Open Source Software Libraries for Computer Integrated Surgery

A team led by Assistant Research Professor Peter Kazanzides at the Computer-Integrated Surgical Systems and Technology (CISST) ERC has created a set of C++ software libraries, called *cisst* (Fig. 1), that facilitate the development of computer integrated surgery systems. This software has been used internally by many research projects and the Foundation Libraries are now freely available via the CISST web site (www.cisst.org/cisst). The Real Time and Interventional Device libraries are planned for open source release over the next year. These software libraries were created to provide:

- Sufficient quality, including documentation and robustness, to facilitate clinical certification (IRB and/or IDE) of applications developed with these libraries.
- Real-time performance for devices that interact with the physical world, such as robots and tracking systems.
- Portability between different operating systems and compilers.
- An environment for rapid prototyping and testing of new devices.

Our development process (Fig. 2) includes tools for source code control, document management, a portable build process, an automated test framework with nightly builds, and tracking of bugs and feature requests. Our documentation suite includes Quick Starts, which illustrate use of libraries through well-documented examples, User Guides, which provide uses (programmers) with comprehensive descriptions of the libraries, and Quick Sheets, which summarize library features in a convenient tabular format. The development process, automated testing and documentation suite all facilitate the creation of high-quality application software that can be clinically certified.

The real-time requirements permeate all levels of the software, including the Foundation Libraries. For example, *cisstVector* uses stack-allocated storage and recursive template metaprogramming to provide an efficient implementation of fixed-size vectors, matrices and transformations that is suitable for real-time use. For completeness, *cisstVector* also provides dynamically allocated vectors and matrices.

The *cisst* libraries are currently supported for various compilers on Windows, Linux, OS X, and RTAI/Linux (a real-time Linux). Operating system dependencies are encapsulated in *cisstOSAbstraction*, so it is relatively easy to port to other operating systems.

For interactive development and testing, it is convenient to use an interpreted scripting language. The *cisst* libraries include Python-compatible interfaces and the *cisstInteractive* library allows the programmer to embed the Interactive Research Environment (IRE) in C++ applications. The IRE is a graphical, Python-based interactive development environment. The *cisst* software also provides an object registry that enables the Python and C++ software to share objects. This is especially useful when embedding the Python interpreter in an application because it allows the user to modify C++ objects from Python.

We believe that the open source *cisst* libraries will accelerate the development of computer integrated surgery systems in our center and elsewhere. This achievement was possible due to the infrastructure support provided by the ERC program.

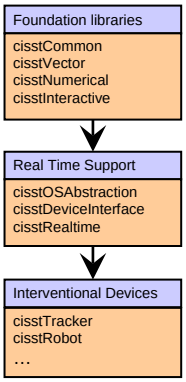

Figure 1: The *cisst* libraries

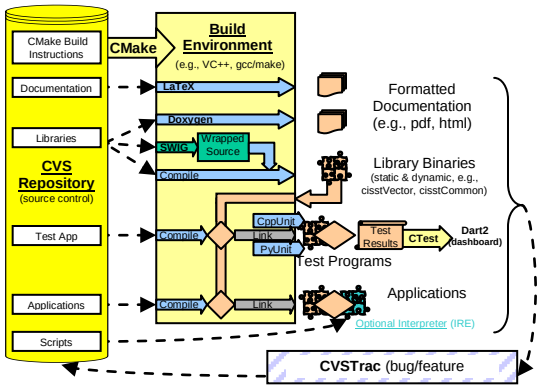

Figure 2: Development process and tools