GRASS 3D Workshop – 3D data visualization with VTK

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FOSS4G2006 Workshop
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The Visualization ToolKit (VTK)

- software system for 3D computer graphics, image processing and visualization
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- written in C++ and bindings for Phyton, Tcl/Tk and Java available
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- software system for 3D computer graphics, image processing and visualization
- multi-platform and supports Windows, several Unix’s and MacOS X
- written in C++ and bindings for Phyton, Tcl/Tk and Java available
- open source and freely available from [http://www.vtk.org](http://www.vtk.org)
Why do visualization with VTK

- the most sophisticated visualization toolkit available on the market
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Why do visualization with VTK

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- provides leading edge data processing and visualization capabilities
- supports all types of raster, vector and volume data implemented in GRASS
- is actively developed and has an advanced software design
- easy to implement visualization applications with VTK (supports rapid prototype development)
ParaView

- multi-platform visualization application based on VTK
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Please start ParaView by typing: paraview
Data import and creation
Display

Data

Display

Parameters
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Features of r.out.vtk

The r.out.vtk script provides various features for exporting and visualizing data:

- **Point data**
  - RGB
  - Vector
  - Scalar

- **Cell data**
  - RGB
  - Vector
  - Scalar

- **Point data with elevation**
  - RGB
  - Vector
  - Scalar
How to use r.out.vtk

- Exporting cell data:  
  ```
  r.out.vtk in=slope
  out=celldata.vtk
  ```
How to use r.out.vtk

- **Exporting cell data:** `r.out.vtk in=slope out=celldata.vtk`
- **Exporting point data:** `r.out.vtk -p in=slope out=pointdata.vtk`
How to use r.out.vtk

- Exporting cell data: `r.out.vtk` in=slope
  out=celldata.vtk

- Exporting point data: `r.out.vtk` -p in=slope
  out=pointdata.vtk

- Exporting several data with elevation: `r.out.vtk`
  in=slope,aspect,elevation
  elevation=elevation out=elev.vtk
Cell data
Point data

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Point and Cell data together
Elevation and data

![ParaView Screenshot](image)
Elevation and data
Elevation and data

Kitware ParaView

View
- Data
- Scalar bar
- Colorbar
- Label Point IDs

Color
- Color by
- Map Scalars
- Interpolate Colors
- Edit Color Map
- Reset Range

Display Style
- Representation
- Interpolation
- Point size
- Line width
- Point ID scale

Actor Control
- Translate
- Scale
- Orientation

ParaView

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Elevation color table
Contouring

1. Select the contour tool from the toolbar.
2. Input the scalar field (e.g., elevation) for contouring.
3. Define contour values or generate them automatically.
4. Accept the settings to visualize the contours.
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Features of v.out.vtk

Points

Lines

Boundaries

Areas

Mixed

Faces

v.out.vtk
Export data with v.out.vtk

- **Exporting vector points:** `v.out.vtk input=Sources3d output=Sources3d.vtk`
Export data with v.out.vtk

- **Exporting vector points:** `v.out.vtk input=Sources3d output=Sources3d.vtk`
- **Exporting vector lines:** `v.out.vtk input=roads3d output=roads3d.vtk type=line`
Export data with v.out.vtk

- **Exporting vector points:** `v.out.vtk input=Sources3d output=Sources3d.vtk`
- **Exporting vector lines:** `v.out.vtk input=roads3d output=roads3d.vtk type=line`
- **Exporting polygonal data**
Export data with v.out.vtk

- **Exporting vector points**: `v.out.vtk input=Sources3d output=Sources3d.vtk`
- **Exporting vector lines**: `v.out.vtk input=roads3d output=roads3d.vtk type=line`
- **Exporting polygonal data**
  - **trees**: `v.out.vtk input=trees3d output=trees3d.vtk type=line,face`
Export data with v.out.vtk

- Exporting vector points: `v.out.vtk input=Sources3d output=Sources3d.vtk`
- Exporting vector lines: `v.out.vtk input=roads3d output=roads3d.vtk type=line`
- Exporting polygonal data
  - trees: `v.out.vtk input=trees3d output=trees3d.vtk type=line,face`
  - buildings: `v.out.vtk input=industry3d output=industry3d.vtk type=face`
Vector points
Using the *Glyph* filter

1. Select the Glyph filter.
2. Choose the input file and select the glyph type (e.g., Sphere1).
3. Adjust the parameters as needed.
Vector lines
Using the **Tube** filter
Trees
Buildings and *Triangulate* filter
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Features of r3.out.vtk

r3.out.vtk

point data

RGB
scalar

resulting from point data with elevation

RGB
scalar

cell data

RGB
scalar

resulting from cell data with elevation

RGB
scalar

How to export with r3.out.vtk
Volume maps in ParaView
Export scalar data

- **Exporting cell data:** `r3.out.vtk in=geology out=geology3d.vtk`
Export scalar data

- **Exporting cell data:** `r3.out.vtk in=geology out=geology3d.vtk`
- **Exporting point data:** `r3.out.vtk -p in=Boundaries,ResultStream out=gw3d.vtk`
Export scalar data

- **Exporting cell data:** `r3.out.vtk in=geology out=geology3d.vtk`
- **Exporting point data:** `r3.out.vtk -p in=Boundaries,ResultStream out=gw3d.vtk`
- **Exporting elevation data**

Export scalar data

- **Exporting cell data:**
  ```
  r3.out.vtk in=geology 
  out=geology3d.vtk
  ```
- **Exporting point data:**
  ```
  r3.out.vtk -p 
  in=Boundaries,ResultStream out=gw3d.vtk
  ```
- **Exporting elevation data**
  - reduce the z-resolution
    ```
    g.region tbres=150
    ```
  - ```
  r3.out.vtk -sp top=elevation 
  bottom=border_sand_clay out=clay3d.vtk
  ```
Export scalar data

- **Exporting cell data:** `r3.out.vtk in=geology
out=geology3d.vtk`

- **Exporting point data:** `r3.out.vtk -p
in=Boundaries,ResultStream out=gw3d.vtk`

- **Exporting elevation data**
  - `reduce the z-resolution` `g.region tbres=150`
  - `r3.out.vtk -sp top=elevation
bottom=border_sand_clay out=clay3d.vtk`
  - `r3.out.vtk -sp top=border_sand_clay
bottom=border_bedrock_sand out=sand3d.vtk`
  - `r3.out.vtk -sp top=border_bedrock_sand
bottom=bottom out=bedrock3d.vtk`
Export scalar data

- **Exporting cell data:** `r3.out.vtk in=geology out=geology3d.vtk`
- **Exporting point data:** `r3.out.vtk -p in=Boundaries,ResultStream out=gw3d.vtk`
- **Exporting elevation data**
  - reduce the z-resolution `g.region tbres=150`
  - `r3.out.vtk -sp top=elevation bottom=border_sand_clay out=clay3d.vtk`
  - `r3.out.vtk -sp top=border_sand_clay bottom=border_bedrock_sand out=sand3d.vtk`
  - `r3.out.vtk -sp top=border_bedrock_sand bottom=bottom out=bedrock3d.vtk`
Elevation data

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Cell data
Point data

ParaView

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How to export with r3.out.vtk
Volume maps in ParaView
Data extraction

1. Select the file `stream3d.vtk` from the list.
2. Open the `Threshold` filter.
3. Set the lower threshold to 0.1 and the upper threshold to 2.
4. Accept the settings.
Data extraction
Clipping

1. Threshold
2. Accept
3. Center [0, 0, 0]
4. Normal [-1, 0, 0]

How to export with r3.out.vtk
Volume maps in ParaView
Export 3d vector data

- Set the default region: `g.region -dp3`
- Exporting vector data: `r3.out.vtk -p in=Boundaries vectormaps=ResultStreamVector_x, ResultStreamVector_y, ResultStreamVector_x out=gwflow3d.vtk`
All together with stream lines
Thank You!