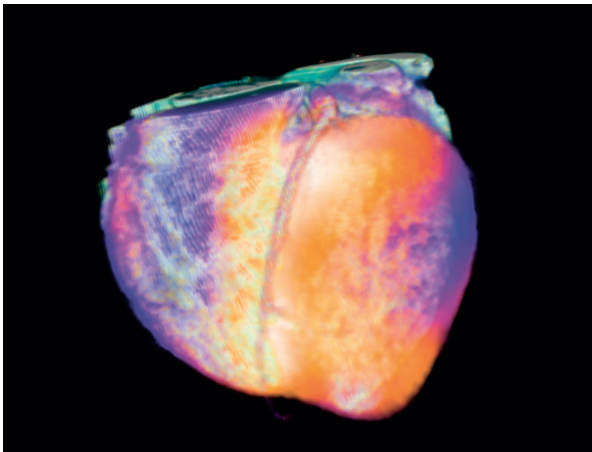# P3D 3D Image Rendering

3D Rendering in Medical Imaging

The amazing improvements in medical imaging devices have led to situations where researchers are confronted with many thousands of slice images covering single organs or the entire body. In such huge data sets, the relevant information may be difficult to localize. Therefore, flexible and targeted data reduction techniques are highly important. One approach is the rendering of selected image parts in pseudo-realistic 3D scenes, which has become the reviewing standard in domains such as angio-CT exams. The added value for the researcher is the ability to interactively compose and manipulate the scene and thus come to a true understanding of the pathology.

P3D allows the construction of 3D scenes from any number of matched input series.

Multi-Modality Rendering

Often, subjects are scanned using several modalities in order to assess complementary aspects of disease. A unique way of integrating such information is to generate 3D scenes from multi-modal data sets.

For instance, the left ventricle anatomy, assessed with angio-CT, can be augmented by color shading representing myocardial tissue perfusion.

Volume and surface rendering can be textured with static or even dynamic information.

Image Rendering with P3D

PMOD's P3D rendering tool offers a unique environment for visualization of information from anatomical and functional studies. It allows the construction of 3D scenes from any number of matched input series. Volume and surface rendering can readily be mixed in order to apply the most adequate technique for any data type. As a particular feature, both rendering types can be textured with static or even dynamic information. Additional elements such as image planes or VOIs enrich the scene, while a cutting facility allows exposure of inner parts of the scene. All of these features are easily available in a highly interactive fashion and make P3D the ideal tool for powerful presentation of research results.
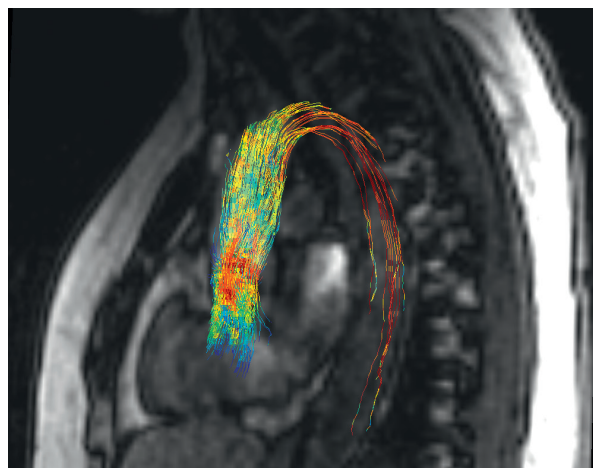

Human heart: Angio-CT derived anatomy combined with SPECT perfusion texture.
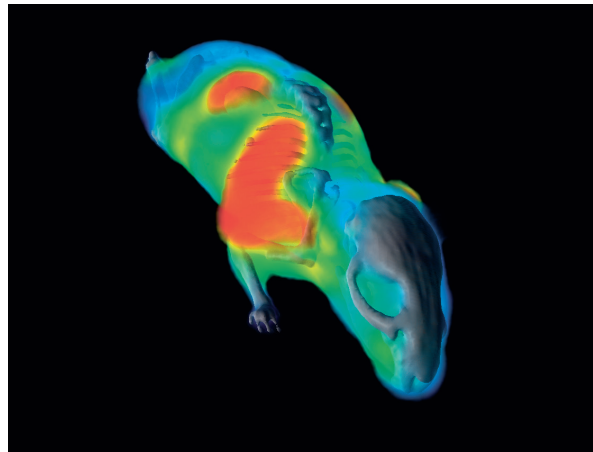
20 g mouse: Surface rendering of CT-derived skeleton combined with volume rendering of a matched SPECT image.
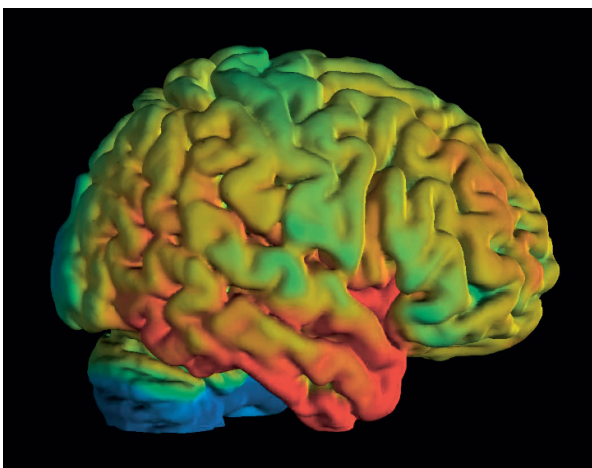
Human brain: Population BP_{nd} average of serotonin 5-HT1A receptor textured on brain surface.
Courtesy of A. Hahn, M. Savli, R. Lanzenberger, http://www.meduniwien.ac.at/neuroimaging/.

Streamlines visualizing blood flow velocity in the aorta, derived from a 4D flow MR acquisition.

Input Data

Objects from several image series can be rendered in a single scene if they have been registered to a common reference before loading. Volumes of interest (VOI) outlined in the images may also be loaded and rendered as surface objects. Furthermore, it is possible to import objects saved in STL (STereo Lithography), VTK tracks, and openFOAM polymesh formats.

Segmentation Procedures

The surface of objects is obtained using a segmentation process. The following segmentations are supported and can also be used to restrict the scope of rendering:
– Volumes-of-interest outlining
– Threshold-based segmentations
– Seeded region-growing techniques
– K-means clustering of dynamic series
Objects segmented from dynamic images can have a different shape over time.

Object Properties and Rendering

Scenes in P3D may contain the following objects, each supporting dedicated properties:
– Surface objects (shaded/wire-frame/points, transparency, color, texture)
– Volume-rendered objects (opacity functions, color transfer functions, texture)
– Vector path calculated from a vessel skeleton
– Oblique plane bound to a path (always orthogonal to path; with texturing)
– Orthogonal slice images (opaque/transparent/ threshold)
– Markers for pin-pointing locations of interest in the scene (cross, sphere)
– Volumes of interest (stripes, closed surface)
– Fiber tracks from diffusion tensor analysis
– Streamlines from 4D flow studies
– Visualization of vector fields such as matching deformation
– Fused MIP rendering of up to three series
– Dynamic objects can be played over time

Interactive Scene Manipulations

The 3D scene can be interactively explored using the mouse and dedicated user interface elements:
– Incrementally add objects to the scene
– Show/hide/remove/cut individual objects
– Cut objects by oblique plane within a definable radius
– Change the object properties
– Add light source
– Change viewpoint, zoom
– Let the scene rotate around any axis
– Run the texture derived from a dynamic scan through time

Results

P3D results can be saved in several formats, including:
– Protocol files encoding entire scene configurations enabling reproduction at any time later
– Images of the segmentation results
– Rotation movies
– STL (ASCII, binary) output of surface-rendered objects
– Image captures of the scene