Chapter VI

Isoluminance Contours: A Fast, Simple Model for 4D Animated Visualization

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ABSTRACT

This chapter introduces the Isoluminance Contour Model, which not only provides a quick and easy method for generating images, but also dramatically reduces the amount of work required by traditional computer graphics methods. It starts with the history of the model from its conception in 1981: it was used to generate flat-shaded greyscale, simple, primitive objects such as cubes, cylinders, cones, and spheres, by generating full-color smooth-shaded images for animated sequences. The model compares the degree of realism and the speed of production it generates with that achieved by using smooth shading and ray-tracing methods. It ultimately describes how the amount of data used by the Isoluminance Contour Model can be adapted dynamically to suit the screen size of the primitive object being generated, making real-time 4-dimensional animated visualization feasible on a Pentium 400 (or equivalent) or faster PC.
HISTORY

In the 1970s and 1980s numerical simulation applications were churning out thousands — even millions — of numerical data values. Because of the sheer volume of data it became impossible to manually interpret all the hidden patterns, trends, and relationships. Software applications were introduced to enable this data to be viewed graphically. The term visualization was introduced to describe the transformation of data into visual images. The first wave of these applications typically generated simple two-dimensional line graphs, bar charts, and pie charts on expensive graphics workstations.

The next generation of visualization software enabled three-dimensional images with single data points typically denoted by dots or crosses as shown in Figure 1. The data points formed a data cloud that would often be accompanied by axes lines or enclosed in a wire frame cube that could be rotated with the cloud, giving some indication of its orientation to the viewing position somewhere along the z-axis. Since all the dots and crosses were the same screen size, however, there was no visual depth cue. As the majority of computers were not fast enough to perform the rotation in real-time, there could still be some confusion in visual interpretation.

Cottingham (1981) first introduced the Isoluminance Contour Model (ICM) as an experimental approach to replacing the dots and crosses with simple primitive solids available in CAD applications at that time. This had the advantage of enabling perspective projection to define depth cue.

Throughout the 1990s PCs became widely available as costs plummeted and processing power increased. In addition the color capability jumped from 16 colors to more than a million, which is more colors than the human eye can actually distinguish. There was an ever-increasing demand from researchers in science, engineering, medicine, and commerce for interpreting the large data sets being produced by this growing number of computers. With the reduction in cost, the increases in speed, and the new wealth of colors visualization grew in popularity: it is now common practice to develop visualization packages for tailor-made for individual data sets where there is some correlation between the visual image and the characteristics of the data.

If the visualization provides the ability to fly around the data in real-time, then hidden relationships in the data may become apparent (even if they are not obvious when viewed as a series of still images).

Most of the researchers generating data, however, tended to be experts in their own fields, lacking the high level programming skills required to develop code for complex, traditional computer graphics techniques. They could turn to the functions available in software applications (such as OpenGL or
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