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—Dr. Rory McCloy,
Surgeon,
Manchester Royal Infirmary

Visual Area Networking at the University of Manchester

Bringing Advanced Visualization to the Operating Room with SGI® OpenGL Vizserver™

Until recently, Dr. Rory McCloy of the Manchester Royal Infirmary was frustrated every time he entered the operating room. Although advanced 3D visualization of patient data from CT and MRI scans had been possible for many years, this technology was still not available to him in the operating room. Instead, he had to work from old-fashioned x-rays that only displayed 2D slices of the organ on which he was operating.

Now all that has changed. In April of 2002, Dr. McCloy experienced the benefits of advanced visualization in the operating room for the first time. Dr. McCloy now uses SGI OpenGL Vizserver to exploit the interactive 3D visualization capabilities of a 32-processor SGI® Onyx® 300 visualization system while surgery is in progress, even though that system is housed more than a kilometer away at the Manchester Visualization Centre (MVC). OpenGL Vizserver is a unique Visual Area Networking product from SGI. It allows detailed, 3D graphical images from an SGI® Onyx® family system to be transferred over a network and manipulated by almost any client system.

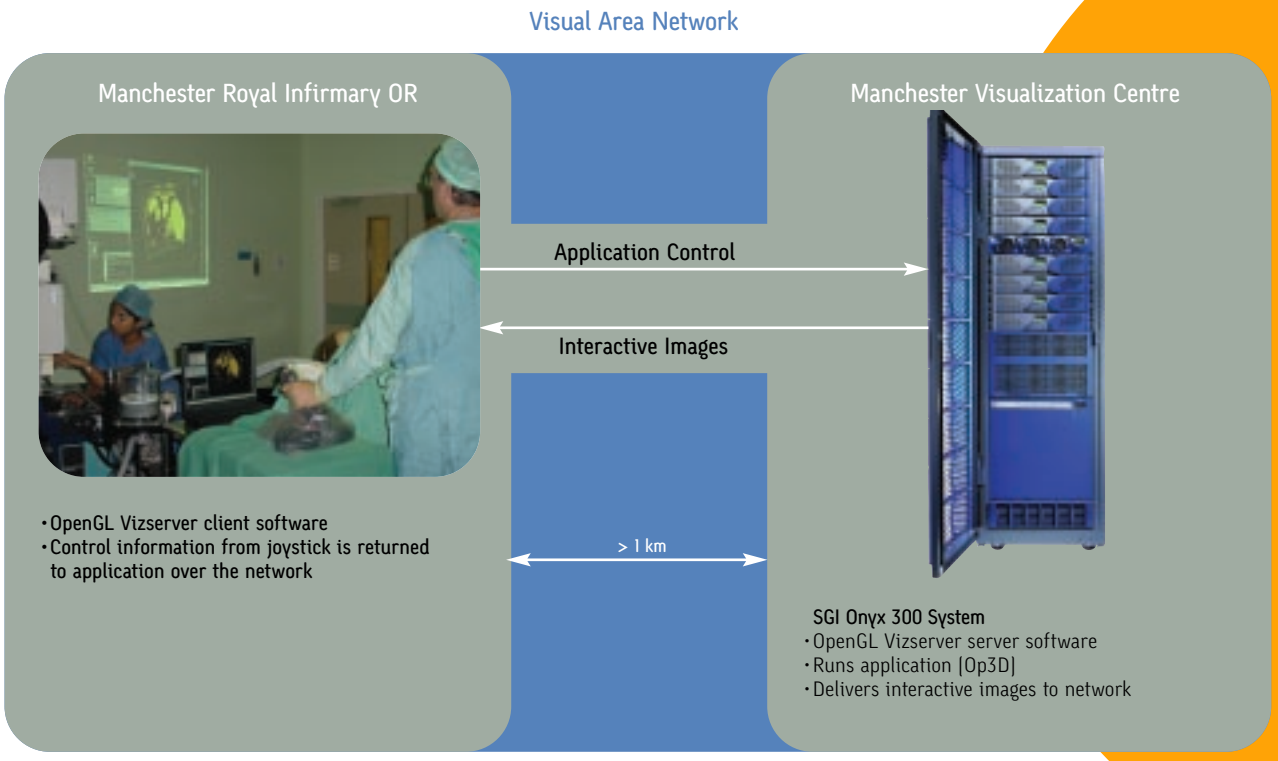
The implementation of OpenGL Vizserver is the result of a collaboration between Dr. McCloy and Dr. Nigel John of the MVC, which is located at the University of Manchester. "Now I can see and manipulate a three-dimensional reconstruction of the organ while I am operating," said Dr. McCloy. "This technology will dramatically improve the accuracy of surgery and result in improved patient outcomes."

Dr. McCloy specializes in liver and pancreatic surgery, often performing delicate operations to remove cancerous tumors. "I don't want to begin an operation only to discover I can't remove the tumor. Currently, up to 40% of pancreatic and liver tumors prove inoperable at the time of surgery," he said. "When I do perform surgery, I also want to avoid cutting across the tumor. This is difficult with the standard 2D information provided to the surgeon in the operating room. I have to look at the 2D scans and try to visualize the location of the tumor in the organ in three dimensions."

"The interactive visualization required by surgeons like Dr. McCloy is only possible with high-end visualization systems that would be difficult or impossible to bring into the operating room. OpenGL Vizserver allowed us to make visualization available in the operating room in a very convenient way," said Dr. John. "We are now exploring ways to use this technology to make visualization more widely available in operating rooms at Manchester hospitals, using techniques that could easily be repeated around the world."

OpenGL Vizserver: Unleashing the Power of Networked Visualization

The benefits of 3D visualization in the operating room seem so obvious that it makes one wonder why it hasn't been implemented before now. Although the technology has been developed, equipping every operating room with the necessary equipment for 3D visualization would be extremely expensive. Plus, the equipment requires significant space. The CT-scanning equipment in radiology departments often has 3D capabilities, but that ability does not extend to the operating room. Instead, radiology continues to provide the familiar 2D x-ray films for viewing on light boxes.



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By making the power of SGI® advanced visualization systems available over standard network connections, OpenGL Vizserver is now able to help overcome these barriers. The solution at Manchester—enabled by OpenGL Vizserver—is elegant in its simplicity. Visual information flows from the visualization server across a network to the operating room. The surgeon manipulates this data in real time to get the exact view needed at any given time.

The only new equipment required in the operating room is a laptop computer (connected to the network) and a video projector. OpenGL Vizserver client software runs on the laptop and communicates with server software on the Onyx 300 system at MVC. The visualization application running on the Onyx 300 system performs all graphics rendering. Instead of displaying rendered images locally, they are read back from the frame buffer and transferred over the network by OpenGL Vizserver and displayed on the laptop. The video projector provides an enlarged image, which is projected on the wall of the operating room to facilitate viewing.

According to Dr. John, "The advantage of OpenGL Vizserver is that it brings the full capabilities of our Onyx family visualization system to the operating room. A surgeon can interactively manipulate the view in real time, rotating and slicing the image in any way necessary. Since the laptop in the OR merely displays the pre-rendered images and passes control information back to the server, it requires no special graphics capabilities."

Op3D: Software Tailored to the Surgeon

Another key to the successful use of visualization in the operating room is the visualization software controlled by the surgeon. When the collaboration between Dr. John and Dr. McCloy began, no software existed that was appropriate to the task, so the two men worked together to develop software that meets a surgeon's needs.

The result is Op3D, a visualization application uniquely suited to the constraints of the operating room. Op3D was developed using OpenGL Volumizer™ from SGI. OpenGL Volumizer provides programmers with an API that facilitates the display and manipulation of volumetric data such as that resulting from diagnostic imaging techniques like CT, MRI, and PET, so it was perfect for the development of Op3D. Since OpenGL Volumizer is built on top of the OpenGL® API, applications created with OpenGL Volumizer are fully compatible with OpenGL Vizserver.




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A major objective of Op3D is to make it easy for a surgeon to use the software and manipulate the visualization while performing surgery. Since the operating room is a sterile environment, a joystick is used as the control device rather than a keyboard and mouse. Prior to surgery, the joystick is covered with a sterile plastic bag, allowing the surgeon to switch between performing surgery and manipulating the visualization without risking contamination.

Op3D is designed to do things in a predetermined order according to a surgeon's preference. Surgeons can create their own profiles that record the steps they will follow during surgery such as slicing a 3D volume, rotating and zooming 3D images or creating 3D cut planes to reveal structures hidden below the surface. That way, they can easily move from step to step at the click of a button without having to make selections from pulldown menus. A surgeon can also practice with the data before entering the operating room. "When I'm in surgery, my attention should be focused on the patient, not the tools. Op3D makes it easy for me to control the 3D visualization so I'm not distracted from my surgery. The result is that I have the best visual information available to guide the surgery and benefit the patient," said Dr. McCloy.

Visual Area Networking

The University of Manchester and the Manchester Royal Infirmary are already connected by a Gigabit network backbone with 100Base-T into the operating room. This makes it possible to deliver the interactive images with full resolution, ensuring that the surgeon does not miss critical details. OpenGL Vizserver, however, is designed to work effectively even over slower network connections.

OpenGL Vizserver is the flagship product of the SGI Visual Area Networking implementation program—a multipronged effort to extend the benefits of advanced visualization across local and wide area networks, delivering visual information to help people work more efficiently and effectively. OpenGL Vizserver clients require no graphics acceleration, so almost any desktop or laptop system can serve as a client. OpenGL Vizserver supports a variety of compression mechanisms—including an API to allow end users to incorporate their own compression schemes—to facilitate visualization over slower transports. Compression can be adjusted on the fly; so high-resolution static images can always be viewed when necessary.

OpenGL Vizserver also supports networked collaboration, allowing multiple network sessions to view and manipulate the same image. For instance, using Op3D and OpenGL Vizserver, a surgeon could consult with a colleague remotely to discuss the best course of action, with both surgeons able to visualize and interactive with the same patient data in real time. This saves the surgeon time and increases his or her efficiency and effectiveness to the benefit of the patient.

Building on Success

Because of its obvious benefits, this project has already received a lot of attention. The BBC filmed the first live trial, in April of 2002. The next trial is taking place in June and will be filmed by the Discovery Channel.

The team at Manchester is entering into a broader collaboration with SGI to integrate the software into a visualization grid. A grid provides a distributed computing environment in which advanced computers and scientific instruments are networked together to facilitate collaboration, tackle the most difficult problems, and maximize the utilization of valuable assets. Extensive grid development is occurring in the U.K. and across Western Europe. Because OpenGL Vizserver extends the usefulness of advanced visualization to network clients, it is ideal for use on grids.




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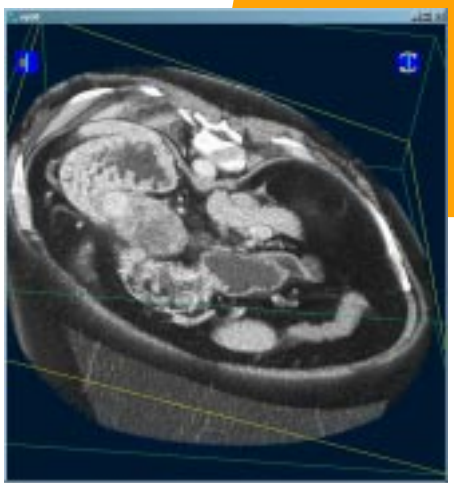
The Op3D-Grid project will provide a level of integration between OpenGL Vizserver and the Globus Toolkit—a de facto standard for grid middleware development—to support remote visualization and simulation and provide secure transmission of input and output data streams on a grid. Failsafe operation that can recover from network outages or other glitches is a major objective. In addition to providing some of the funding, SGI will provide development assistance from its OpenGL Vizserver team and Medical Applications Group. SGI will also provide early access to new SGI technologies as necessary to ensure success.



While the joystick used in the initial configuration works well, the surgeon still has to have one hand free to manipulate the view. Switching frequently between patient and joystick limits usability and may increase the chance of contamination and infection. SGI recently filed patent on a revolutionary new method for intuitive, interactive, 3D navigation in virtual environments that can be controlled with simple gestures or by voice command. This system will be incorporated to assist surgeons in getting to the location, view, and orientation required with minimum disruption to the ongoing surgery, enabling them to concentrate on the job at hand.

Working together, the collaborators will extend the functionality and robustness of Op3D, including the addition of a "virtual scalpel" that will allow surgeons to simulate and rehearse a surgery. The ultimate aim is to make visualization available on the grid to surgeons at other hospitals. Surgeons will be able to reserve time on a grid-based visualization server and initiate visualization sessions from the operating room using equipment similar to that used at Manchester. The promise of this endeavor is clear and far reaching. According to Dr. McCloy, "Surgeons and patients can look forward to the day when 3D visualization in the OR is commonplace, improving the effectiveness of surgical interventions."

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Forward-Looking Statements
The discussion in this success story of OpenGL Vizserver products and services from SGI and any pending patents for 3D navigation contain forward-looking statements that involve risks and uncertainties, including government approvals, the timely release of products to manufacturing, the availability of components from suppliers, the impact of competitive products and pricing, the acceptance of the technology identified in this success story, and other risks detailed from time to time in SGI's SEC reports. Actual results may vary.

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