Neuroinformatics with VRML

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Abstract

We propose the use of VRML — Virtual Reality Modeling Language — in neuroimaging.

Vast amounts of information are generated from neuroimaging experiments. VRML can meet some of the challenges in organizing the rich set of information surrounding neuroimaging experiments.

We believe that VRML is a suitable — though not optimal — format for a neuroimaging database and the interface to it. The language facilitates better communication between researchers, and the language of images is an advantage in an interdisciplinary environment.

A library of VRML components for the use in neuroimaging is available at:
`http://hendrix.imm.dtu.dk/vrml/talairach`

VRML

- VRML — Virtual Reality Modeling Language: "It is the International Standard (ISO/IEC 14772) file format for describing interactive 3D multimedia on the Internet." [1]
- The language is platform independent.
- Requires a browser. Several exist. They are usually implemented as plugins to HTML-browsers, and with present day 3D video cards medium sized visualizations can be rendered at interactive speeds. [6]
- Computer graphics primitives: points, lines, polygons.
- Color, transparency, textures.
- Capability to make prototypes and library of prototypes.
- Hyperlinking and inlining of other VRML-files.
- Interactive and dynamic environments implemented with a *scripting language*, e.g., point and click interfaces.
- No 3D structures, i.e., volumes must be rendered as polygons, wireframes or slices.

Neuroimaging with VRML

How can VRML be used in neuroimaging?

- Plot of functional volumes / statistical parametric maps. Supplement to 2D plots: Better perception of the 3D structure of the "blobs". The ability to move the viewpoint at interactive speeds is of great importance to the perception of depth. 3D visualizations such as the CornerCube Environment give the researcher a better ability to judge the size and number of blobs [5].
- Comparison of several studies integrated in a single environment: Different analysis methods, different subjects, . . .
- Inspection of the image alignment methods.
- Information visualization, e.g., visualization of the neuroimaging process. Abstract representation of the multimedia components of a functional neuroimaging study: Data files, analysis packages, movies of the scanning.
- Virtual conferences: A group of researchers discuss and interact with the same visualization. The researchers can be situated anywhere on the Internet.

Talairach visualization with VRML

Components we might include in a functional volume visualization:

- Talairach frame of reference.
- Frames: Axes, grid lines, axis labels,
- Anatomical references, e.g., Drury's triangulation of the Visible Man data set [2].
- CornerCube Environment, walls and shadows [5].
- Functional volumes from neuroimaging studies.
- Database content, e.g., entries from the BrainMap database [3].

All volumes must be converted to a form VRML can handle, e.g., isosurface-polygons obtained with the marching-cube algorithm [4].

By making a control interface we are able to control the appearance of the actual visual components, e.g., change the color, visibility or position among other things.

Information visualization

- Interactive graphical overview of the process of one or more functional neuroimaging studies.
- Hyperlinking and geometric representation of all kinds of web-based material that describes a functional neuroimaging study: text, imagery, movies.

Example

- The neuroimaging process organized as a torus.
- Hyperlinking to researchers, homepages, scientific papers, analysis package, data files.
- Description of scanning protocol. Movies of the scanning.

Example

Functional neuroimaging study. Ian Law, Rigshospitalet, Copenhagen, Denmark. PET-study analyzed with SPM.

Components:

- Frames: Grid lines, AC-PC axes, Penfield and Rasmussen's Homonculus (Red: sensor, blueish: motor).
- Talairach atlas slice at +35 mm.
- Yellow blob: Mouth movement
- Magenta wireframe: Saccadic eye movements

The functional volumes have been triangularized with the marching cube algorithm.

Using transparency for the cortex surface of Drury's visible human the position of the mouth movement blob relative to the fissures becomes quite clear.

Conclusion

- ☺ Good motion depth cue by rendering at interactive speeds is important for the perception of the 3D structures.
- ☺ VRML forms a good basis for integrating different types of data situated locally and remotely on the Internet.
- ☹ VRML is an evolving language, e.g., the important scripting language is not yet in the ISO standard.
- ☹ No direct method for visualizing 3D data structures (volumes) in VRML, - only through polygons and slices.
- ☹ VRML does not interface well with statistical software if it is written C or Matlab.
- ☺ VRML is a general purpose language, — the neuroimaging community can take advantage of the common effort for the standardization, implementation and spread of the language.
- ☺ VRML can easily be published on the Internet or on a CD-ROM, giving an other researcher the ability to interact with the visualization, e.g., viewing the volume visualization from different viewpoints, or integrating it into her own visualizations.

Bibliography

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