Illustrating Transparency: communicating the 3D shape of layered transparent surfaces via texture

by

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ABSTRACT

Victoria L. Interrante. **Illustrating Transparency: communicating the 3D shape of layered transparent surfaces via texture.**

(Under the direction of Drs. Henry Fuchs and Stephen Pizer)

There are many applications in which transparency can be a useful tool for displaying the outer surface of an object together with underlying structures. The driving application for this research is radiation therapy treatment planning, in which physicians need to understand the volume distribution of radiation dose in the context of patient anatomy.

To effectively display data containing multiple overlapping surfaces, the surfaces must be rendered in such a way that they can simultaneously be seen and also seen *through*. In computer-generated images, as in real life, however, it is often difficult to adequately perceive the three-dimensional shape of a plain transparent surface and to judge its relative depth distance from underlying opaque objects.

Inspired by the ability of gifted artists to define a figure with just a few strokes, I have explored methods for automatically generating a small, stable set of intuitively meaningful lines that intend to capture the essence of a surface's shape. This dissertation describes my investigations into the use of opaque texture lines as an artistic device for enhancing the communication of the shape and depth of an external transparent surface while only minimally occluding underlying structure.

I provide an overview of the role of 3D visualization in radiation treatment planning and a survey of shape and depth perception, focusing on aspects that may be most crucial for conveying shape and depth information in computer-generated images, and then motivate the use of two specific types of shape-conveying surface markings: valley/ridge lines, which may be useful for sketching the essential form of certain surfaces, and distributed short strokes, oriented in the direction of greatest normal curvature, which may meaningfully convey the local shape of general surface patches.

An experimental paradigm is proposed for objectively measuring observers' ability to simultaneously see and see through a transparent surface, and is used to demonstrate, in an experiment with five subjects, that consistent performance improvements can be achieved, on a task relevant to the needs of radiotherapy treatment planning and based on images generated from actual clinical data, when opaque texture lines are added to an otherwise plain transparent surface.

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