

Vesselize: A System for Analysis and Visualization of Magnetic Resonance Angiography

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VESSEL ANATOMY and pathology are difficult to assess from magnetic resonance angiography (MRA) source images due to the complexity of vessel shape. We present a system that enables high-quality three-dimensional visualization of MRA necessary for surgical planning. The system includes both standard tools and recent innovations, which improve speed and visualization quality. The system operates on a mid-range PC with sufficient memory to process MRA.

Vesselize offers an easy-to-use graphical user interface to the clinician in a familiar windowing environment. The application was developed using

Visual C++, OpenGL, and Win32 SDK and is functional on any Windows (NT, 9x; Microsoft, Redmond, WA) platform. Standard visualization

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3D skeletal lines superimposed on MIP

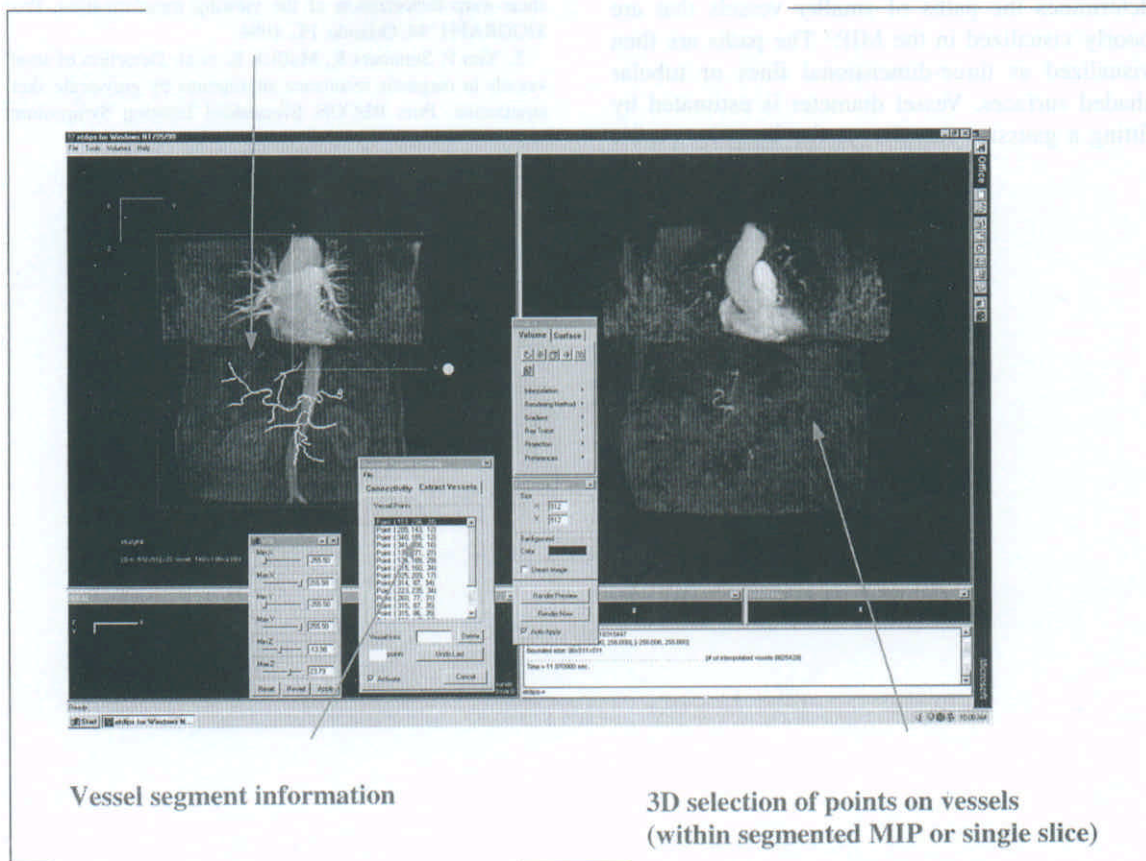


Fig 1. Vesselize user interface. MRA is visualized on the Windows/PC platform. Hepatic arteries are identified with the ordered-region growing (ORG) skeletonization. The vessel paths are superimposed on the maximum intensity projection (MIP). The ORG skeletonization is produced from a set of vessel endpoints indicated by the user. The shaded surfaces and the MIP can be rotated in real-time.

methods provided include direct viewing of the source images, the maximum intensity projection (MIP), the subvolume MIP and the iso-intensity shaded surface. Data can be read in Digital Imaging and Communications in Medicine (DICOM) 3.0, raw (two-dimensional and three-dimensional), and in BMP (two-dimensional stack) format.

MIP volume rendering is performed either on the system central processing unit using an optimized software algorithm or through hardware. Rendering is performed with the VolumePro 500 card (Realtime Visualization, Mitsubishi Electric, Concord, MA; www.rtviz.com), which is based on object order ray casting (similar to the shear-warp algorithm).¹ With this card, the MIP can be rotated in real-time, which is necessary for resolving overlapping structures.

A path detection process is provided for evaluating vascular anatomy. The method is based on the ordered region-growing (ORG) algorithm, which determines the paths of smaller vessels that are poorly visualized in the MIP.² The paths are then visualized as three-dimensional lines or tubular shaded surfaces. Vessel diameter is estimated by fitting a gaussian function to the intensity profile

normal to the vessel axes. The paths are determined based on a set of vessel endpoints specified by the user. This method has been found to be effective for determining assessing the anatomic variation of the hepatic circulation for surgical planning.

This system is based on the plug-in software architecture, which allows for third parties and independent researchers to expand the functionality of an application without increasing its size and complexity. It also gives the flexibility to rapidly implement custom applications for the end-user in their own work environment.

In conclusion, we present a system that provides the radiologist with access to powerful visualization methods, which will enhance the ability to evaluate vascular anatomy.

REFERENCES

1. Lacroute P, Levoy M: Fast volume rendering using a shear-warp factorization of the viewing transformation. Proc SIGGRAPH '94, Orlando, FL, 1994
2. Yim P, Summers R, Mullick R, et al: Detection of small vessels in magnetic resonance angiograms by grey-scale skeletonization. Proc BECON Biomedical Imaging Symposium, National Institutes of Health, Bethesda, MD, 1999



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