Real-Time Visualization of the "da Vinci" Surgical Robot

Dan Morris, Stanford University

In Collaboration with Nick Swarup (Intuitive Surgical) and Ken Salisbury (Stanford University)

The "da Vinci" Surgical Robot allows a surgeon – controlling a robot from a manipulator console – to perform minimally invasive laparoscopic surgeries that would be difficult or impossible to perform manually. The robot includes two arms capable of carrying and positioning tools, and a third arm that carries and positions a stereo camera.

In order to allow third parties to develop software or hardware that augments the functionality of the system (e.g. video overlay enhancements, automated surgical performance evaluation, etc.) the robot makes the position of each joint available at all times via an RS-232 serial port. Intuitive provides the serial data format to developers, along with a Linux API that makes this data more easily accessible to Linux applications.

We have developed a visualizer that captures this serial data stream and displays a physically accurate representation of the robot in real time. The system can also record the data stream to disk and "play back" the robot's movements offline. This work was conducted with three parallel goals in mind :

- Stanford is actively developing software for simulating surgical procedures, and a kinematically accurate model of the "da Vinci" robot will help incorporate the Intuitive platform into our simulations.

- Many third party developers may not have access to a "da Vinci" robot at all times, and it is thus useful to some developers to have a visualization of the system with which they can experiment when they cannot access an actually robot.

- Customers purchasing a "da Vinci" system appreciate a graphical "hello world" that confirms that the "da Vinci" software is running as expected. This does not replace the numerous internal diagnostic tests performed by the system, but it provides tangible and immediate feedback to technicians and/or medical personnel who may want visual confirmation that the software is running properly.

The visualizer was developed in C++/OpenGL and runs in Windows. It has shipped to several Intuitive customers, primarily as the "hello world" system described in goal (3).

A screenshot from the visualization is provided along with a corresponding photograph of the "da Vinci" system :
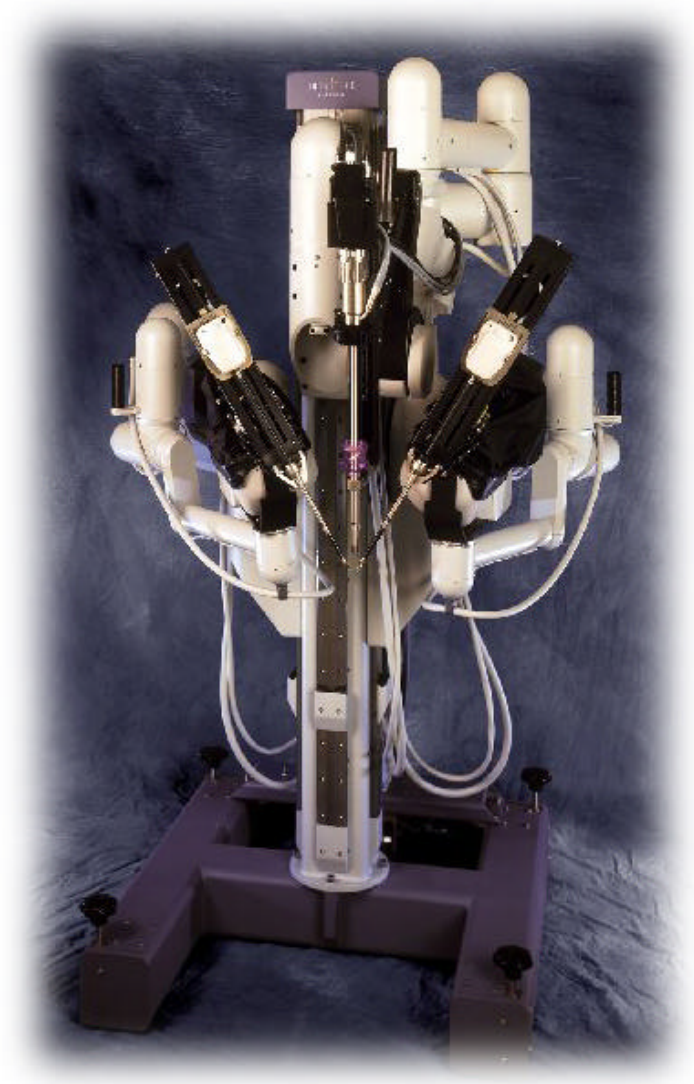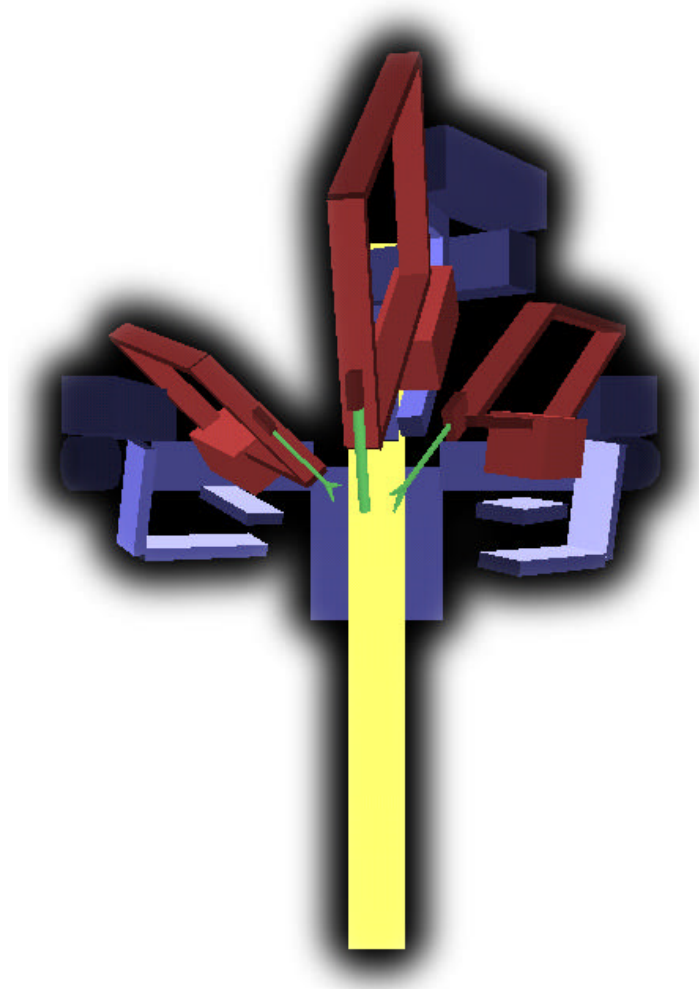
An additional screenshot of the system with a virtual operating room table for context :
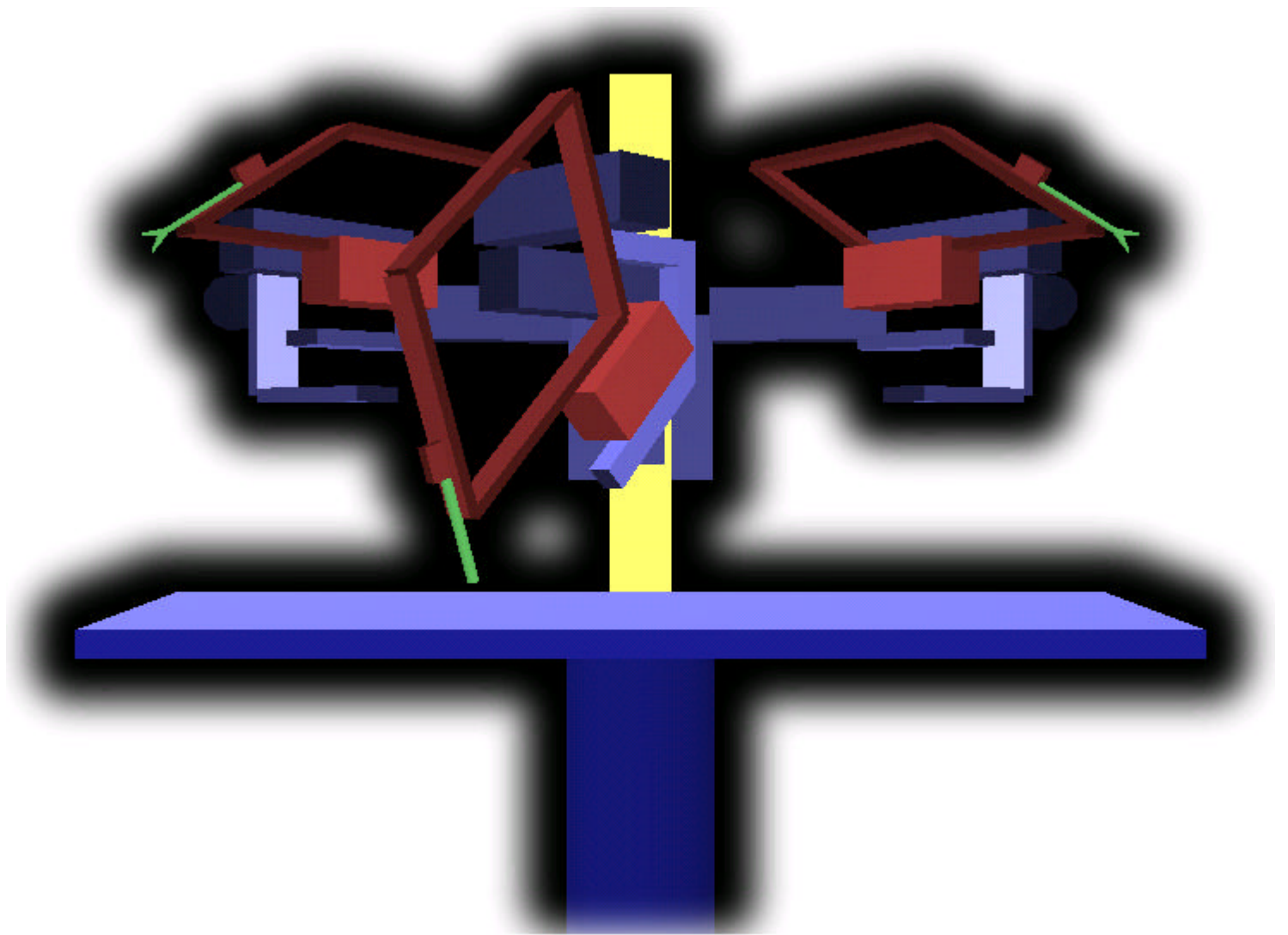
The visualizer is also capable of rendering an image from the perspective of the camera, mounted on the third arm of the "da Vinci" system. The following screenshots demonstrate the "third-person" and "first-person" views of the robot; a highlighted area is provided to clarify the perspective.