

VoxelScope™ II

DESCRIPTION

The VoxelScope II real-time medical image display and reformatting system provides capabilities for 2-dimensional analysis, multiplanar reformatting, 3-dimensional reconstruction, as well as cine and multi-modality displays.

The system's most exceptional feature is its ability to perform multiplanar volumetric reformatting and 3-dimensional reconstruction in real-time, without lengthy preprocessing or preselection of views. Real-time manipulation of images may also be performed — any 3-dimensional image may be interactively rotated, sliced or adjusted along any plane, level or angle.

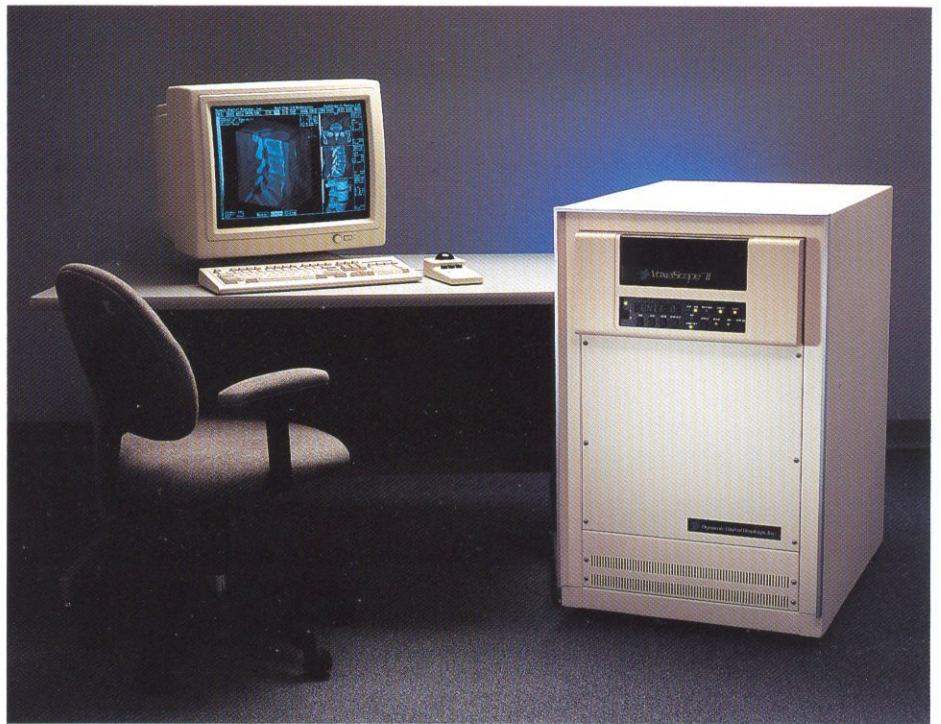
The VoxelScope II provides superior image quality. All images are created at the full spatial and density resolution of the original data, displaying the most intricate details of anatomy.

Because the VoxelScope II is an independent system, image processing can be performed without interfering with the operation of the scanner, providing for greater throughput of patient cases.

The VoxelScope II is extremely easy to operate. Datasets are loaded into the system via magnetic tape or direct interface. Images are displayed, and can be manipulated using special function keys. Any image which is created may then be saved on hard copy using the camera or laser imager option.

PERFORMANCE

The VoxelScope II achieves its real-time, interactive capabilities through its patented image



computer, the Voxel Processor™. The Voxel Processor has a large on-line memory, which is capable of holding a patient's entire dataset accessible for the creation of any image on command. This eliminates the need for lengthy preprocessing, and allows a typical case to be completed in under 10 minutes.

A breakdown of the processing speed is as follows:

- **Loading Speed:** Data is loaded from the disk to the Voxel Processor at a rate of approximately one 512 x 512 slice per second.
- **Rendering Speed:** Typical rendering times are shown below (512 x 512 image):

TYPICAL RENDERING SPEEDS

2-D	> 20 frames/second
Basic Axial MPR	> 10 frames/second
Basic Sagittal MPR	> 20 frames/second
Basic Coronal MPR	> 20 frames/second
Average/Oblique MPR	1 - 5 frames/second
3-D Shaded Surface	10 million voxels/second (not including shading — maximum overhead approximately 1.25 sec.)

3-D Examples:

A 3-D shaded surface display of a 320 x 320 x 171 voxel object takes 2.5 seconds, while a 160 x 160 x 171 voxel object takes 1 second. A medium sized dataset (512 x 512 x 89 voxels) takes 3 seconds.

FEATURES

Multi-Image Display

The VoxelScope II monitor screen is divided into one main and three sub-viewports, which display images simultaneously. This means that independent or related images from one or more datasets may be examined together on the same screen (e.g., 2-D, MPR and 3-D images; images from a patient's current and previous scan; and images from CT, MR and other modalities).

Images in each of the four viewports may be manipulated independently, and transferred freely from one viewport to another. The large main viewport is most often used for close examination and filming.

VX Interactive Visualization Software

Basic features and capabilities provided by the VoxelScope II VX Interactive Visualization Software include:

2-D Image Analysis

Enables the viewing of data exactly as it was acquired, prior to any interpolation.

TruLife Resolution™

Provides superior image quality. Volume-rendering algorithms yield images at full spatial and density resolution.

Window/Level

Allows adjustment to achieve optimal viewing parameters.

Roam

Permits movement of the image on the screen.

Flip

Provides the ability to "flip" an image 180° or rotate it 90°.

Volume of Interest (VOI)

Adjustment

Permits the selection of a subregion of the original dataset, to eliminate artifacts or unwanted areas.

Slice/Select

Allows images to be loaded or displayed one at a time, or "rolled-through" in real-time.

Cine (Loop)

Sequences through slices at a user-selectable rate.

On-Line Users Manual

Provides answers to commonly asked questions by pressing the "Help" key.

Utility

Provides for disk/dataset management; adjustment of screen annotations; and access to detailed information.

Color

Replaces the gray scale map with a proportional color scale map.

Tone Scale Segmentation

Allows the selection of tissue types and the assignment of specific colors to each tissue type (e.g., bone in white; muscle in red; etc.).

Slice Plane

Allows a selection of specified tissues to remain visible in front of an adjustable slice plane.

Zoom

Magnifies any image on command.

Disarticulation

Provides the ability to manually identify a structure (e.g., part of a joint) so that it may be removed for easier visualization. Structures identified or "tagged" may either be made invisible or colored.

Region of Interest

Enables specification of a region of an image for quantitative analysis using the measurement package. The region may be defined using a hand-drawn contour, or an adjustable ellipse or box.

Measurement Package

Computes distance (in mm), angle, and area (in square mm) for 2-D and MPR images, and the volume (in cubic mm) for 3-D images. Also computes the following for a Region of Interest: minimum and maximum CT number, mean CT number and standard deviation, and the area (number of pixels and square mm).

Gantry Tilt Data Analysis

Enables complete analysis of datasets in which all images have the same degree of gantry tilt.

Split Screen Presentation

Allows examination of multiple views of the same or different slices on the screen at one time. Provides capabilities for adjustment of window and level for each view independently.

Multi-Planar Reformating Software:

The MPR mode is entered with the touch of one key, and multi-planar reformatted images are created instantaneously. Initially, the center axial slice of the dataset is displayed in the main viewport, with axial, sagittal and coronal views shown in the sub-viewports. Throughout the MPR analysis, annotations in the sub-viewports show the exact position of the image in the main viewport on the orthogonal planes.

Other MPR mode capabilities include:

Slice/Select

Permits individual selection of axial, sagittal or coronal slices.

Cine (Loop)

Provides a rapid display sequence in each plane.

Oblique MPR

Provides the ability to rapidly generate an image along any paraxial or true oblique plane.

Reprojection

Provides the ability to create an x-ray-like image (digitally reconstructed radiograph) from a CT dataset.

3-D Reconstruction Software:

This software provides the capability for **real-time, interactive** generation and manipulation of 3-D reconstructed images. Shaded-surface display, subvolume or chunk presentation is available. 3-D images are generated by pushing one function key — **and no lengthy background reconstruction of contour files is necessary.**

Special 3-D capabilities include:

Window/Level

Enables adjustment of the threshold of the display object, and selection of the proper mapping type for optimal display. Permits selection of tissue densities and modification of tone scale maps.

Rotate

Rotates the object about an arbitrary, user-specified axis.

Spin

Continuously repeats the last rotation command (movie mode).

Slice

Slices shaded-surface displays in an object or image space plane. Object space slicing cuts along planes which remain fixed to the object as it is rotated. Image space slicing cuts along a plane parallel to the screen.

Shading

Allows operator to interactively set contrast and brightness, and adjust the gradient (shading factor) of the image displayed.

4-D

Displays dynamically changing 3-dimensional datasets, so that, for example, a 3-dimensional heart can be viewed while it is beating.

SPECIFICATIONS

Components

- **Color Monitor:** 19" Full Color (RGB) monitor; 60 Hz, non-interlaced.
- **Video Display:** Full color (24-bit RGB) image viewport;

576 x 768 (whole screen).

Allows for the display of one 512 x 512 image in the main viewport, and one 170 x 170 image in each of the 3 sub-viewport. 12-bit text/graphics overlay provides copy, instructions and annotations. Monitor speed: line frequency: 36 kHz; dot clock: 35 MHz.

- **Keyboard:** Full keyboard with alphanumeric and labelled function keys.
- **Trackball/Mouse:** Used for rotating, positioning and slicing images; disarticulation; and adjusting window and level.
- **Desk-Side Enclosure:** Houses Voxel Processor, System CPU, Disk Drive, Tape Drive and Power Supply.
- **Modem:** Hayes™ compatible 2400/1200/300 Baud. Compatible with Bell 103 and 212A, as well as CCITT V.22 and V.22 bis standard.

Computer System

- **System CPU:** Embedded 32-bit Motorola/68030 Host with 8 Mbyte memory, floating point processor, UNIX™-based operating system.
- **Voxel Processor:** Uses a custom bit-slice parallel/pipeline architecture. Provides 200 - 300 MIPS performance for MPR/3-D rendering.

16 Mbyte Voxel Processor Memory

- The memory can hold up to 30 original full 512 x 512 slices on-line. The effective slice capacity may be increased by using the volume of interest (VOI) feature.

Image Storage

- **300 Mbyte Disk Drive:** Formatted hard disk drive (CDC Wren™ IV) and controller; allows for the storage of up to 400 512 x 512 images on line. At 30 images per study, this represents a capacity of 13 patient studies.

Data Interface

- **9-Track Magnetic Tape Drive:** The tape drive interface enables the VoxelScope to be used with most scanners. It provides auto-loading of all standard tape sizes, and reads the following densities: 800 bytes/inch (bpi); 1600 bpi; and 3200 bpi.

SYSTEM OPTIONS

Expanded Voxel Processor Memory

- The Voxel Processor memory may be expanded to 32 or 64 Mbytes. The 32 Mbyte memory can hold approximately 60 512 x 512 slices on-line, and the 64 Mbyte memory can hold approximately 126 512 x 512 slices. Effective slice capacity may be increased by reducing the volume of interest.

Additional Disk Storage

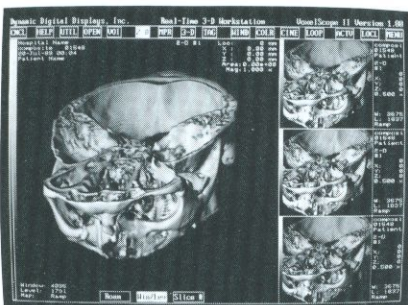
- Available in 300 Mbyte increments, up to 1.2 Gbytes. Approximate storage capacities are as follows:

Additional Disk Storage

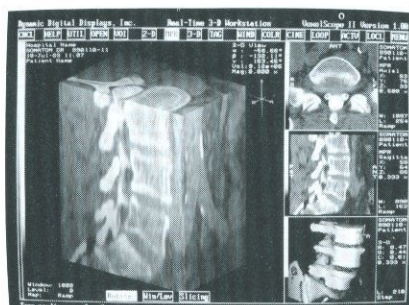
Size Disk Drive	No. 512 x 512 Images Stored	No. Studies (30 Images/Study)
300 Mbyte	400	13
600 Mbyte	1000	33
900 Mbyte	1600	53
1.2 Gbyte	2200	73

Cameras/Interfaces

- **Dedicated Matrix MI-10™ (Standard or Auto-Loader):** Multi-Imager system; highest resolution available is 768 x 576 at 60 Hz.
- **Dedicated Laser Imager:** Offers multiple film sizes and formats; black and white. High-speed processing, multi-original capabilities.



TruLife Resolution



Volumetric Rendering

SYSTEM OPTIONS (Continued)

- **Camera Interfaces:** These provide the option of having the VoxelScope interface to an existing camera on-site. *Note: The customer must provide a remote keypad on the camera if it is being shared with another input device.*

Data Interfaces

- **Ethernet™ Hardware Interface and TCP/IP Software:** Available as an option for loading of data at a speed of 10 million bits/second. *Note: The customer is responsible for the cable connection to the VoxelScope.*

Remote System Components

- **Tape Loading Terminal:** This may be used to control tape loading independently from the main console, and can be connected at a distance of up to 250 feet.
- **Remote Monitor/Keyboard/Trackball:** The system unit (in the desk-side enclosure) may be located up to 250 feet away from the user interface/console.
- **Additional Display Monitors:** Up to 4 additional remote monitors may be added to any system.

Miscellaneous Options

- **Desk and Chair:** Gray computer desk; 2-leg with modesty panel. Monitor, keyboard and trackball fit easily together on the desktop. Matching adjustable chair.
- **Extended UNIX Manuals:** These provide the documentation necessary to use the VoxelScope system as a general-purpose computer. Manuals provide descriptions of all UNIX facilities, and documentation on the C-language compiler.

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SITE REQUIREMENTS

- **Electrical:** Standard 120 VAC 20 Amp dedicated circuit (standard 3 prong plug).
- **Lighting:** Subdued, indirect lighting suitable for computer terminal type equipment.
- **Telephone:** Dedicated phone line for the modem must be available at the time of installation.
- **Proximity To Magnetic Fields:** Image quality may be adversely affected by the proximity of the VoxelScope II monitor to sources of strong magnetic fields (e.g., MRI units).

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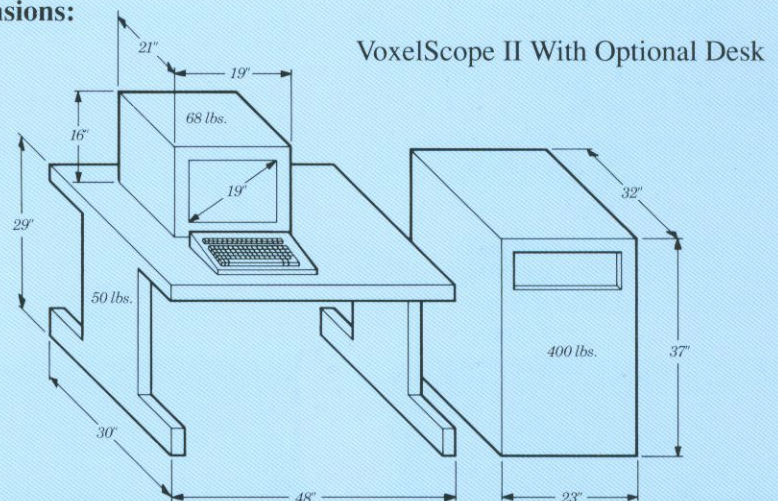
Environmental:

Ambient Temperature	50 - 80 degrees F
Humidity	20 - 80%
Altitude	0 - 10,000 feet

Power Dissipation:

Host + Graphics Processor	1700 BTU/hr.
Tape Drive	1700 BTU/hr.
Video Monitor/KB/Trackball	850 BTU/hr.
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Total	4250 BTU/hr.

Dimensions:



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