

PLUS: An open-source toolkit for developing ultrasound-guided intervention systems

Andras Lasso, Tamas Heffter, Csaba Pinter, Tamas Ungi, Thomas K. Chen, Alexis Boucharin, and Gabor Fichtinger

Queen's University, Laboratory for Percutaneous Surgery, Kingston ON, Canada

Purpose

Ultrasound-guided intervention systems require the integration of many hardware and software components, such as ultrasound scanner, position tracking device, data processing algorithms, and visualization software. The objective of this work is to provide a free and sharable software platform – PLUS (Public software Library for UltraSound) – to facilitate rapid prototyping of ultrasound-guided intervention systems for translational clinical research.

Methods

Our solution is based on the open-source SynchroGrab library that implemented tracked ultrasound capturing and 3D reconstruction using a few hardware devices. This monolithic library was redesigned into a modular toolkit, modules were thoroughly tested and enhanced. A Double-N phantom based spatial calibration and change-detection based temporal calibration algorithms were added. Support for Ascension electromagnetic tracker and digitally encoded brachytherapy steppers were added. Standard data formats are used for streaming (OpenIGTLink) and storage (MetaIO image format with additional custom fields for each ultrasound frame). All hardware and software configuration settings are described in a single XML file. Building of the application is fully automated, uses CMake to download and build all required software libraries (ITK, VTK, QT, OpenIGTLink) and it supports building modules for 3D Slicer. Automatic tests are executed using CTest after each submitted software change to verify the main functionalities of the toolkit. Test results are submitted to a CDash web-based dashboard. Source control, documentation, issue tracking are all integrated and managed on a public website.

Results

PLUS currently supports RF and B-mode ultrasound acquisition using Ultrasonix devices and any B-mode image acquisition on any other imaging device using frame-grabber. Position tracking is supported for NDI Certus, Ascension 3DG trackers, and the CIVCO, CMS Accuseed, and Burdette Medical Systems brachytherapy steppers. Several example applications were developed for tracked ultrasound capturing, calibration, real-time display, and streaming. The toolkit is used by research groups at Queen's University, University of British Columbia, and Robarts Research Institute for prototyping prostate and spine intervention applications. The toolkit has a BSD-type license, which allows free usage and modification. The source code will be published at <https://www.assembla.com/spaces/plus/> in October 2011.

Conclusions

The proposed toolkit has proven to be useful for developing for ultrasound-guided intervention systems. We are looking forward to seeing more research groups using, improving, and extending PLUS after its public release.