Neuroinformatics based on VRML/Talairach

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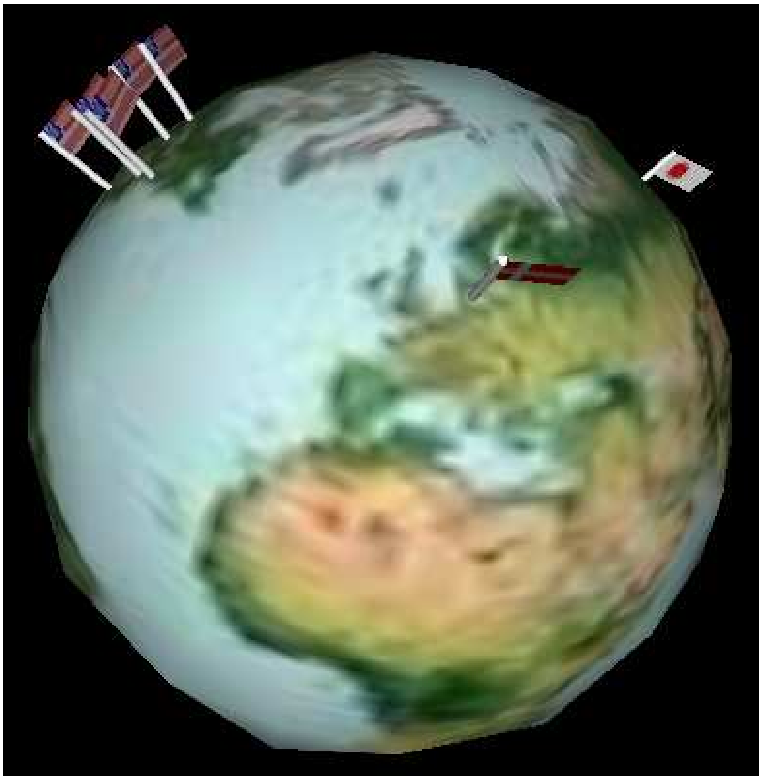
VRML



- Virtual Reality Modeling Language
- File format for 3D interactive animated computer graphics on the internet
- ISO standard
- Textured polygon graphics with hierarchical scene graph, inlining, hyperlinking, "behaviour" (animation), mouse interaction
- Interface to Java (partially in the standard)
- Wide application area: Web-graphics, scientific visualization, architecture, small computer games, ...

VRML

```
#VRML V2.0 utf8

Shape { geometry Text { string [ "Hello, World" ] } }
```

```
#VRML V2.0 utf8

Shape {
  appearance Appearance {
    material Material {
      diffuseColor 0.8 0.8 0
      emissiveColor 0.8 0 0
    }
  }
  geometry Text {
    string [ "Hello, World" ]
  }
}
```

More information

- `http://www.web3d.org`
  Web 3d consortium. Defines the standard.
- `http://www.sdsc.edu/vrml`
  "The VRML Repository" in San Diego.
- `http://cosmosoftware.com/`
  Homepage for the "CosmoPlayer"

GENERATION AND VIEWING

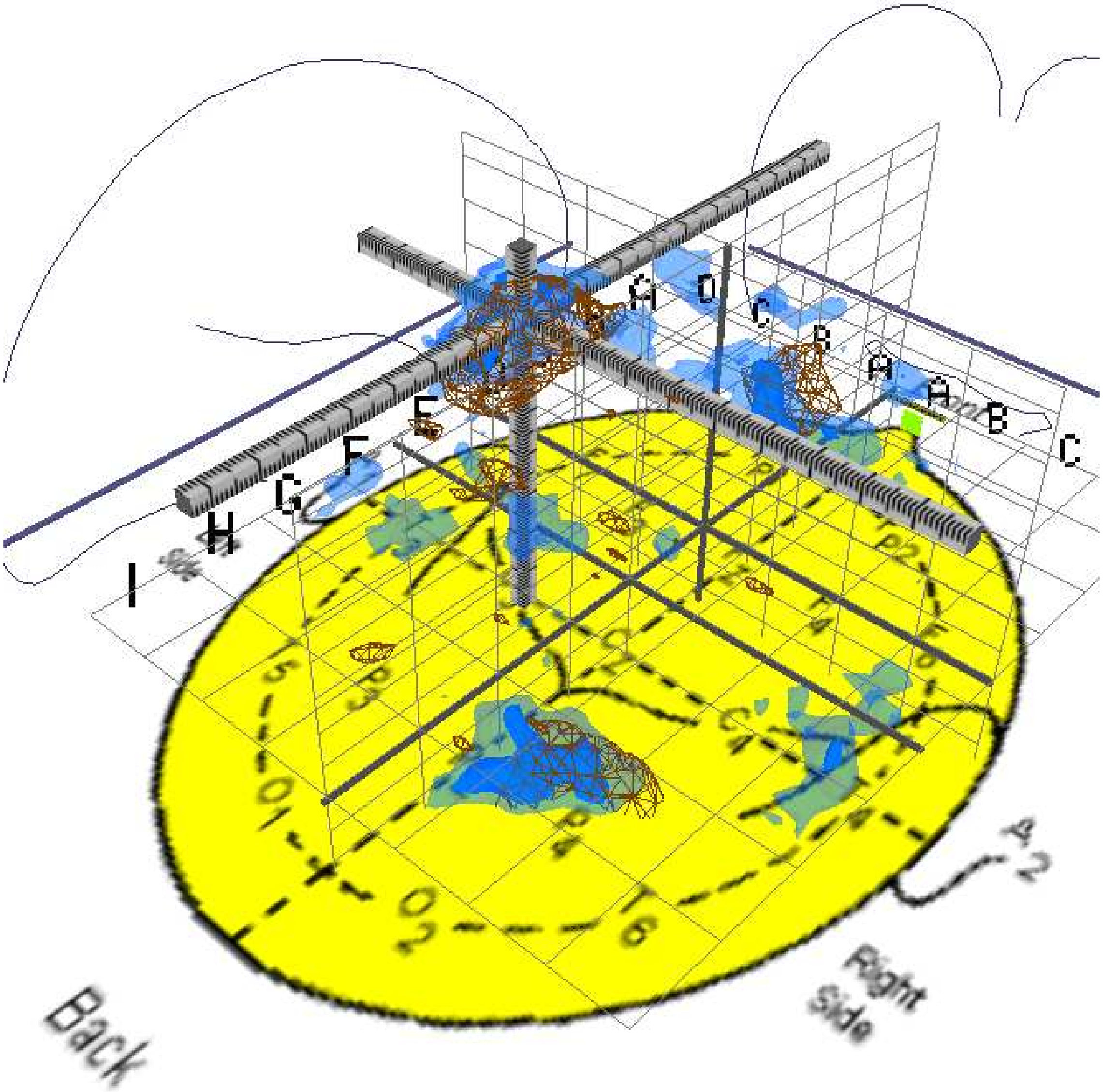
Generation of VRML

- Hand-coding in a text editor.
- Builder programs: CosmoWorlds, 3D studio, ...
- Home-build programs: C, Matlab (`vrml.m`), ...
- Generation of surfaces from volumes: "Marching cube" [Lorensen and Cline, 1987].
  - Polyr program. [Jensen, 1995] [Nielsen, 1998] `http://hendrix.imm.dtu.dk/software`.

Viewing VRML

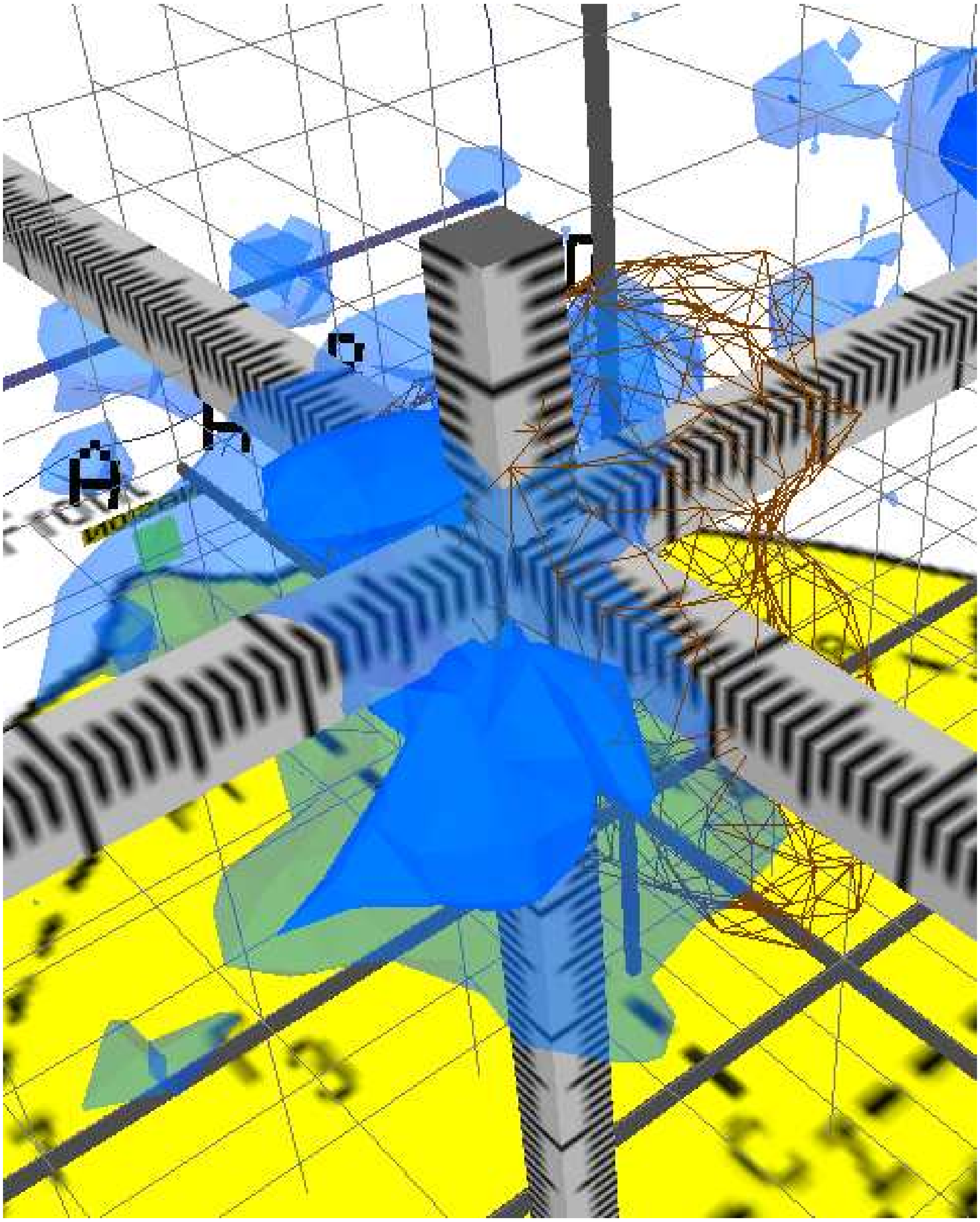
- Plugin to webbrowser (CosmoPlayer, ...)
- Stand-alone browser (vrwave)
- Import

VRML IN NEUROIMAGING



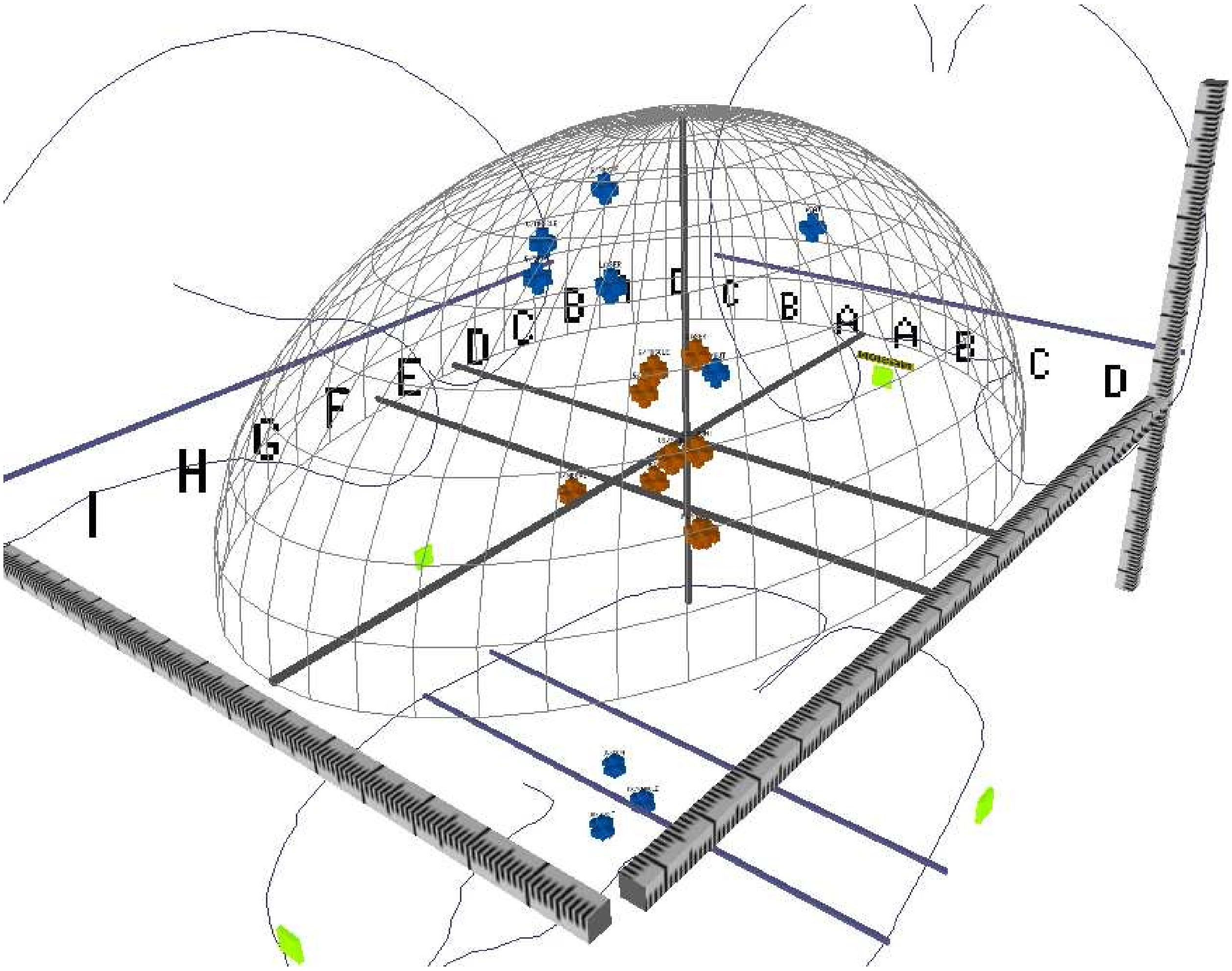
- Framework: Talairach.
- Rendered activation foci.
- Enhance with symbols/glyphs [Rehm et al., 1998].

EXAMPLE: PET "BLOBS"



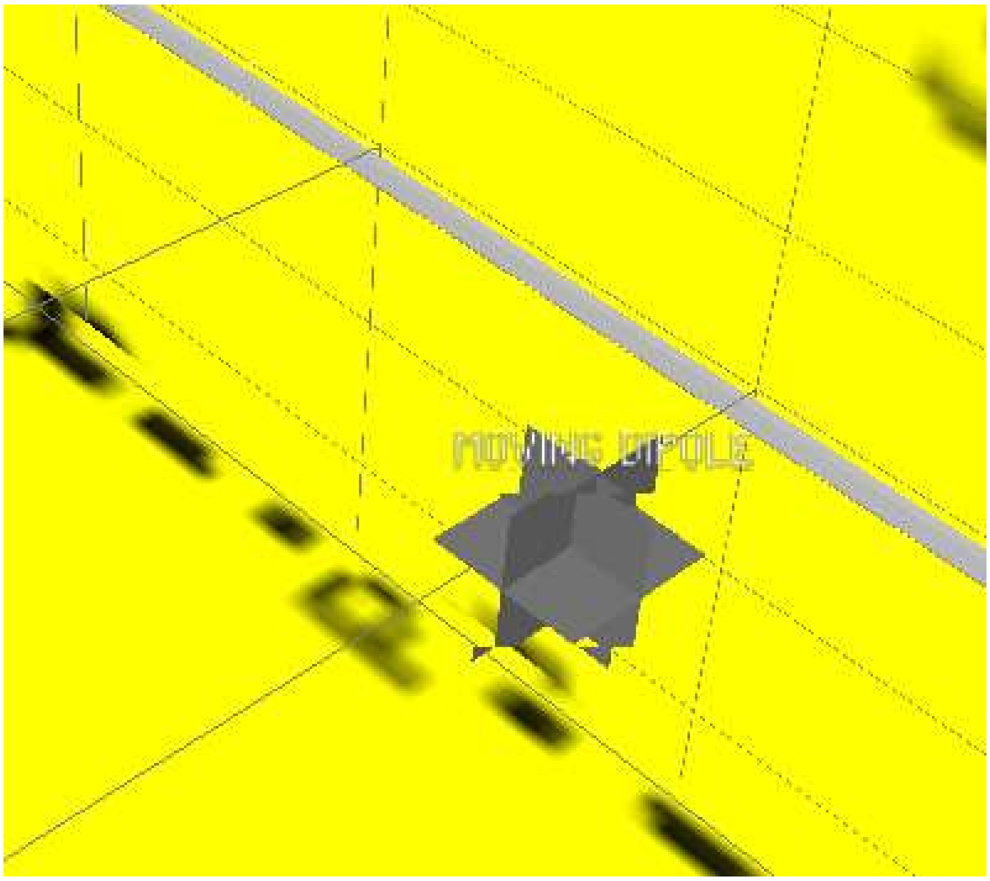
- First volume: Blue polygons (transparent/opaque denote different thresholds).
- Second volume: Orange lines.

EXAMPLE: ANDREW CHEN, PAIN



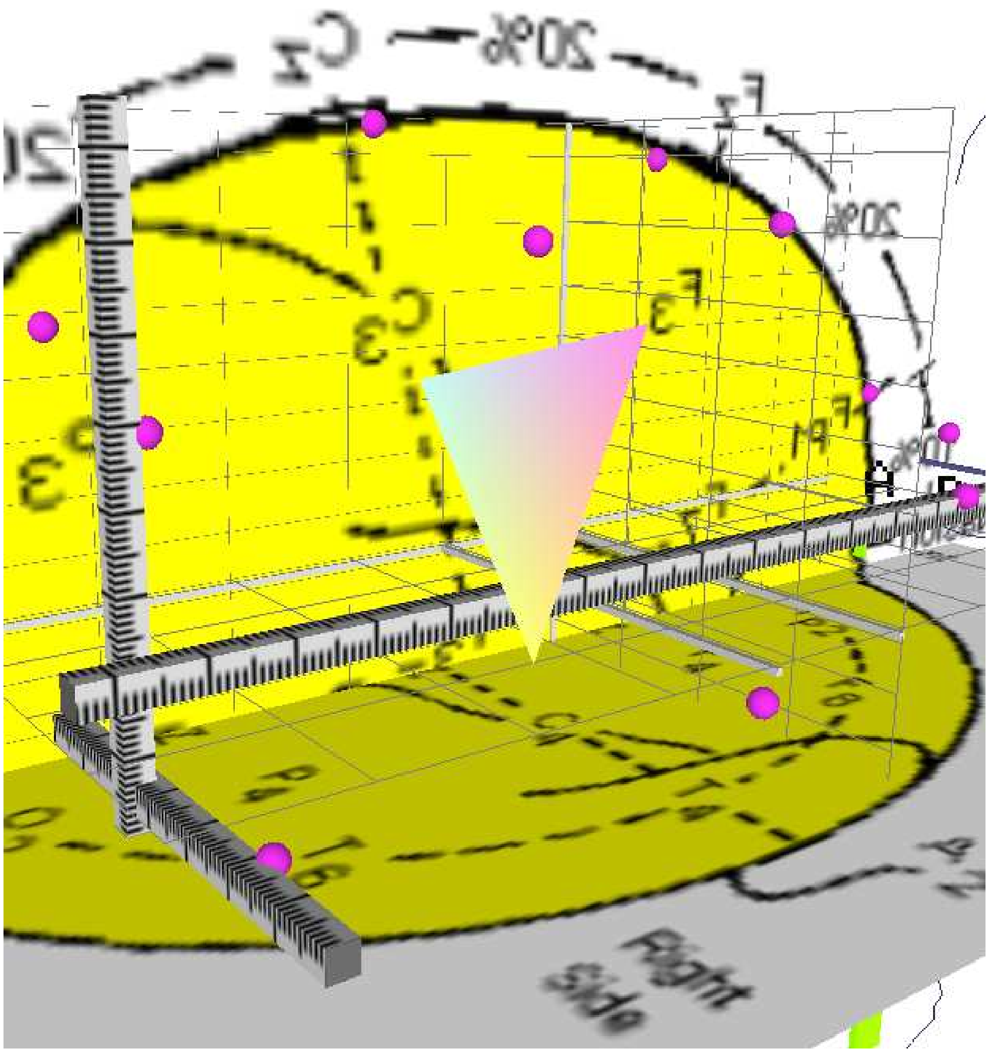
- Small glyphs as dipole points.
- How does the EEG coordinate system map onto the Talairach system?

EXAMPLE: MOVING DIPOLE



- Simple animation for a moving dipole by combination of `TimeSensor`, `PositionInterpolator`, `Transform`.

EXAMPLE: SCALP CURRENT DENSITY



- Static: Texture on polygons
- Dynamic: Combination of `TimeSensor`, `Script`, `Color`, Combination of `TimeSensor`, `ColorInterpolator`, `Material`.

BREDE

- Matlab toolbox for neuroinformatics
- Very early stage of development.
- Construct Talairach VRML content. E.g., Read a ACSII file with coordinate specification and construct the foci.
- `http://hendrix.imm.dtu.dk/software/brede`
- Command line based at the moment, later graphical user interface.

```
fid = fopen('Nielsen1999Neuroinformatics.wrl', 'w');

% Write VRML header
fprintf(fid, '#VRML V2.0 utf8\n\n');

% Write VRML
brede_vta_viewpoint(fid);
brede_vta_navigate(fid);
brede_vta_bkground(fid);
brede_vta_axes(fid, 'DiffuseColor', [0 0 0]);

textAbove = brede_read_txtlines('Chen1999Are.text.txt');
load Chen1999Are.P.txt
P = Chen1999Are;

brede_vta_point(fid, ...
  P(:,1:9)' / 1000, ...
  'PointType', 'plus', ...
  'Scale', 3, ...
  'diffuseColor', [1 0.5 0], ...
  'TextAbove', textAbove, ...
  'TextAboveColor', [ 0.1 0.1 0.1 ] );

fclose(fid);
```

TO USE VRML

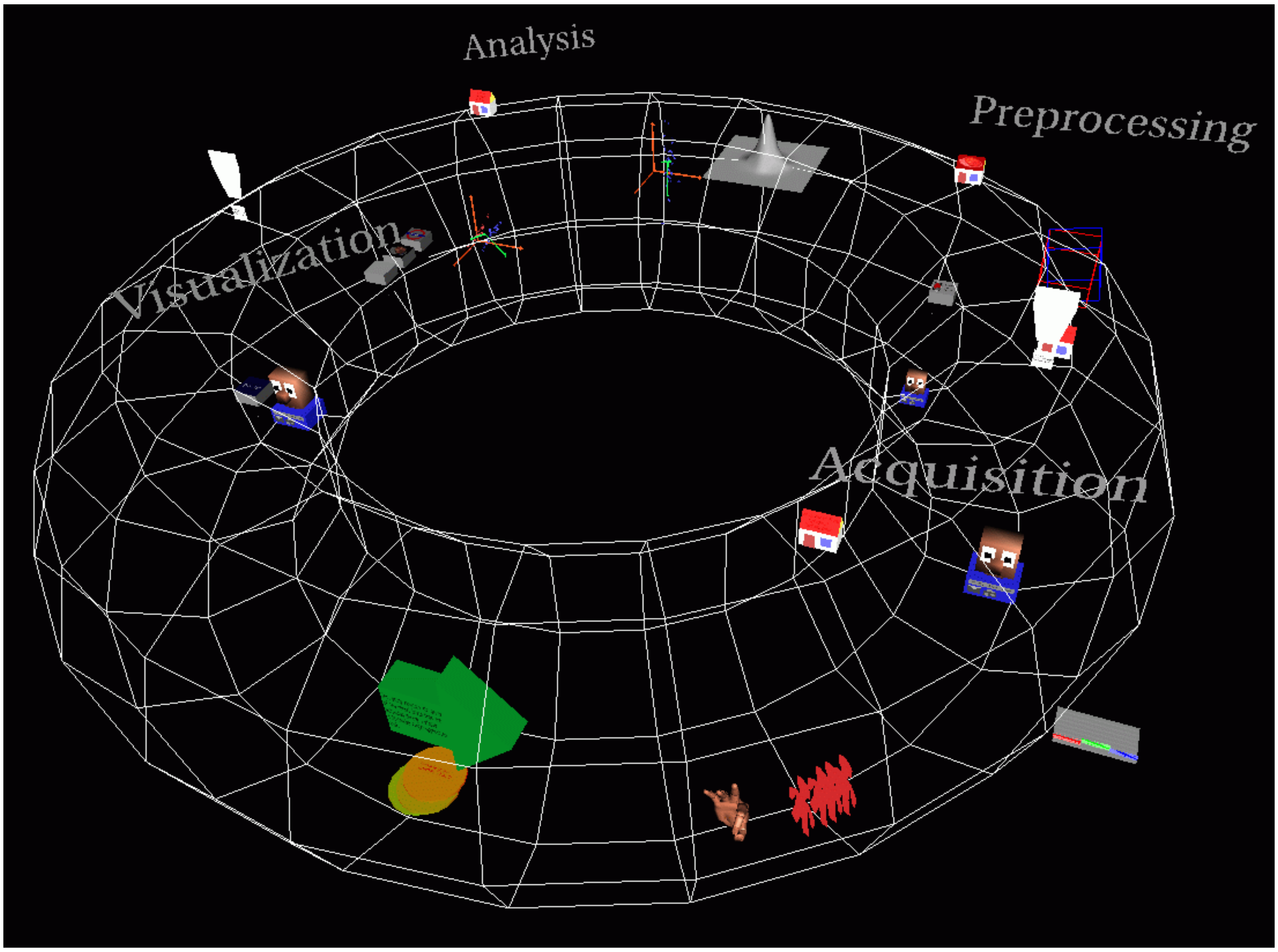
Why

- Flexible format: Can describe a wide range of graphics, easy integration.
- Real-time graphics: Easy to judge where the foci and “blobs” are, good depth cue through motion.
- Easy to share.
- Publish-able in electronic form
  - Electronic journals.
  - CD-rom with conventional journals.
  - Web-pages.

Why not

- Difficult interaction with mathematical programs.
- No/difficult volume rendering
- Problems with conformity: behaviour languages split between Java and JavaScript (VRMLScript).
- Varying quality of browsers.

FURTHER IDEAS



- Information Visualization: Visualize every kind of information surrounding a neuroimaging study
- "Distributed Cooperative Visualization" [Brodlie et al., 1998].
  - Electronic pinchboard (link BSCW for HTML).
  - Virtual Conference

References

[Brodlie et al., 1998] Brodlie, K. W., Duce, D. A., Gallop, J. R., and Wood, J. D. (1998). Distributed cooperative visualization. In *Eurographics'98: STAR State of The Art Report*, pages 27–50. Eurographics.

[Jensen, 1995] Jensen, J. J. (1995). 3d visualisering. Technical report, Electronics Institute, Technical University of Denmark, Lyngby, Denmark. In Danish.

[Lorensen and Cline, 1987] Lorensen, W. E. and Cline, H. E. (1987). Marching cubes: A high resolution 3D surface construction algoritm. *Computer graphics*.

[Nielsen, 1998] Nielsen, F. Å. (1998). *polyr, Polygon generation program*. Section for Digital Signal Processing, Department of Mathematical Modelling, Technical University of Denmark, Lyngby, Denmark, 1.0.0 edition.

[Rehm et al., 1998] Rehm, K., Lakshminaryan, K., Frutiger, S., Schaper, K. A., Summers, D., Strother, S. C., Anderson, J. R., and Rottenberg, D. A. (1998). A symbolic environment for visualizating activated foci in functional neuroimaging datasets. *Medical Image Analysis*, 2(3):215–226.