Volumetric Visualization

Outline

- Announcements
  - PS III due today
  - contest entries by tomorrow
  - PS IV online today--GUI vs. VV
  - Demos on Friday
- What is VV?
- Slices
- Isosurfaces
- Controlling transparency
- Example: CT data

What is VV?

- y=f(x) => lines
- z=f(x,y) => surfaces
- v=f(x(t),y(t),z(t)) => surfaces with color≠ z
- v=f(x,y,z) => true 3D data ?

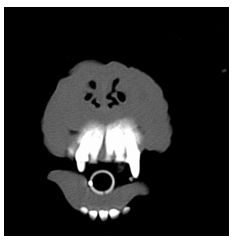
Representing V=f(x,y,z)

- we have a value ofVv for every point in a volume
- V is a cube of data (m-by-n-by-p)
- We need X, Y, Z of the same size to indicate positions of data
  - Typically, we have a regular grid defined by vectors x, y, & z
  - [X,Y,Z]=meshgrid(x,y,z) produces 3D arrays needed by Matlab's VV functions
    - X, Y, Z are m-by-n-by-p
    - for all j & k, X(j,:,k)=x, Y(:,j,k)=y, Z(j,k,:)=z

Example: CT data

- CT scans ("Computerized Tomography" a.k.a. CAT scans) produce a series of cross-sectional x-rays
- Several slices can be stacked together to form a volume

Example: CT data



- CT scans of head and thorax from dogs provided by Dr. Ned Dykes at NYSCVM
- Each slice is a separate tiff file
  - loaded each tiff with imread
  - stacked into array head
  - Thinned the data set
  - [Xs,Ys,Zs,Heads]=reducevolume(X,Y,Z,Head,[4,4,1]);
  - Cropped data
  - Head_reduce4.4.1_crop.mat

Visualizing V

- Simplest way is to look at a particular row/column/layer of V
  - pcolor(x,y,V(:,:,k))--layer k
  - pcolor(x,z,squeeze(V(:,k,:)))--column k
  - pcolor(y,z,squeeze(V(k,:,:)))--row k
- squeeze removes singleton dimensions
  - v(k,:,:) is 1-by-n-by-p
  - squeeze(v(k,:,:)) is n-by-p

General Slicing

- h=slice(X,Y,Z,V,xs,ys,zs)
  - slices V at multiple planes
  - slice(X,Y,Z,V,[20 30],[],[10]) produces 3 slices:
    - x=20, x=30, z=10
  - What if a slice falls between a row or column?
- h=slice(X,Y,Z,V,Xsurf,Ysurf,Zsurf)
  - slices V with a surface defined by Zs=f(Xs,Ys)

Slicing the dog

- clearslice(Xs,Ys,Zs,Heads,xs,ys,zs,thresh)
  - same as slice(Xs …) but values of Heads below the threshold are set to clear

Controlling Opacity

- The opacity of an object is controlled like color
  - can specify edgealpha and facealpha of a surface object
    - can be set to a particular alpha level (0=transparent, 1=opaque)
    - can be set to flat or interp just like colors
    - in this case, Matlab uses determines opacity from
      - alphadata of surface (like cdata)
      - alphamap of figure (like colormap, but n-by-1)
      - alim of axes (like clim)

Isosurfaces

- Before perspective plots and color mapping, people plotted z=f(x,y) with countours:
  - curves of constant z
- Isosurfaces are analogous methods in 3D
  - find X,Y,Z s.t. f(X,Y,Z)=v

Isosurfaces

- fv=isosurface(X,Y,Z,V,v);
- fv is a struct describing a patch (or surface) object on a triangular mesh
- fv.vertices(j,:)=position of jth vertex[x, y, z]
- fv.faces(j,:)=1-by-3--index to 3 vertices forming triangle (like tri)
- h=patch(fv) will display the surface
  - set(h,'edgecolor','none','facecolor',Colorspec,'faceligh ting','phong')

Isosurfacing the Dog

- visiso(Xs,Ys,Zs,Hs,v)--makes a pretty isosurface, adds a light source