection point on the support surface. Once the simulation is over, texture

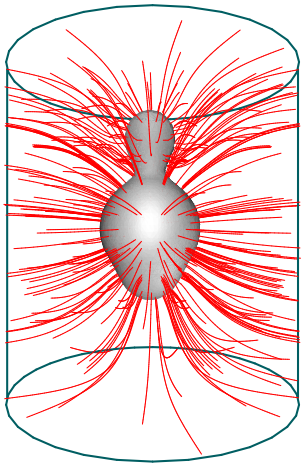
coordinates are available for each vertex of the polyhedron approximating the surface. Linear interpolation of texture coordinates on each face then completes the texturing of the implicit surface.

Control

The dynamic behavior of a particle system allows us to create a set of tools for controlling the placement of the texture onto the surface. Global control is done by positioning the implicit and support surfaces relative to each other. Local control is achieved by introducing external forces in the system, such as attractive and repulsive point, curve or surface sources.

Example

The figures below demonstrate how the method acurately applies an image onto a blobby surface. A cylinder is chosen as a support surface for the texture and the particle system is generated from a blend of the blobby and support surfaces gradient vector fields. More examples, including animations, can be seen at `http://www.impa.br/visgraf/Projects/dtexture`.

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References

1. G. Wyvill, C. McPheeters, B. Wyvill, “Solid texture of soft objects”, *IEEE CG&A* **7** (1987).
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