## *Surgical Assistant Workstation for Teleoperated Surgical Robots (SAWTSR)*

The Computer-Integrated Surgical Systems and Technology (CISST) ERC has designed a Surgical Assistant Workstation for Teleoperated Surgical Robots (SAWTSR), which is an environment that integrates both research and commercial subsystems and capabilities. Examples of research capabilities include stereo video reconstruction, patient modeling, intraoperative registration, ultrasound image processing, haptic interfaces, and robotics. Commercial systems include the daVinci surgical robot (Intuitive Surgical Systems), as well as various video cameras, ultrasound systems, tracking systems, and 3D displays (see Figure 1). This development is supported by core and supplemental ERC funds, and includes a subcontract to an industrial affiliate, Intuitive Surgical Systems.

The development output includes requirements, use cases, and multiple architectural viewpoints. These documents are intended to facilitate dissemination of the software and to provide a forum for capturing suggestions and requests from external researchers. We adopted UML 2.0 because it is the standard for modeling software and graphically representing the architectural viewpoints. The SAWTSR will extend the existing open source CISST software package ([www.cisst.org/cisst](www.cisst.org/cisst)) and uses the same development tools for configuration management (CVS), portable building (CMake), reference manual generation (Doxygen), automated testing (CppUnit, Dart), and tracking of defects or feature requests (CVStrac).

The initial use cases include the integration of patient models and laparoscopic ultrasound within the stereo video display of a telesurgical robot system such as the daVinci. A representative data flow is shown in Figure 2. A real-time data pipeline processes the feedback, which is mostly video but includes other data such as robot positions. The stereo video is rendered on the 3D display, possibly with image fusion and/or overlay of ultrasound images or patient models, such as intraoperative images. The Volume Viewer requires widgets to display the information and the ability to use the "master" manipulators to interact with these widgets and the graphical objects rendered within them (e.g., as "6 degree-of-freedom mice"). Other major subsystems (not shown) include the registration methods that can be used to co-register the stereo video, patient models, and laparoscopic ultrasound. The interface supports overlay of registered patient models (with adjustable transparency) onto the stereo display, as well as the manipulation of unregistered models (e.g., the ability to view CT cross-sections). Laparoscopic ultrasound images appear on a 2D plane that is correctly positioned within the 3D view; this registration is achieved by the Tool Tracking module (Figure 2), which uses a combination of robot position feedback and visual tracking.

Although many initial applications target the daVinci robot, the project will define a generic Robot API, with specific implementations for each different robot. The implementation for the daVinci robot will translate method calls to the Robot API into function calls to the research API provided by Intuitive. This extra layer of abstraction allows researchers to develop portable software that is not dependent on a particular robot API. This will, for example, enable JHU researchers to use the daVinci "master" manipulators to control other "patient side" manipulators, such as the small snake-like robots currently under development.

The SAWTSR project is expected to provide the enabling infrastructure for researchers to develop new surgical robot systems and for industry partners to integrate research results with their systems.

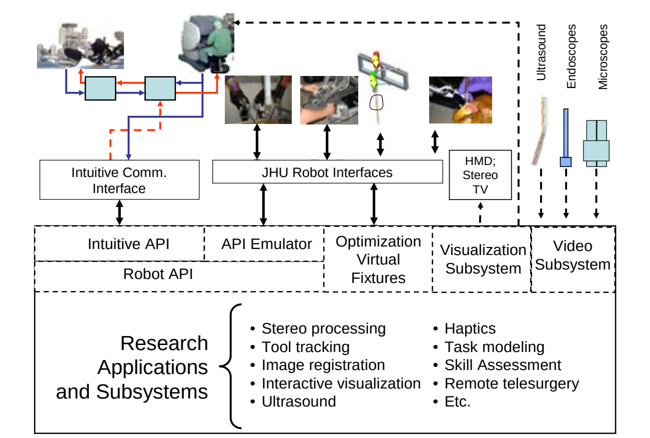


**Figure 2:** SAWTSR Block Diagram

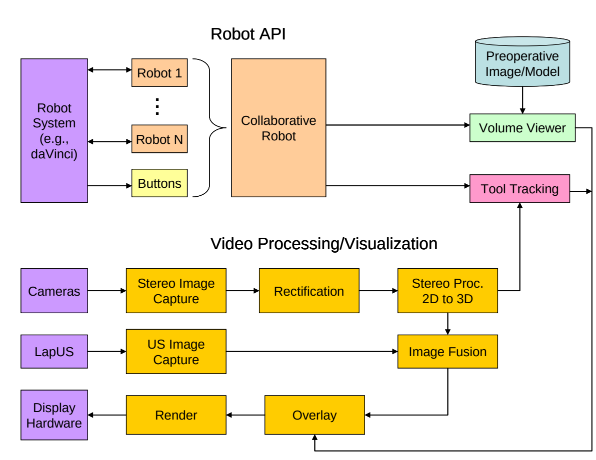


**Figure 1:** Representative Data Flow