

RENDERING OF 3D SEISMIC MODEL

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ABSTRACT. 3D seismic model is described by the velocities in a rectangular grid and by the curved interfaces between geological blocks. PEXlib is a 3D graphics library which gives us an opportunity to render 3D seismic models in the X Window System. Differences between velocities are expressed by colors and shades. The curved interfaces are computed by means of the B-spline surfaces.

1. INTRODUCTION

One goal of the internal project of Czech Academy of Sciences, Seismic tomography and refraction data processing, is to display seismic models of 3D inhomogeneous geological structures with curved interfaces between geological blocks. Model imaging is connected with subroutine package MODEL, that specifies seismic model [Klimeš 1994]. PEXlib seems to be suitable method to display 3D seismic model interactively. This paper includes a short description of PEXlib and shows first results of using PEXlib functions.

2. PEXLIB

PEXlib 5.1 is a programming library for 3D graphics with only C language binding [Gaskins 1992]. It is the lowest-level and most direct interface for drawing 3D pictures in the X Window System Version 11 Release 5. PEXlib was devised by the X Consortium to support the PEX protocol, an extension to the X protocol. It is therefore a de facto standard in the X community. PEX is an acronym for "PHIGS Extension to X". PHIGS (Programmer's Hierarchical Interactive Graphics System) is a popular 3D graphics ISO standard but PEX goes beyond PHIGS in its functionality (better integrated with X). With PEXlib we can define objects in convenient coordinate systems, rotate and move them with modeling transforms, view them from different angles, and create lit and shaded scenes. The PEXlib library contains over 200 functions.

3. SEISMIC MODEL

We can imagine seismic model as a block with velocities defined in a rectangular grid where differences between velocities are expressed by colors and shades. PEXlib function "Set of fill area sets with data" seems to be convenient to render this type of data. The function enables us to set vertex normals, vertex colors, facet normal, facet color and edge visibility flag for each facet (Fig. 1). These data give us more precise control over color, shading, lighting and edges.

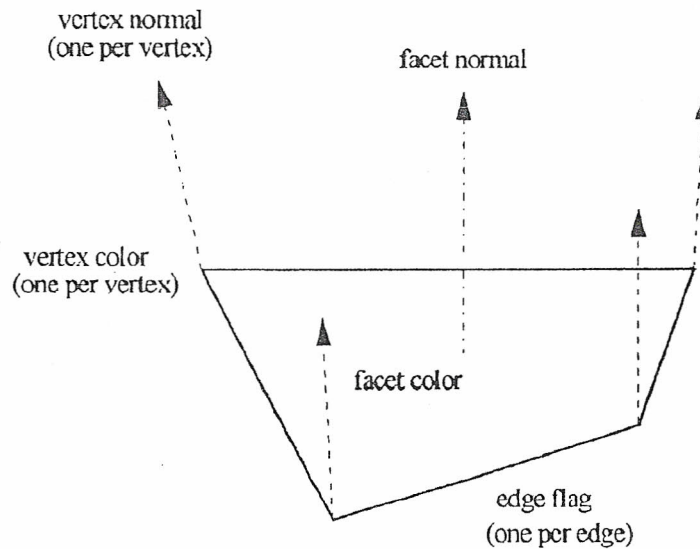


FIG. 1. Facet attributes [Gaskins 1992].

Another part of the seismic model is a curved interface (e.g. surface of the Earth). PEXlib offers us a function, "B-spline surface", which can render the curved interface defined by:

$$S(u, v) = \sum_{i=1}^n \sum_{j=1}^m B_{i,k}(u) B_{j,l}(v) P_{i,j},$$

where

- u, v - parameters,
- $B_{i,k}$ and $B_{j,l}$ - B-spline basis functions of the order k and l ,
- $P_{i,j}$ - control points,
- n, m - number of control points in the u, v dimension.

A simple untruthful seismic model was interpreted by Hewlett-Packard's implementation of PEXlib functions (ANSI-C language binding) on HP 720 workstation. The velocity block is specified by a rectangular grid, an array of dimensions (10, 8, 14) in X, Y, Z axes. All points in PEX are given in a right-handed, Cartesian coordinate system, with the Z axis towards the viewer. Three colors (red, green,

blue) are used to distinguish between points with different velocities. The surface of the model (curved interface) is defined by 20 control points (5 in u dimension and 4 in v dimension) and by the B-spline curve orders 5 and 4. The surface has solid interior style. There are two points on the surface representing source and receiver (e.g. refraction studies). Two types of velocity model were tested:

- a) *wireframe* – Hollow interior style makes the interior of the model empty and transparent.
- b) *pseudo solid* – The solid interior style is used for the block of velocities, facet culling mode is set to back faces, and the Gouraud shading method is used. The sides of small cubes are filled but the interior of cubes is hollow (Fig. 2).

Slices of the model clipped by the model clipping volume (which is defined by the direction vector and coordinate point that the model-clipping plane passes through) were tested successfully.

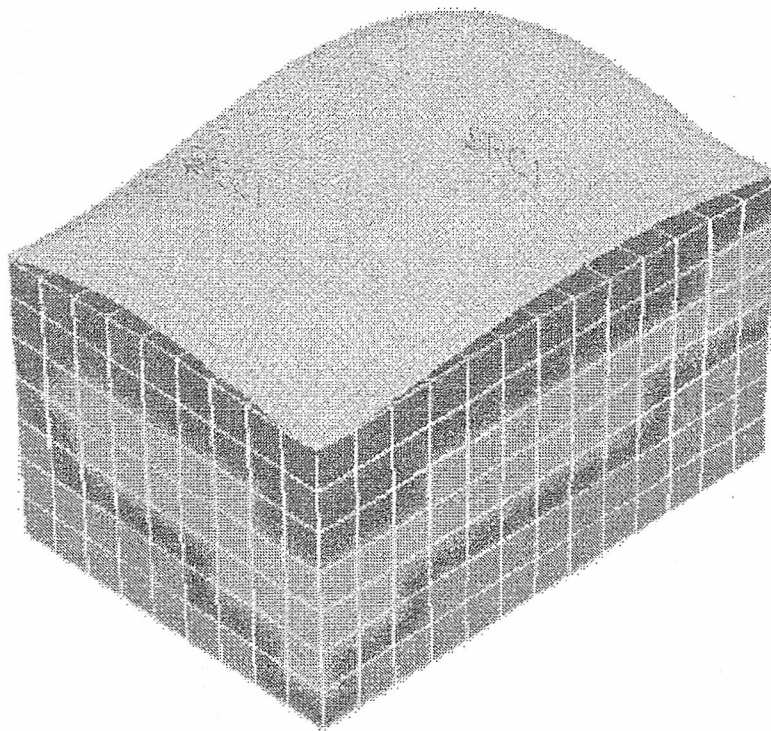


FIG. 2. Velocity model and curved interface (surface).

Figure 2 was scanned with 8-bit grayscale from color originals. The gray shades do not express colors and color shades exactly.

We can interactively change the view orientation (rotate the model). Panning around the model is accomplished by changing the view plane normal in response to mouse movement.

4. CONCLUSION

Our first results of using PEXlib to render seismic model were given in this paper. There is a lot of work to integrate the blocks and curved interfaces, to position sources and receivers, render seismic rays, etc. Interactive work with complex models will require efficient workstation.

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