F o r e w o r d

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Triangular Patches under Tension

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Abstract: Given a triangular surface scheme that only approximates the initial data the resulting surfaces do not reflect the shape of control vertices as much as the user would have liked. By supplying tension parameters, or what in this case might be called "shape" parameters, the user is able to force the triangular surface patch to follow the control vertices as closely as desired without moving or introducing additional control points.

Introduction

Let n be a positive integer and for each set of nonnegative integers i, j, k such that i+j+k = n, let $\alpha_{ijk} > 0$, define

$$Q_{ijk}(\alpha,u,v,w) = \alpha_{ijk}\ (n!/i!j!k!)\ u^i\ v^j\ w^k\ /d(\alpha,u,v,w),$$

where

$$d(\alpha,u,v,w) = \Sigma_{i+j+k=n}\ \alpha_{ijk}\ (n!/i!j!k!)\ u^i\ v^j\ w^k,$$

the last sum being taken over all nonnegative integers i,j,k summing to n. Thus the surface patch

$$Q(\alpha,u,v,w) = \Sigma_{i+j+k=n}\ Q_{ijk}\ (\alpha,u,v,w)\ P_{ijk}$$

clearly interpolates to the points P_{n00}, P_{0n0}, P_{00n}, where as usual the P_{ijk} are labeled as in the typical Bezier triangle method [Farin 1983] (see Fig. 7.1). The patches above are two-variable functions, e.g. if u, v are given such that $u \in [0,1]$, $v \in [0,1-u]$, then $w = 1 - u - v$ is determined. Triangular patches have been subject of an extensive research since in certain situations we need to draw non-rectangular patches. These surfaces have similar properties as those of tensor product Bezier patches, e.g. convex hull property, affine invariance, and the most techniques used in rectangular patch geometry can be extended to triangular ones, e.g. recursive definition of surface points [de Casteljau Algorithm], degree elevation and subdivision.

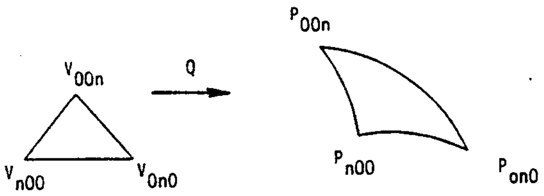

Figure 7.1. Typical Bezier triangle methods send the verticies of the domain to the points P_{00n}, P_{n00}, and P_{0n0}.

It is simple to show that if some shape parameter α_{ijk} increases/decreases the resulting surface patch is dragged towards/away from corresponding control point P_{ijk}. In many situations it is desirable to straighten up/twist a part of the surface. Hence the shape parameters α_{ijk} give considerable control over the shape of the surface patch. In addition to that their modifications can be coupled together with modification of control points P_{ijk}. Note that if all $\alpha_{ijk} = 1$ then Q is just ordinary Bezier triangle surface patch.
The following figures illustrate some of the flexibility gained in using this method.

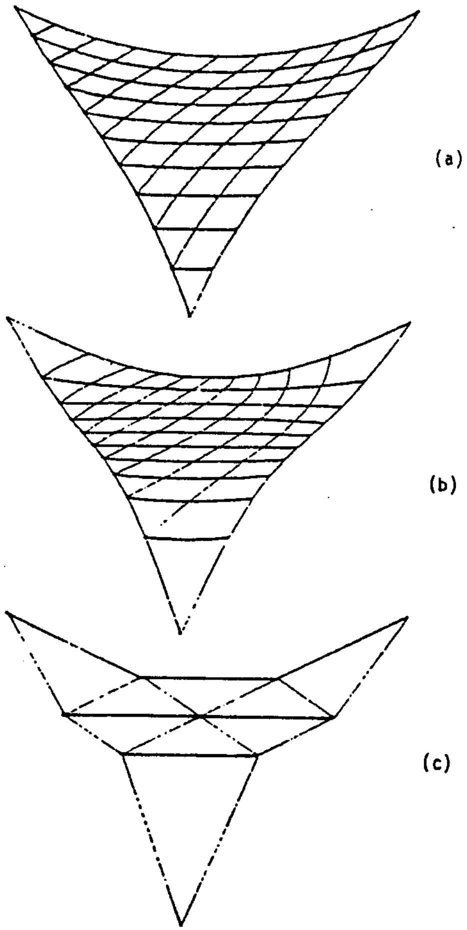

Figure 7.2. Two surfaces based on the control polygon (c). Surface (a) is the Bezier surface of degree 3 and (b) is a rational Bezier surface of degree 3. See Table 3 for data.

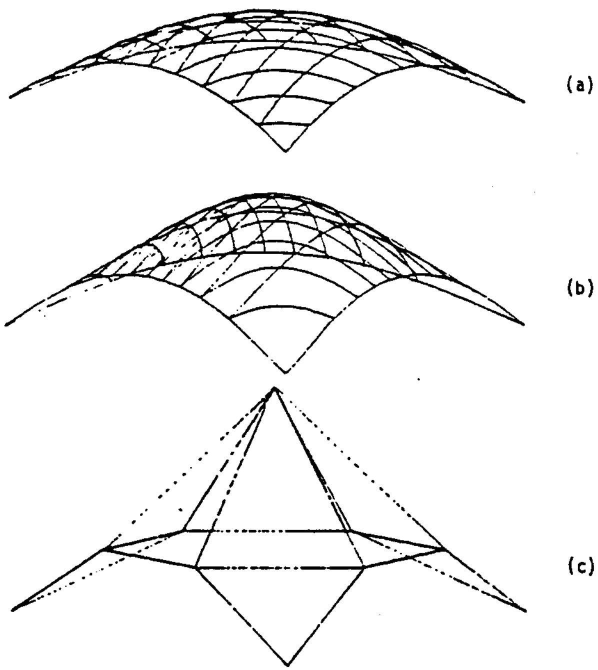

Figure 7.4. Two surfaces based on the control polygon (c). Surface (a) is the Bezier surface of degree 3 and (b) is a rational Bezier surface of degree 3. See Table 3 for data. Note that surface (a) does not feel the peak of the control polygon as well as surface (b).

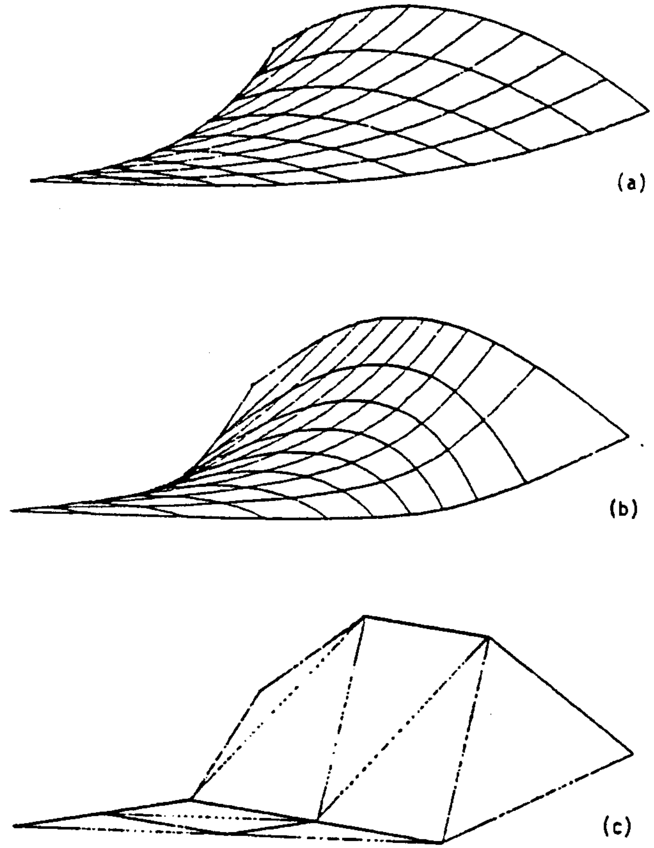

Figure 7.6. Two surfaces based on the control polygon (c). Surface (a) is the Bezier surface of degree 3 and (b) is a rational Bezier surface of degree 3. See Table 3 for data.

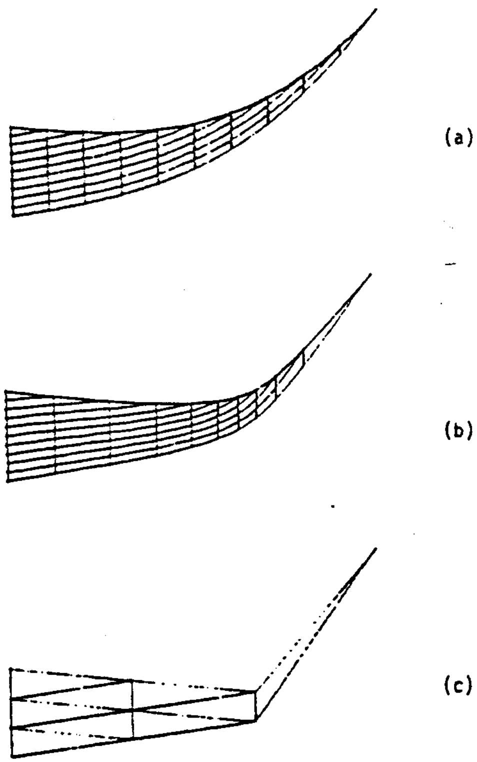

Figure 7.8. Two surfaces based on the control polygon (c). Surface (a) is the Bezier surface of degree 3 and (b) is a rational Bezier surface of degree 3. See Table 3 for data.

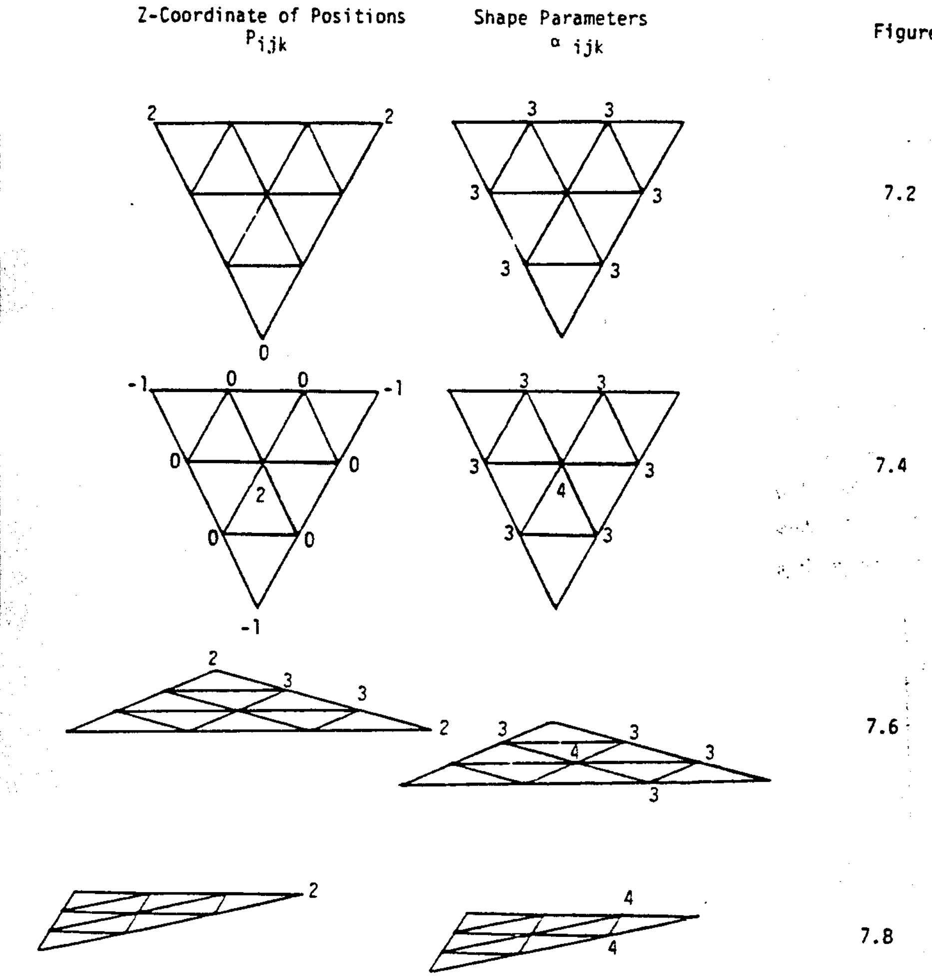

Table 3. Z-coordinates of the positions for verticies of the Bezier net (left hand column) are assumed to be 0 if unmarked, otherwise the appropriate value is indicated adjacent to the corresponding vertex. Shape parameters α^i_{ijk} for the verticie of the same Bezier net (right hand column) are as indicated or 1 if unmarked.

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Cubic Monte Carlo Radiosity

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Abstract

A revised radiosity method for curved surfaces is proposed, based on the Monte Carlo approach. In order to improve the accuracy of the solution, a smoothly reconstructed illumination function with selected discontinuities is used during the radiosity computation. The reconstructed function is used as a random number distribution for position sampling to overcome the constant radiosity assumption syndrome. Illumination information stored at the surface control points is used to preserve continuity of the illumination across the boundary of adjacent surfaces and to avoid Mach band effects. Implementation in Flatland is discussed.

1.Introduction

Realistic simulation of illumination effects is often a primary goal in computer generated imagery. Because of the complexity of light behavior interacting with an environment, one can't hope for closed-form solutions to global illumination problems. The techniques for global illumination have to consider the basic interdependency of the light energy transfer problem: the radiance of every object is determined by the radiance of all other objects in the scene visible from this object. Radiosity methods have been shown to be an effective solution to the global illumination problem in diffuse environments. They have been introduced to computer graphics from the simulation of radiative heat transfer. The method is based on the principle of energy conservation. All light energy emitted within the scene is reflected off surfaces and transfered between surfaces within this environment. Thus, the basic