# Dicom image handling for medical analysis and the ViVa Project

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**Objective**

The aim of this work was to build the basic system for medical image retrieval and elaboration suitable for the ViVa Project, aiming at building, from clinical data, virtual vascular systems where also blood flow fields can be simulated and analysed.

**Introduction**

In this paper we describe the facilities for image retrieval, display and segmentation used both for direct medical analysis of the images and the 3d reconstructions requested by the CRS4 ViVa (VIrtual VAscular) project. The target of this project is the realization of a simulated vascular environment obtained by reconstructing the 3D vessel structures from processed diagnostic images and then performing blood flow simulations or guided navigation in the "virtual" vessels. For this project image retrieval and elaboration is a basic step and an efficient way to send the diagnostic images acquired or stored in several remote sites to the elaboration and reconstruction programs is a fundamental need.

We also describe how these images are elaborated and handled by the client side. The clients of the image server are Java and C user-friendly interfaces supporting several segmentation tools (2D and soon 3D) able to send to the elaborated data in the correct format for further work like geometry reconstruction, mesh generation and flow simulation with finite element solution of the Navier-Stokes equations.

**System Description**

On the image server workstation a DICOM storage application (based on CTN routines) is running and it is able to get and receive images from other DICOM modalities connected on the net. On the same workstation an image server program (DIRSI) is installed and can accept requests for images by name or by patient information, sending back the slices in the format requested by the Java or C/C++ viewing station (8,16 bits etc., conversions are performed by the server). In this way, elaborations, analysis, 3D reconstruction, flow simulation for diagnosis or surgical planning can be realized as soon as the DICOM modality sends the image to the CRS4 CTN image server.

**The scheme of the interaction is shown in Fig. 1.**

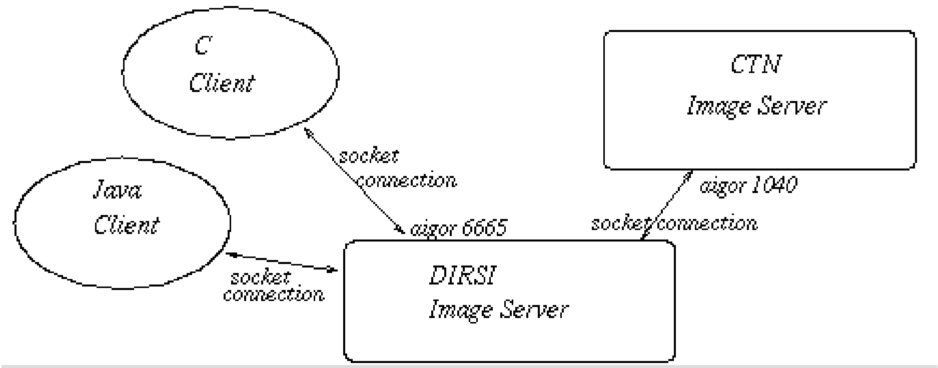


Fig. 1: The scheme of the image retrieval system

C++/Java libraries to make requests to the server have been realized and segmentation tools for local workstations realized at CRS4 use the routines included in them to get the images.

The main display/segmentation facility developed at CRS4 is the OODISS, a Java Object Oriented display and segmentation tool. This tool allows the user to load multiple images, perform almost any kind of basic image processing and several segmentation procedure based on edge following, a balloon model and the Generalised snakes routine (GSNAKE) through a client-server CORBA connection with the original C program. The object oriented approach and the multi-display system will allow the insertion of other processing tools (both with Java computational kernel or C kernel on particular platforms through the client-server CORBA connection if the computational weight is huge), the use of Java makes the viewer platform-independent.

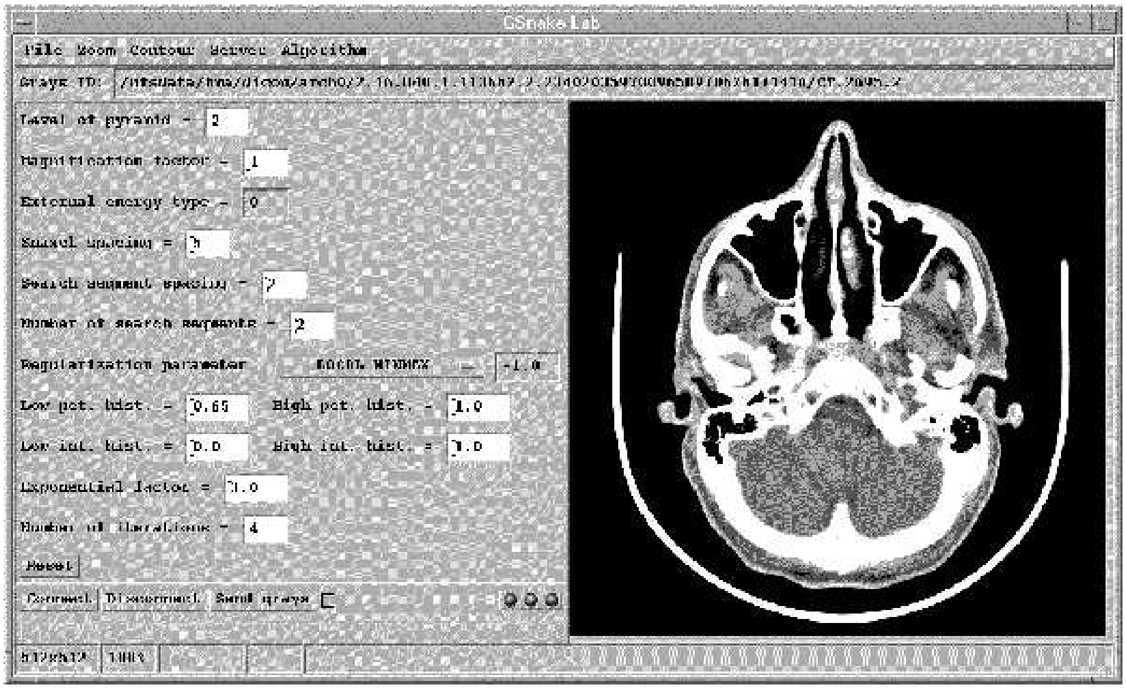

Fig. 2 OODISS Segmentation Window

In this way the system is ready to be applied in a hospital environment with DICOM modalities and can allow an easy image retrieval and examination from any PC or workstation connected on the local area network.

For the ViVa project, the OODISS is able to extract and save 2D contours from the slices in the format required by the geometry reconstruction tool developed at CRS4 and in the future will be directly interfaced using CORBA with the reconstruction programs based on XOX SHAPES libraries. Support for direct 3D segmentation and reconstruction will be also added.

Other elaboration and segmentation tool have been realized with C programs and X interfaces including also region growing algorithms, direct contours joining with inter-slice forces and 3D reconstruction performed using XOX SHAPES (MicroTopology) libraries. In this way the result of the elaboration is not simply a series of contours, but a well defined 3D geometry. Further work will be done to realize a more specific 3D balloon for a better 3D surface definition and also model based geometry reconstruction for particular structures like bifurcations.

## Results

The system is now working with good results and it is under testing at CRS4. Several 3D reconstructions have been performed and the simulation schedule is under planning.

## Discussion

Image retrieval and elaboration is very important for biomedical research. The widely accepted DICOM standard simplifies the image handling but also makes necessary to develop systems supporting the DICOM format. The image server realized and the socket transmission used make the images available on the network and easily loaded in the preferred format by the Java/C clients running on any PC or workstation.

The elaboration systems developed seems to be useful for the image analysis but have been also specifically designed to provide all the information and data necessary for the vessel reconstruction, the aim of the ViVa Project.

## References

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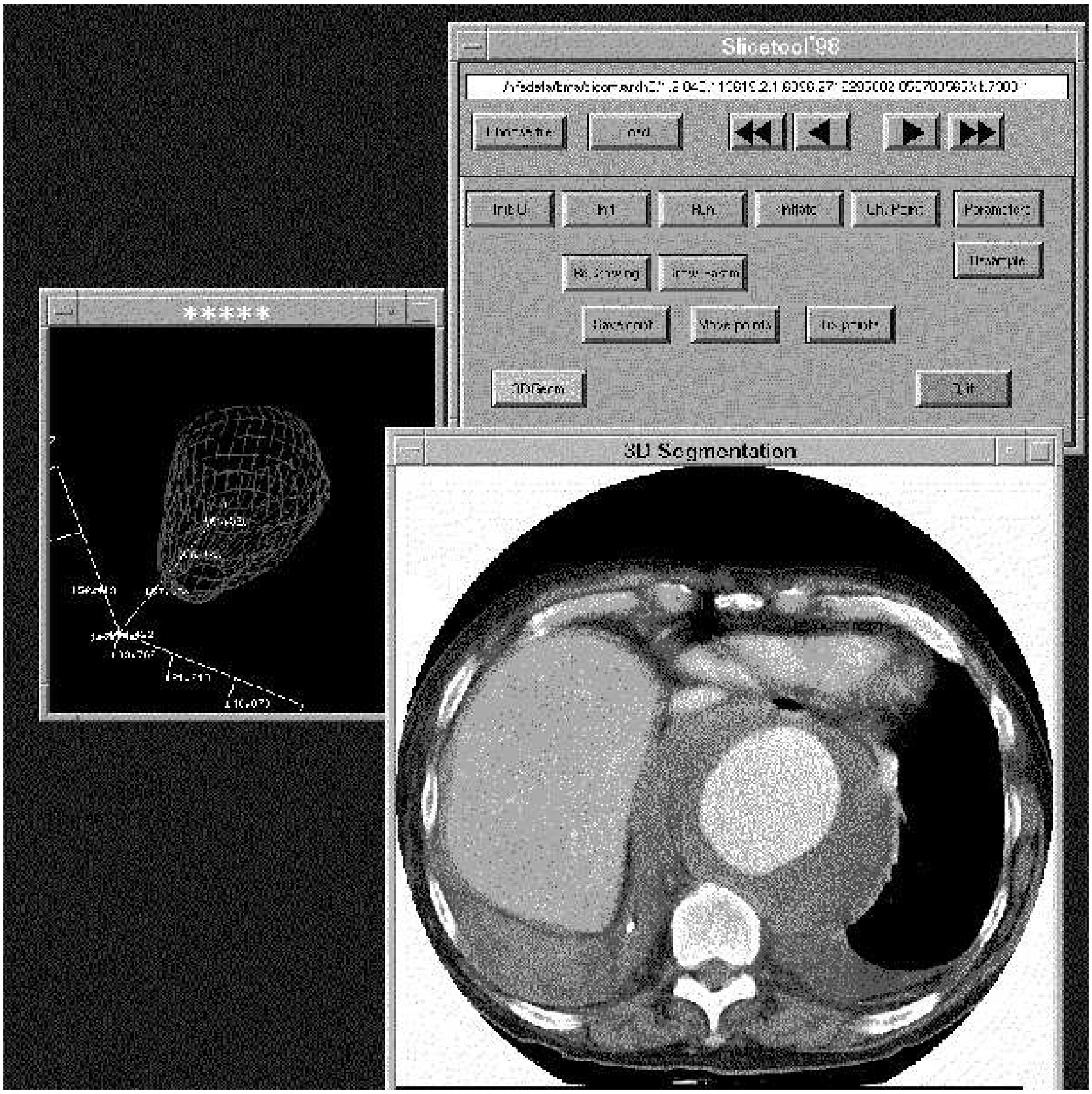


Fig. 3: 3D segmentation/reconstruction of an aneurysm. (Data courtesily provided by Dept. of Radiology, University of Pisa).

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