

VOXEL-MAN 3D-Navigator: Inner Organs

Regional, Systemic, and Radiological Anatomy

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1. Getting Started

For optimum viewing conditions, it is advisable to set the screen resolution to at least 1024×768 pixels. The computer should be set to use the maximum number of available colors. Please make sure that the paging file size (virtual memory) of your system is set to at least 100 MB.

After the program has been started, the [Table of Contents](#) appears with a set of icons, each of which represents a scene. When the mouse is moved over an icon the title of the scene is displayed.

A scene is chosen by clicking on one of the icons. Thus, a [Scene Window](#), a [List of Objects](#), and an [Instruction Window](#) appear. Move the mouse within the Scene Window up/down and left/right, with the **left** mouse button held down. The scene reacts, for instance, by rotating in two directions. The [Instruction Window](#) indicates which actions the mouse affects. The scene may also be controlled using the [Scene Control](#) buttons on the [Main Menu](#).

To explore a scene, move the mouse to an object and press the **right** mouse button. A popup menu reveals the name of the object and its relations to other objects. If you release the button over one of the names, the respective object will be [painted](#), [marked](#), [annotated](#), or shown in its largest extend ([Seek](#)), depending on the choice of the [Mode](#) switch.

Objects may also be addressed by clicking on their name on the [List of Objects](#). In [Seek](#) mode, this list contains all objects which may be visible anywhere in the scene; otherwise, the currently visible objects are shown.

To return to the [Table of Contents](#), click on the [Home](#) button.

Due to limited capacity, scenes are stored on three CD-ROMs. Before starting a new scene, the program may ask you to insert a different CD-ROM.

2. General

VOXEL-MAN 3D-Navigator is a new kind of anatomical and radiological atlas. It is novel in at least two respects:

- Unlike books or traditional multimedia programs, it allows interactive exploration of a three-dimensional anatomical model. Each structure is labeled and described, and can thus be interrogated directly on the screen. The advantages of dealing with real anatomy are thus combined with the advantages of learning from a book (associated knowledge).
- Unlike traditional sources of knowledge, **VOXEL-MAN 3D-Navigator** presents the radiological manifestation of normal anatomy in the context of three-dimensional anatomy. It thus decisively improves the understanding of both X-ray and cross-sectional radiological images.

VOXEL-MAN 3D-Navigator thus provides unique reference material not only for medical students but also for professionals in all medical disciplines involving anatomy and radiology. Moreover, **VOXEL-MAN 3D-Navigator** is so easy to handle that also interested non-specialists can explore the inner structure of the human body.

The material is organized as a set of interactively explorable scenes, each of which shows a special aspect of anatomy, radiology, or both. The user's range of options includes inspection of anatomy from all directions, unveiling interior structures, and simulation of radiological examinations.

3. Material

The scenes were generated from the photographic cross-sectional images of the [Visible Human Project](#) (National Library of Medicine, Bethesda, MD). The original data set consists of photographic and computer-tomographic cross-sectional images of a frozen cadaver taken at a slice distance of 1 mm. The photographic cross-sections have a spatial resolution of 1/3 mm. Limitations of storage and computing capacity required that the resolution had to be reduced to 1 mm. From 770 slices, an image volume of 573×330×770 volume elements ("voxels") of 1 mm was composed. This volume was segmented into about 650 anatomical objects.

There exists a second computer-tomographic data set taken at about 3 mm slice distance from the fresh cadaver which has better quality, but is not congruent to the photographic data set. It is used for the scenes where 3D anatomy is correlated to computer tomography. 3D segmentation, visualization, and generation of the interactive scenes was performed with the VOXEL-MAN system developed at the Institute of Mathematics and Computer Science in Medicine at the University Hospital Eppendorf, Hamburg, Germany.

The scenes are interactive movies in an extended **Quick-Time VR** format. A user can navigate through a scene by moving the mouse up/down or left/right. This technique opens different modes of navigation. For example, the mouse can be used to control two directions of rotation. Alternatively, one mouse direction may control a rotation, while the other direction affects the addition or subtraction of anatomical objects, thus simulating a dissection.

Each picture element (pixel) of the scene is connected to a **knowledge base**, which can be addressed by clicking at a desired point on the image. The names of the anatomical objects may be interrogated according to three different organizational schemes which can be clarified if we use the example of the kidneys:

- **regional anatomy**
In this view the kidneys would be envisaged as part of the abdominal cavity.
- **systemic anatomy**
In this view the kidneys are shown as part of the urogenital system.
- **relation to peritoneum** (abdominal cavity)
In this view the kidneys are shown as part of the primary retroperitoneal organs.

There are two ways of accessing the information related to a scene:

- by clicking on the object of interest in the image window (scene), or
- by selecting an object from the list of objects attached to each scene.

4. User Interface

The user interface of **VOXEL-MAN 3D-Navigator** consists of

- the [Main Menu](#), which allows setting of the exploration parameters and control of the scenes ([fig. 1](#)),
- the [Table of Contents](#) from which the scenes may be selected ([fig. 2](#)),
- the [Scene Window](#) showing the current scene,
- the [Instruction Window](#) containing instructions on how to use the selected scene
- the [List of Objects](#) window from which anatomical objects may be selected for further exploration or identification.
- the [Brightness/Contrast Window](#), which allows adjusting brightness and contrast, as well as saturation of paint colors, in radiological images.

The [Main Menu](#) is always present, the [Table of Contents](#) appears at the beginning and when the [Home](#) button is pressed. The [Instruction Window](#) and the window for the [List of Objects](#) appear whenever a scene is chosen. The [Brightness/Contrast Window](#) appears with scenes that have black/white images. The latter three windows may be opened or closed via the [Windows](#) pull-down menu.

4.1 Main Menu



Fig. 1. Main Menu of VOXEL-MAN 3D-Navigator.

4.1.1 Menu Bar

File

Exit Exits the program

Edit

Undo / Redo Last Paint / Mark Reverses the last [Paint/Mark](#) action of this kind

Clear All Paint / Mark Clears all [Paint/Mark](#) highlighting

Clear All Annotations Clears all [Annotations](#) in the scene window

Reset Brightness / Contrast Resets the [Brightness and Contrast](#) controls to their original values

Options

Keep Paint During Motion Keeps the [Paint/Mark](#) colors during the motion of the scene. NOTE that the speed is thus decreased.

Paint After Seek Paints the addressed object when it is found.

Mark After Seek Marks the addressed object when it is found.

Windows

Object List Opens/closes the [List of Objects](#) window.

Instructions Opens/closes the [Instruction](#) window.

Black&White Brightness / Contrast Opens/closes the window with the [Brightness and Contrast](#) controls.

Size Adjusts the size of the [Scene](#) window.

Help

Contents Program description

About VOXEL-MAN 3D-Navigator Information about copyright, authorship, etc.

4.1.2 Control Bar

Scene Control



Moves the scene one frame up/down or left/right.



Starts a back and forth loop.

Note: After the first loop the movie may run much faster, because it is stored in the memory. Use the +/- buttons to influence the speed of the movie.



Stops the movie.



Increases or decreases the speed of the movie loop. Maximum speed depends on the PC used.

View

- Systemic Anatomy** Shows names and relations between the objects with respect to systemic anatomy.
- Regional Anatomy** Shows names and relations between the objects with respect to regional anatomy.
- Relation To Peritoneum** Shows names and relations between the objects with respect to their localization in relation to the peritoneum.
- All** Shows all names and relations between the objects within all three contexts.

Mode

Clicking with the **right** mouse button on the scene will enable different functions, depending on the Mode switch.

- Paint** Paints the chosen object with one out of a sequence of ten predefined colors. Multiple Paint operations are accumulated. Original colors may be restored with the [Clear All Paint/Mark](#) command.
- Mark** Shows everything but the selected object in black and white. Multiple Mark operations are accumulated. The original colors may be restored with the [Clear All Paint/Mark](#) command.

Note: **Paint** and **Mark** disappear while changing the scene, unless the [Keep Paint During Motion](#) option is set.

- Unpaint** Unpaints the chosen object.
- Unmark** Unmarks the chosen object.
- Annotate** Annotates the chosen object with its name. Annotations can be moved by dragging them with the middle mouse button (or ALT+left button) held down.
- Seek** Moves the scene to the frame that shows the object with its largest extension and marks or paints it, depending on the setting of the [Mark/Paint After Seek](#) option.

Nomenclature

For the object names in the popup menus and the [List Of Objects](#), different languages may be chosen.

- English** according to [Terminologia Anatomica](#) (where available).
- German** colloquial terminology.
- Latin** according to [Terminologia Anatomica](#) (where available).

Home

Returns to the [Table of Contents](#) from which a new scene can be chosen.

4.2 Table of Contents

The table of contents contains icons, each of which represents a scene (fig. 2). The scenes may be called up by clicking on the icons. Some of the scenes are accompanied by a red/green eye glasses symbol. Clicking on the symbol calls a red/green stereo version of the scene. It must be viewed with red/green glasses.

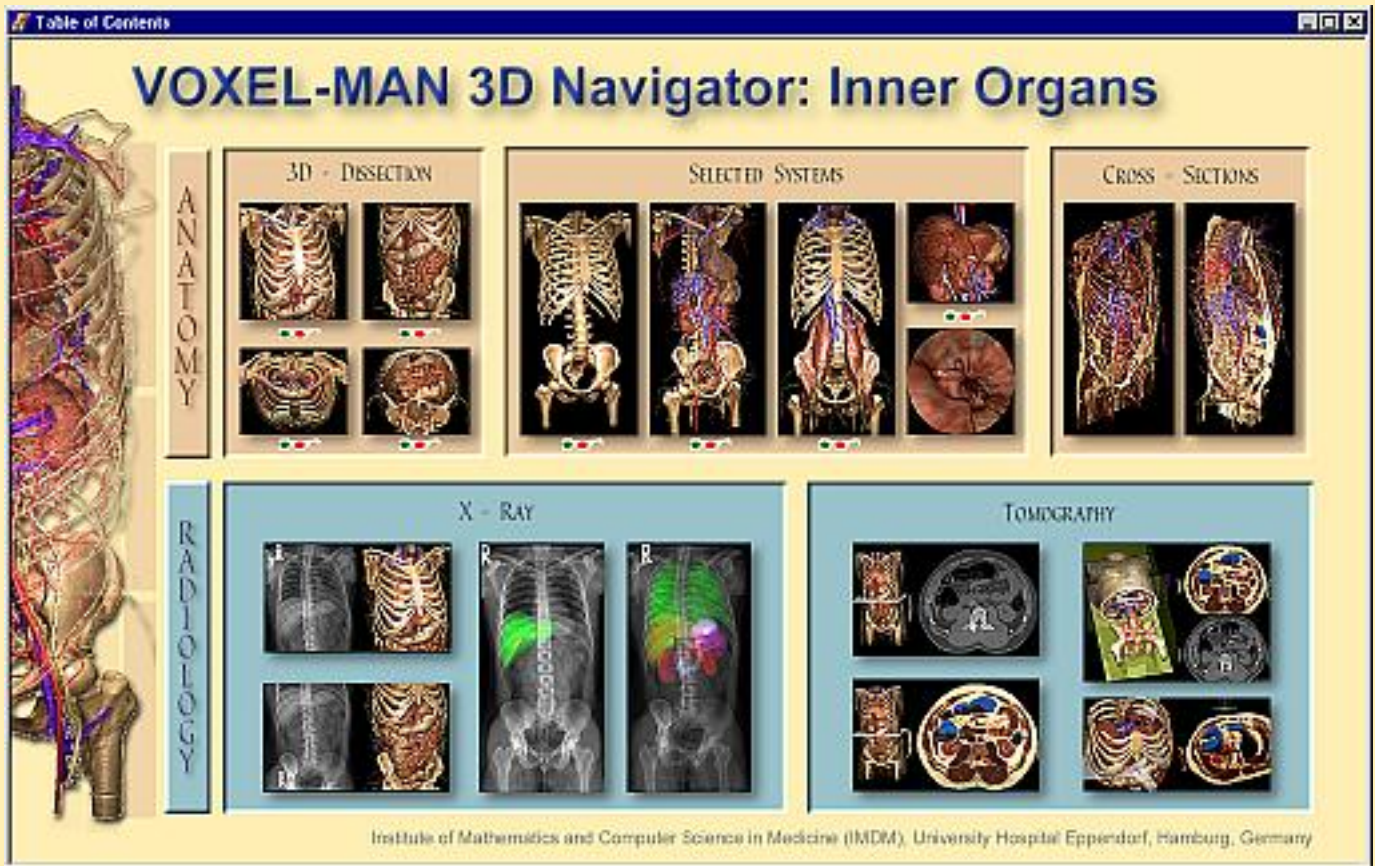


Fig. 2. Table of Contents. Clicking on one of the icons calls the corresponding interactively explorable scene.

4.3 Scene Window

The scene window shows the currently selected scene. Its size may be changed with the [Size](#) control in the [Main Menu](#). When it is larger than the screen or is dragged to a smaller size, scroll bars appear.

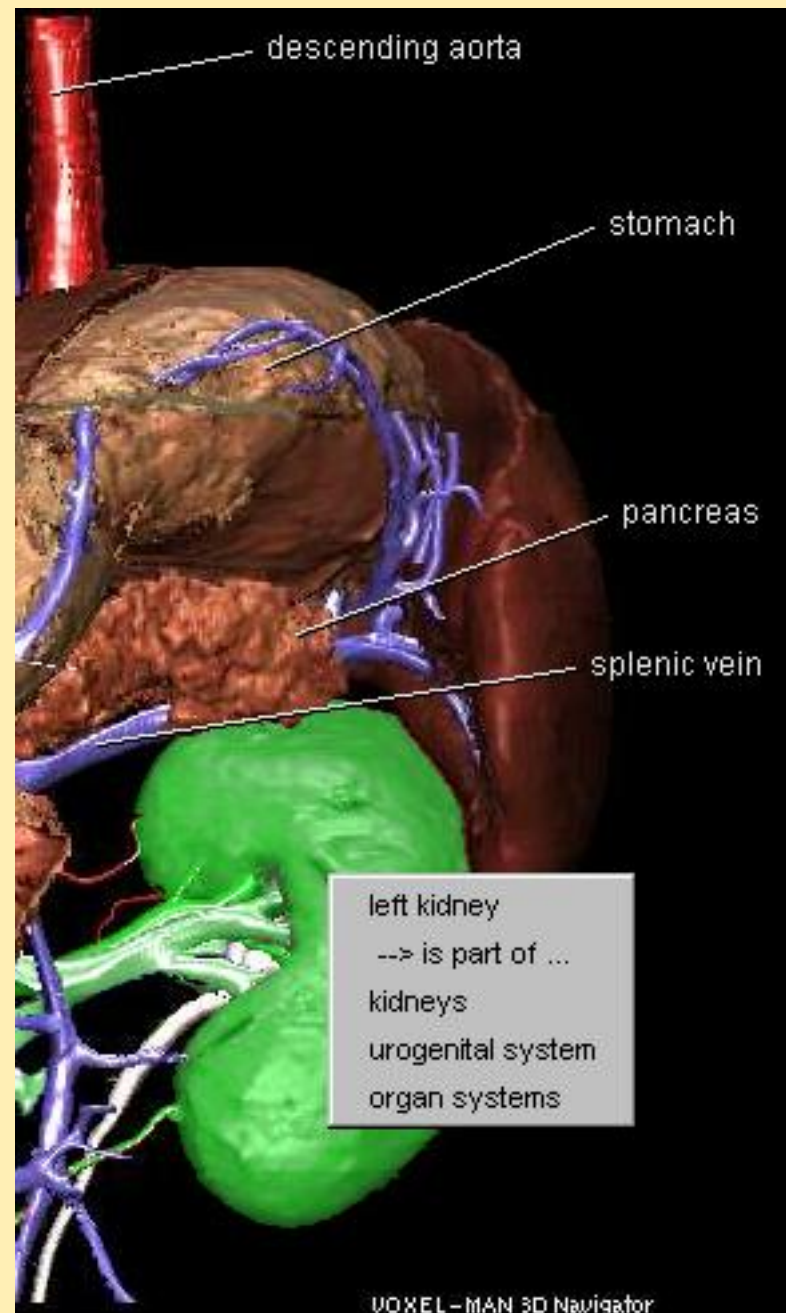


Fig. 3. The scene may be interactively explored by clicking on it with the right mouse button. A popup menu shows the name of the corresponding object and its relations to other objects. Depending on the [Mode](#) switch, different actions (like automatic annotation or coloring) may be invoked.

4.4 Instruction Window

The instruction window appears automatically with every [scene](#), unless it has been disabled in the [Windows](#) pull down menu. It contains specific [instructions](#) on how to use the selected scene.

4.5 List of Objects

In all modes but [Seek](#), this window displays the names of the objects present in the currently visible frame of the scene. The list is updated every time the scene changes. In [Seek](#) mode, the list displays all objects contained in the entire scene.

Actions like [Paint](#) or [Seek](#) are activated by double-clicking on the object name or pressing the button at the bottom of the list while an object name is highlighted. The number of objects in the list may be reduced by the **Filter** function. Entering "right art" will select all names which contain both of these character strings, such as the arteries on the right side of the body.

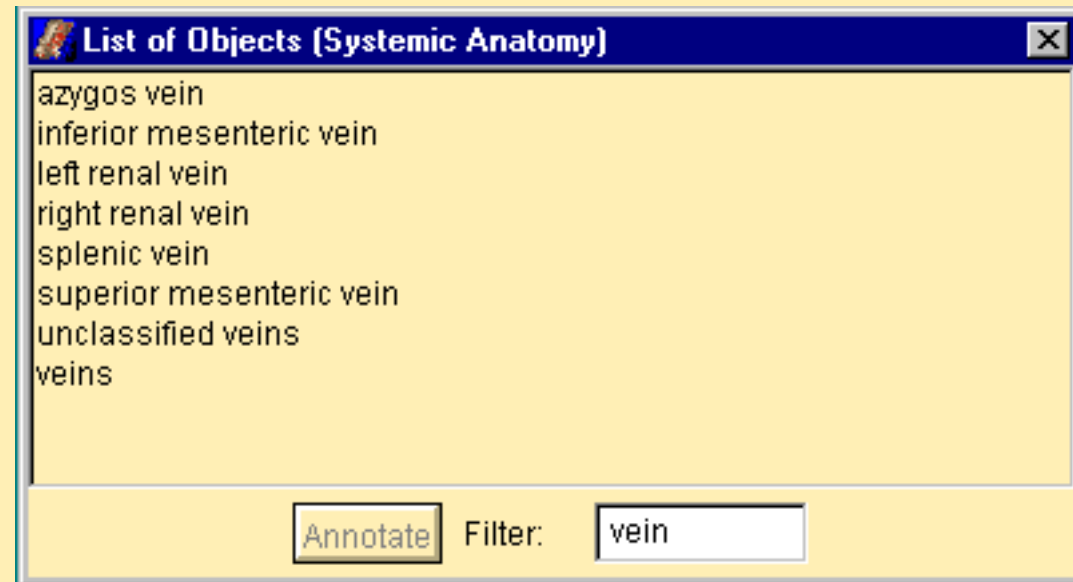



Fig. 4 Actions like coloring or searching for an object may be invoked by double clicking on an object in the object list. The number of objects may be restricted by a filter function reducing them to those containing a certain character string (here "vein").

4.6 Black/White Brightness/Contrast Window

When radiological images appear in the scenes, their brightness and contrast as well as the saturation of the paint colors may be tuned. For this purpose the sliders can be moved to the desired position. Alternatively (recommended) the sliders can be moved stepwise by clicking next to the slider (larger steps) or on the small arrows (smaller steps).

4.7 Stereo Scenes

Some of the scenes are available in red/green stereo. They are activated by clicking on the red/green eye glasses symbol  and must be viewed with red/green eye glasses. The green color is for the right eye. The cursor is not in stereo, it maps correctly on the red image only. For exactly positioning it on an object, the right eye must therefore be closed.

For stereo scenes, only [Seek](#) and [Annotate](#) modes are available, since Paint or Mark would destroy the stereoscopic impression.

5. Hardware Requirements

VOXEL-MAN 3D-Navigator runs under Windows9x/WindowsNT 4.0/2000 on any PC. For satisfactory performance, the following minimum configuration is required:

- CPU Pentium 233 MHz (recommended 400 MHz or more)
- Windows9x: 64 MB RAM (recommended 96 MB or more)
WindowsNT/2000: 96 MB RAM (recommended 128 MB or more)
- 15 MB permanent hard disk space
- Virtual Memory: 100 MB Paging File size
- screen resolution 800×600 pixels, 65536 colors (recommended 1024×768 pixels or more, TrueColor or 16M colors)
- 8× CD-ROM drive (recommended 16× or more)

6. Troubleshooting

Please examine the file 'readme.txt' provided on the MAIN CD-ROM which may contain some last minute information about possible problems. If the problem persists, please contact

Springer-Verlag
Electronic Media
Tiergartenstr. 17
D-69121 Heidelberg
e-mail: em-helpdesk@springer.de

7. References

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- Institute of Mathematics and Computer Science in Medicine (IMDM), World Wide Web pages: <http://www.uke.uni-hamburg.de/navigator>