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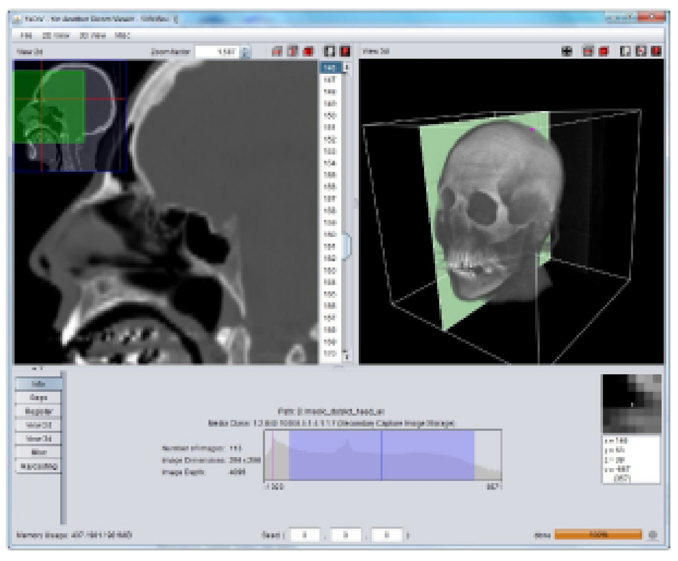
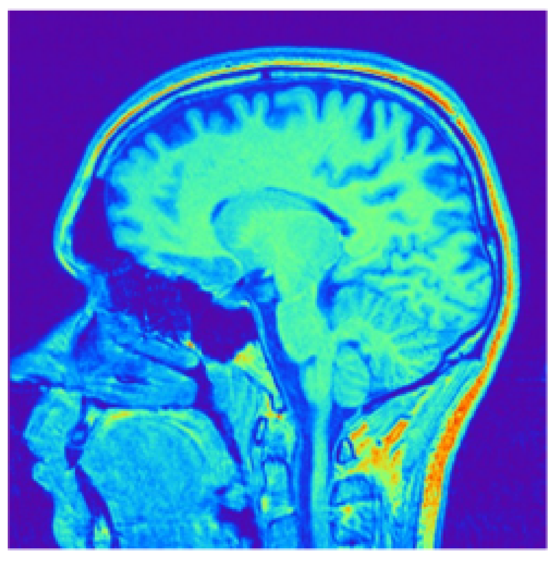
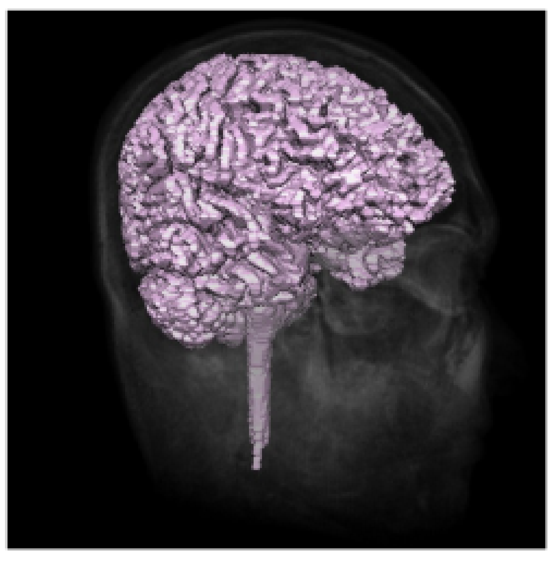
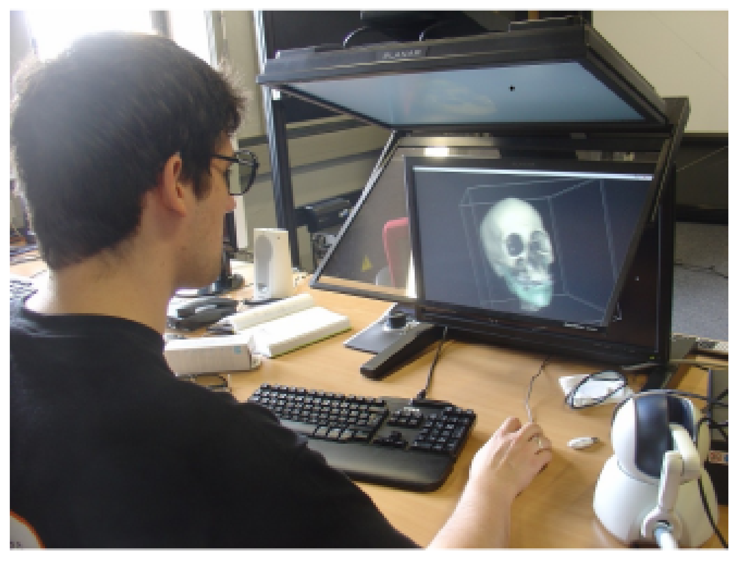
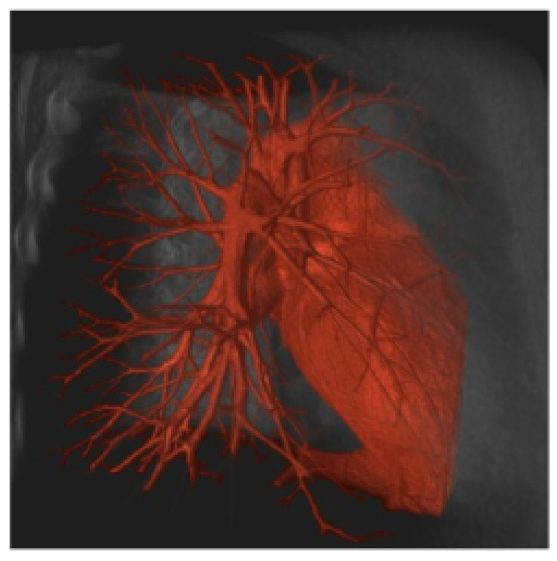
YaDiV - Yet Another DICOM Viewer

An Open Platform for Medical Visualization and Segmentation

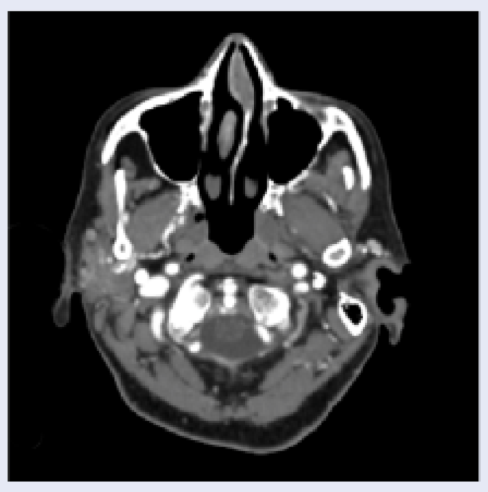
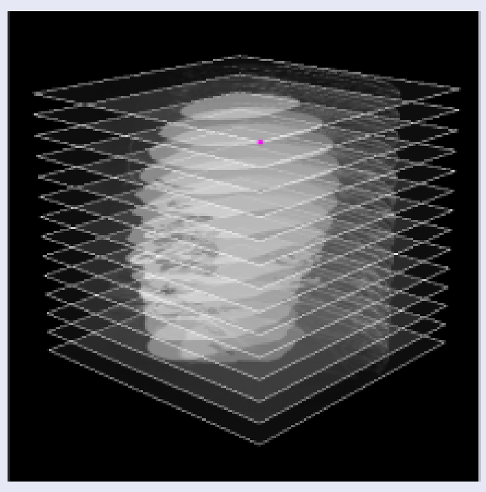






3D Medical Imaging

Medical Imaging refers to the techniques and processes used to create images of the human body for clinical purposes (diagnosis) or medical science (study of anatomy and physiology). While classic 2D techniques like radiology are used since 1950s, 3D methods started to become a regular part of clinical work in the beginning of 1990s. The first Computer Tomography (CT) scan of a human body was made 1970, today several other methods like Magnet Resonance Imaging (MRI) or 3D Ultrasonography (US) are used.

Tomography

While a classic radiology image contains the combined information of the whole body part, a modern tomography image contains only the information of one individual slice. Several of such images form a tomography scan (tomo = crop/cut, graph = writing) and result in a volumetric image set. The smallest unit of such volume data is called "voxel", similar to "pixel" being the smallest unit in a two dimensional image.

Depending on the tomography method, different tissues can be studied. While in CT scans bones are well distinguished, MRT scans allow for better discrimination of soft tissue like muscles or the brain. The common data format for medical (volume) data is called DICOM which stands for Digital Imaging and Communications in Medicine.

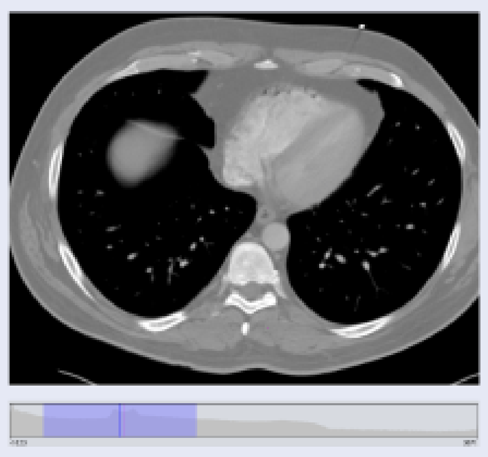
The Platform

YaDiV was written as an open platform for the visualization and segmentation of medical data, independent from operating systems and hardware. Mainly for this reason the program was implemented in Java and the 3D visualization makes use of the Java3D library. YaDiV can read DICOM data and contains modules for interactive as well as high quality volume visualization, segmentation methods and support for haptic devices. The complete architecture is thread based and utilizes modern multiprocessor and hyperthreading technologies. While its main purpose is to be a platform for software developers, it has an easy to use user interface which is evaluated by our clinical partners.

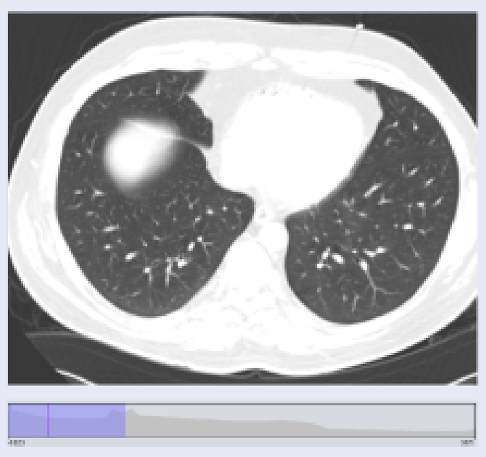
YaDiV was developed at the Welfenlab. A closed source version of YaDiV is already available on our web page. The development process is part of a PhD thesis, the first open source release is scheduled for the end of 2009.

Visualize the Data

The main window of YaDiV contains two elements to explore and analyse the loaded data: the "View 2d" and the "View 3d". Both will display the raw (volume) data as well as segments and other meta information. The volume data rendering is influenced by the selected Region of Interest (ROI). Since the range of intensity values from CT or MRT is larger (from 2^{12} up to 2^{16}) than the range of grey values that can be displayed with a standard computer monitor (2^8), the ROI defines an application-dependent region of intensity values, for example a bone window for surgery or a soft tissue window for neuroradiology.



bone ROI window

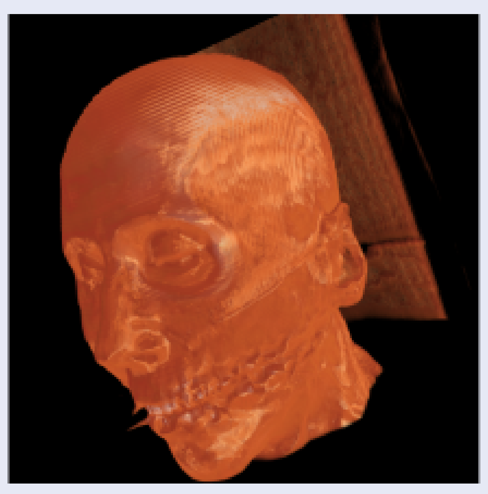
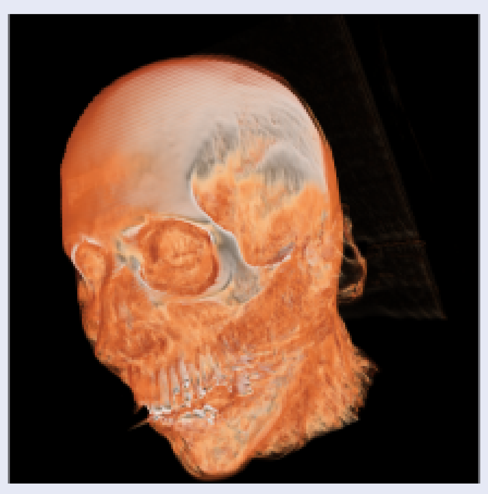


lung ROI window

The common and traditional visualization method is to display the data as two dimensional slices in transversal, sagittal or frontal mode. Modern Computer-Aided Preoperative Planning (CAPP) requires three dimensional rendering techniques, which can make use of the features of current graphic cards.

A simple 3D visualization technique is the 2D-Texture Visualization. It basically renders several slices in transversal, sagittal and frontal projection with a low transparency value, allowing a fast and three-dimensional analysis of the loaded data set. This method makes use of the 2D texture rendering hardware that is supported by every modern graphic card. The overall transparency allows to look "through" the data to analyse internal structures and it is possible to choose between a "grey scale" and "pseudo color" mode or interactively define an own transfer function. The quality of the 2D-Texture Visualization strongly depends on the number of planes.

A more modern texture visualization method makes use of real 3D textures, resulting in an improved rendering quality. The difference to 2D Texture Rendering is that only one set of parallel planes is used, which will always be orthogonal to the viewing direction; instead of rotating the geometry, the 3D texture coordinates are rotated. This results in less memory and avoids transparency problems of the 2D rendering method. An additional feature of the 3D texture implementation is the support of shading by using gradient normals and employing vertex shaders (via the OpenGL Shading Language).

ray casting with lit sphere mapping

All of the described rendering methods are very fast and allow interactive changing of parameters like color mode, transparency, visualization quality etc. A higher rendering quality can be obtained by using the optional ray casting module, including illustrative rendering techniques like lit sphere mapping.

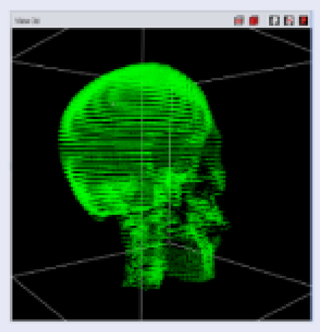
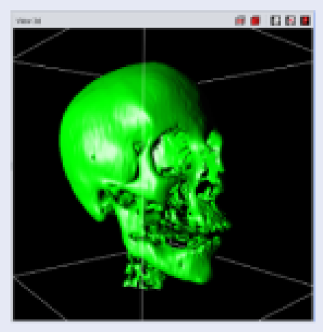
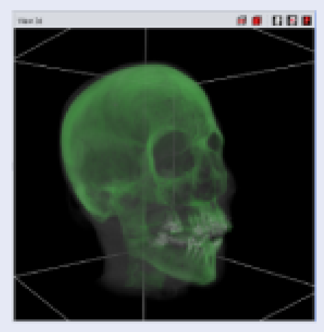
Segmenting

Segments are used to identify certain structures in the volume data, such as bones, muscles or organs. From the computer science point of view, a segment is a simple data structure, assigning a "belongs to me" or "does not belong to me" label to each voxel.

To create a segment, different segmentation methods can be used and combined. YaDiV already contains

- region grow,
- range based,
- two active contour algorithms and
- support for manual segmentation.

An advanced atlas based segmentation method is currently being implemented.

Segments an be visualized in the 2D and 3D View. The 3D supported visualization techniques are point cloud, texture based and a modified, self refining marching cube (used to extract the segment surface). The visualization is very fast and updates interactively during the segmentation process.

Stereoscopic View and Haptics

To get a natural impression, classic 2D projections of complex volume data is not enough. Therefore YaDiV supports stereoscopic rendering using quadbuffer stereo hardware and stereo output devices such as Head Mounted Displays (HMD) or stereoscopic monitors, allowing an intuitive and deeper understanding of the data. Together with a support of haptic input devices such as Sensable Phantom™or Novint Falcon™, new approaches in data exploration and a complete new virtual reality based workflow can be tested.

The following people helped to bring YaDiV to its current state: Benjamin Berger, Philipp Blanke, Richard Guercke, Robert Meyer, Maximilian Müller, Dominik Sarnow, Björn Scheuermann, Christoph Vollmer, Johannes Wahle and Yifan Yu. The evaluation was done by our medical partners, especially the facial surgery, the neuroradiology and the biomechanical laboratory (LBB) of the Medical University of Hannover (MHH)