Non-Photorealistic Rendering of Stylized Block Diagrams

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Abstract

Geographical and geological investigations have long made use of perspective drawings like those of Lobeck and others to describe landforms and processes. This paper will explore some new approaches toward computer-based, non-photorealistic renderings of landscapes in the style of the illustrative block diagram. Much work has already been done on automated hachured presentations including Yoeli's 1985 work on rule-based hachuring, Saito and Takahashi's image processing approach in 1990, Kennelly and Kimerling's reanalysis of Tanaka's illuminated contours in 2001 and another variation of Tanaka's work by Lesage and Visvalingam in 2007. A parallel line of research, emanating both from work in image-space (2D) and object-space (3D) data regimes, has focused on the extraction and rendering of image 'silhouettes,' the edges between visible and invisible regions within a scene that depend upon the observer's viewing geometry. A comprehensive survey of this work is provided by Isenberg and others (2003).

This paper will introduce object-space procedures for extracting silhouettes and form lines from DEMs and discuss their implementation in a C#/Direct3D prototype. The ultimate goal of this work is to produce fully-automated tools that can imitate the style of illustrations characterized by traditional pen and ink block diagrams. By working in object space, the procedures can better infer surface topography than could be done from 2D images, providing access to a large array of methods for extracting, and thus rendering, drainage divides, slope breaks, and other surface features (known as creases in the non-photorealistic rendering literature) that are independent of the viewing geometry. The current implementation includes procedures for silhouette and form line extraction from an adaptively-resampled DEM. By decreasing sampling resolution with distance from the viewpoint, a rendered scene appears to be composed of triangular facets that cover approximately equal regions of image space. This approach establishes a de facto generalization mechanism before the rendering process begins, avoiding an expensive cycle of renderings, quality evaluations, and refinements.

An object-space approach is not entirely without disadvantages. Aesthetically-pleasing renderings of linear features often demand linework wider than a single pixel. Although it is possible to thicken lines in 2D space after rendering, such approaches require time-consuming special case handling when their application undermines hidden line removal procedures. This project uses a billboarding technique to assure that the geometry of an object-space silhouette or hachure segment polygon is oriented such that its front-facing

surface normal is parallel with the viewer's line of sight (the Z axis). Furthermore, the width of the silhouette or hachure polygon in object space is scaled with respect to its Z value, assuring that similar features appear the same, regardless of their distances and orientations.

By establishing a prototype system, this project also establishes a testing platform for the application of stylistic elements to silhouettes and hachures. Both types of features are first extracted from triangular facets. In the case of silhouettes, a 'ridgeline' procedure locates and connects adjacent silhouette segments, applies a stylistic operator (B-spline or other polynomial technique), and then applies billboarding to thicken the line in object space. Numerous variables can affect the quality of the resulting linework, especially with regard to the physical nature of the symbolized feature. Not all silhouettes are created equally; some appear superfluous or 'unnatural' after rendering. This project will begin to explore the aesthetic effects of accounting for slope ranges, aspect, and surface angles between adjacent surface facets bordering a silhouette. It will also address the effect of width and curvature on the quality of rendered lines. It is hoped that such an analysis will lead toward fully-automated renderings of block diagrams in a fashion comparable to manual methods.

References (abstract only)

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