

Building Computer-Aided Surgery Systems using 3D Slicer

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August 18, 2021



The Ferenc Jolesz
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3D Slicer
image computing platform



HARVARD MEDICAL SCHOOL
TEACHING HOSPITAL

About Myself..

Junichi Tokuda

Lead Investigator, Brigham and Women's Hospital

Associate Professor of Radiology, Harvard Medical School

Areas of Interest

- MRI-Guided Interventions, Medical Robotics, Open-Source Software

Education/Academic Appointments

- 2007: Ph.D., Graduate School of Information Science and Technology, University of Tokyo (Dohi-Masamune Laboratory)
- 2007-2009: Research Fellow, Harvard Medical School
- 2009-2014: Instructor in Radiology, Harvard Medical School
- 2014-2020: Assistant Professor of Radiology, Harvard Medical School
- 2021- : Associate Professor of Radiology, Harvard Medical School



Exploding Demands for Software in CAS Systems

- Advanced hardware – higher degree of freedom,
- Advanced visualization
- Advanced data processing - AI
- Data exchange standards, e.g., DICOM, HL7, etc.



The Wall Street Journal / Axel Krieger, Johns Hopkins University

In-House Development – Problem of “Reinventing the Wheel”

Design/develop/maintain software codes within the lab

- Pros:
 - Freedom of design
 - IP protection
- Cons:
 - Lack of reproducibility
 - Requires re-implementation of existing algorithms, i.e., “Re-Inventing the wheel”



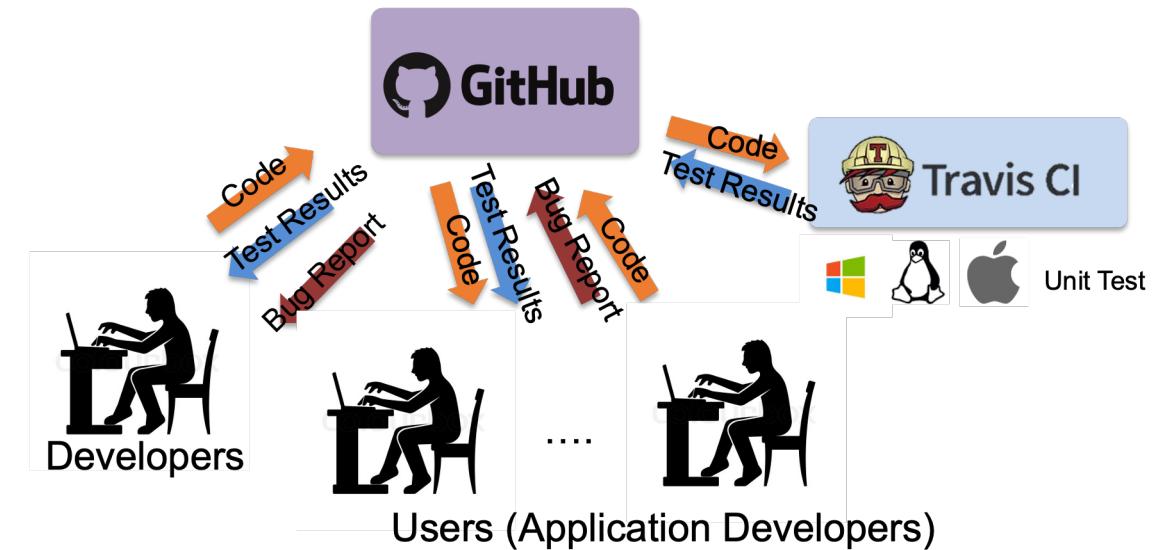
<https://www.robotshop.com/>



Open-Source Development

Develop an application on top of open-source software platforms

- Pros
 - Proven software architecture
 - Minimal coding effort
 - Access to state-of-the-art algorithms
 - Support from experts in the community
- Cons
 - Lack of flexibility
 - Steep learning curve



3D Slicer

Open-source medical image computing software

- Multi-platform (Windows, Mac, Linux)
- Written in C++
- Python interface for application development
- 2D/3D image visualization
 - 3D image reformatting
 - Surface/volume rendering
- Medical image processing
 - Filtering
 - Segmentation
 - Registration
 - DTI tractography

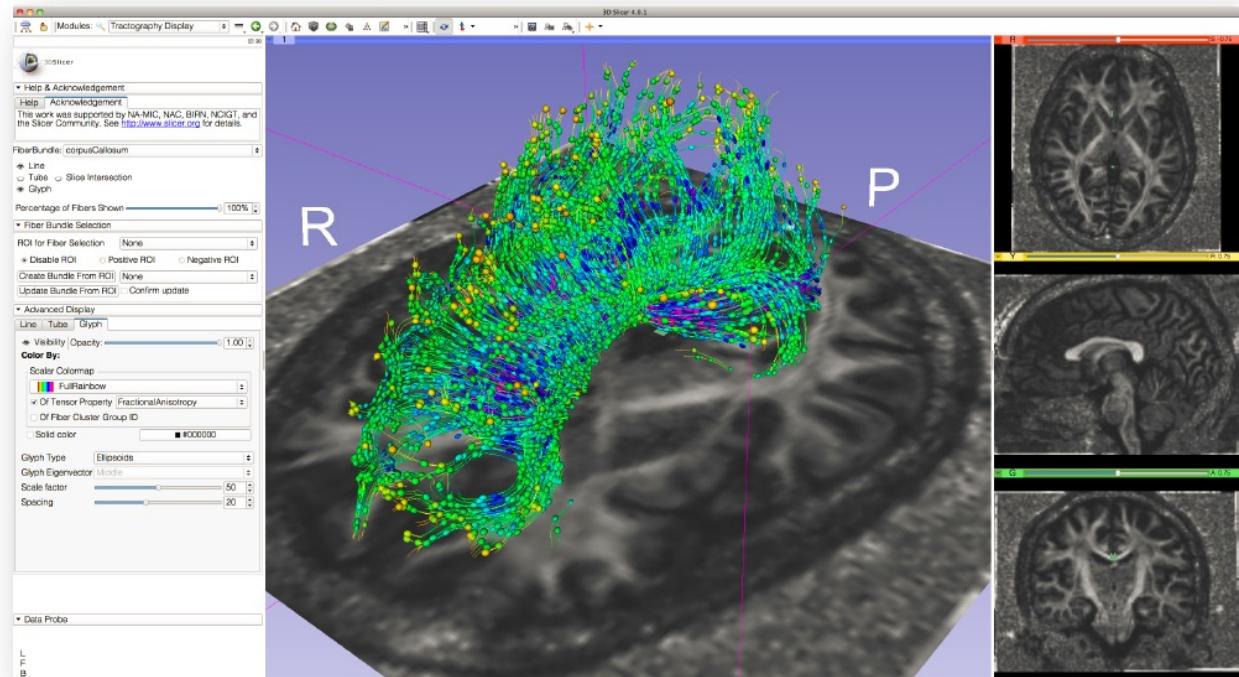
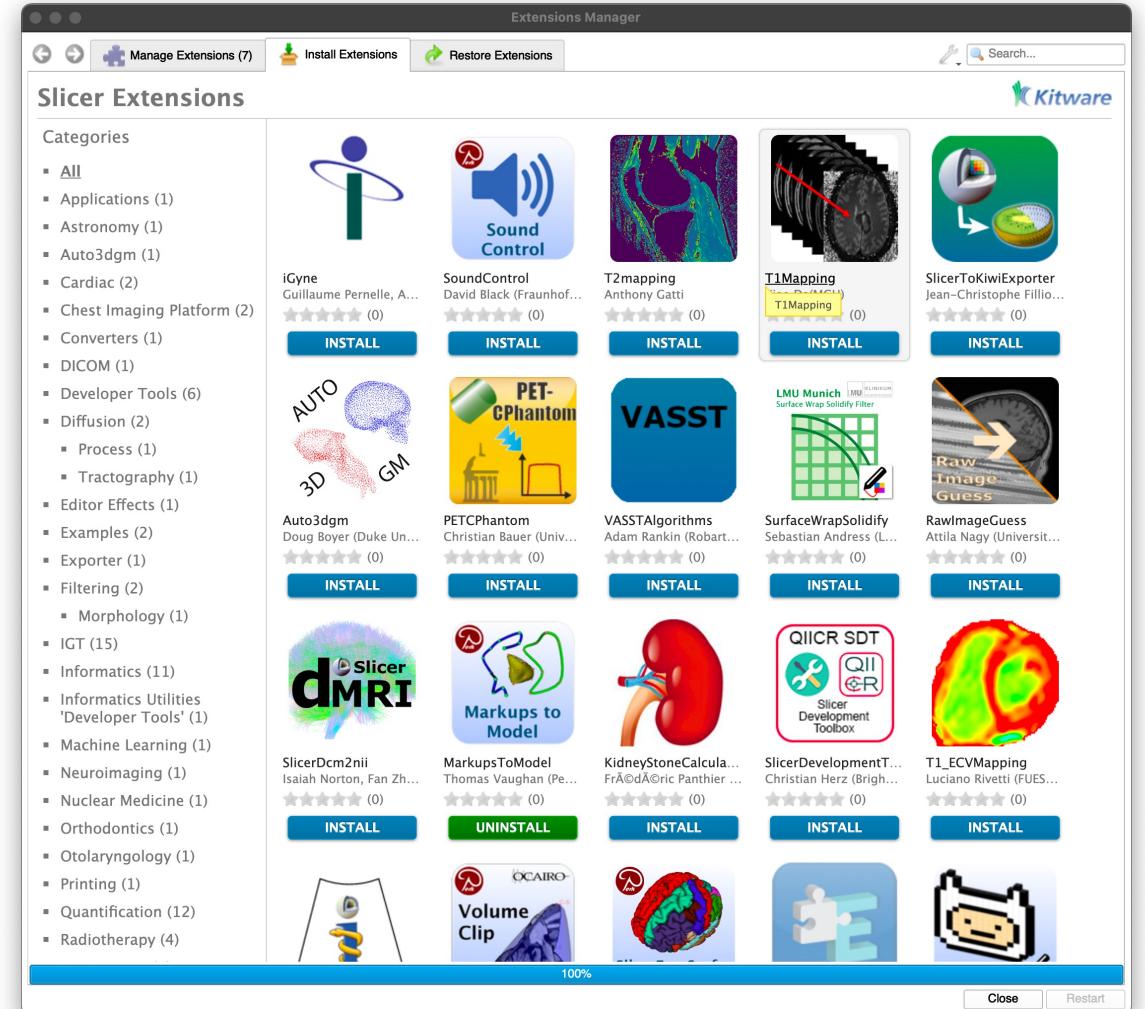


Image courtesy: Sonia Pujol, Brigham and Women's Hospital

3D Slicer - Extensions

- A plug-in mechanism to add new features developed by the community
- An AppStore-like interface where users can find and download plugins

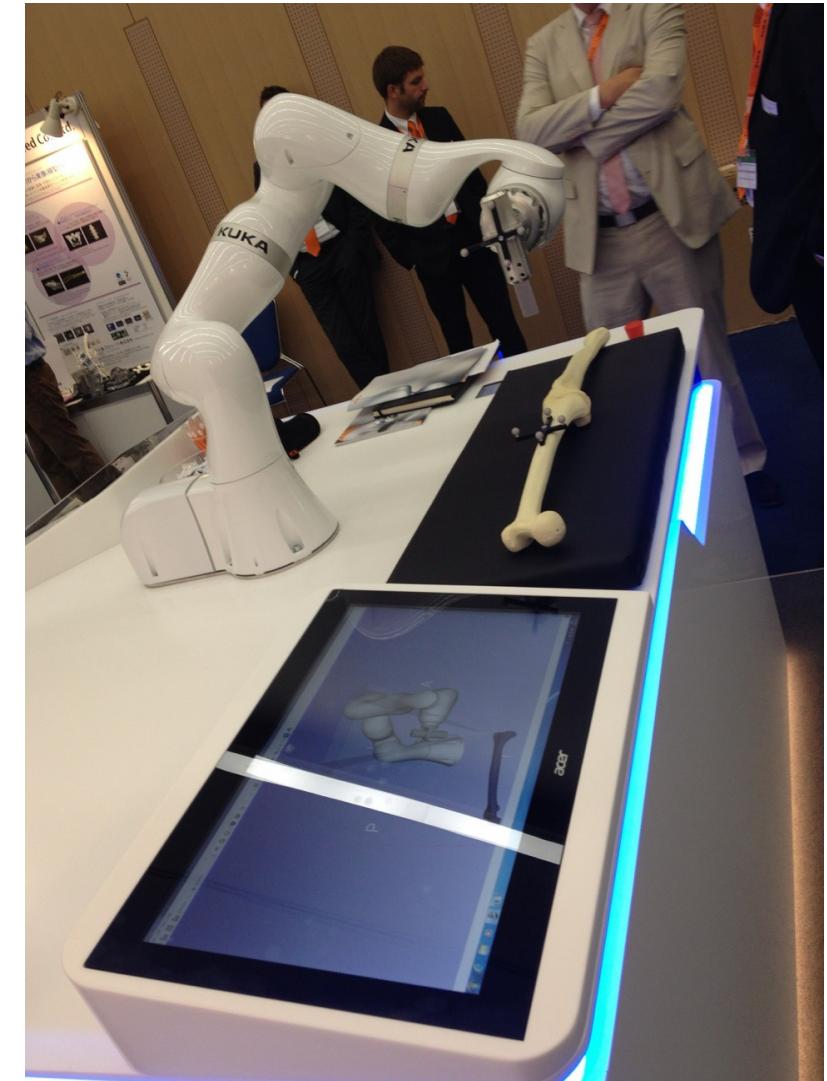
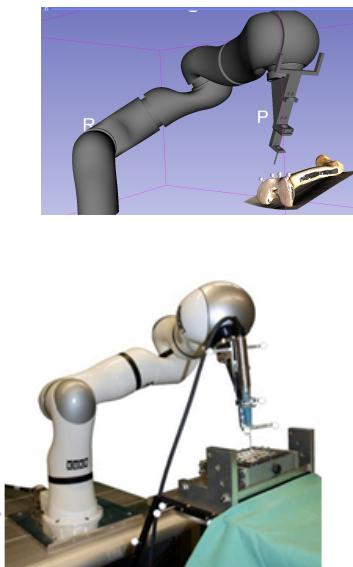
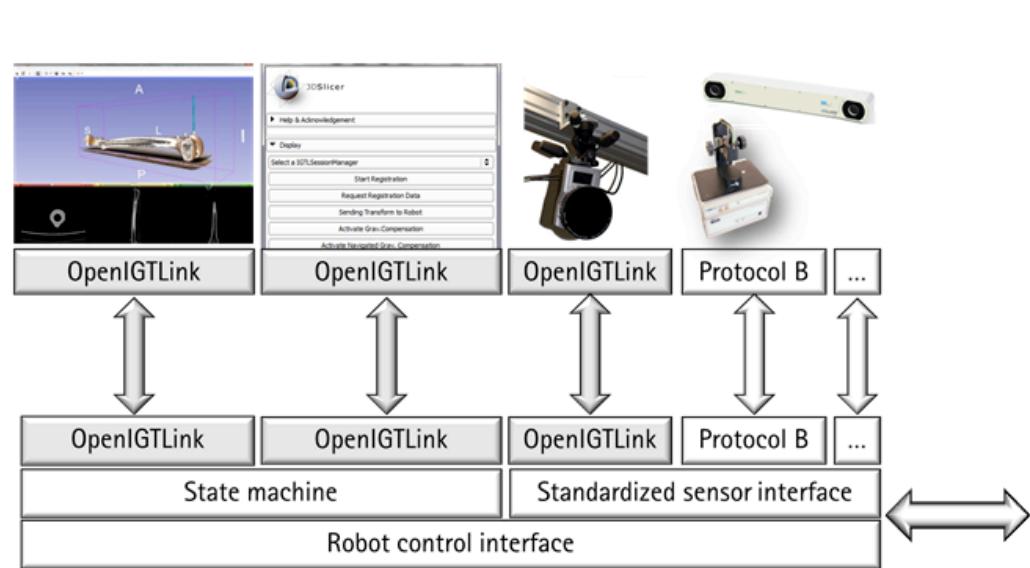


3D Slicer – OpenIGTLink for Device Integration

Network communication interface to integrate 3D Slicer with external software/hardware

Compatible with other software packages

- PLUS (Queen's University)
- ROS
- ...



3D Slicer – Hardware Support via PLUS Toolkit

External devices may be connected to 3D Slicer via OpenIGTLink and PLUS Toolkit

PLUS is open-source software for data acquisition, pre-processing, calibration, and real-time streaming of imaging, position tracking, and other sensor data.



Proprietary connections



3D Slicer for Image-Guided Therapy Applications: SlicerIGT

- Open-source platform for image-guided therapy systems
- Consists of:
 - 3D Slicer
 - PLUS (data acquisition server for imaging and tracking devices)
 - OpenIGTLink (Communication with PLUS)
 - SlicerIGT Extension (IGT-specific features, including point-based registration)

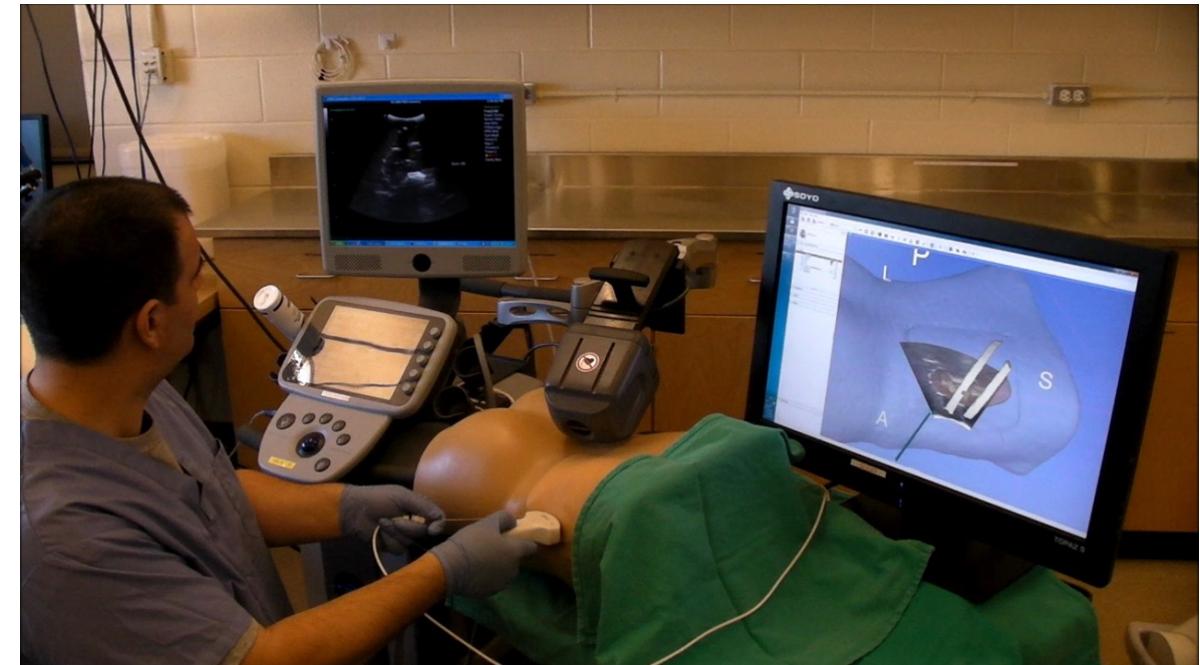


Image courtesy: Tamas Ungi, Queen's University



SlicerIGT
NAVIGATE MEDICAL INTERVENTIONS



3D Slicer - Community

- Researchers from all over the world, including U.S., Canada, Spain, U.K., France, Germany, etc..
- Training sessions organized at conferences
- Project Week – Hack-a-thon event focused on 3D Slicer (twice a year)



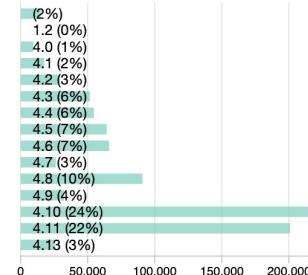
3D Slicer - Statistics



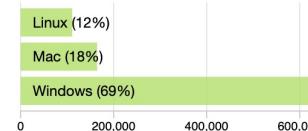
Slicer4 download stats

Date range
Nov 28, 2011 - Aug 11, 2021

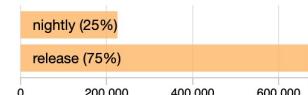
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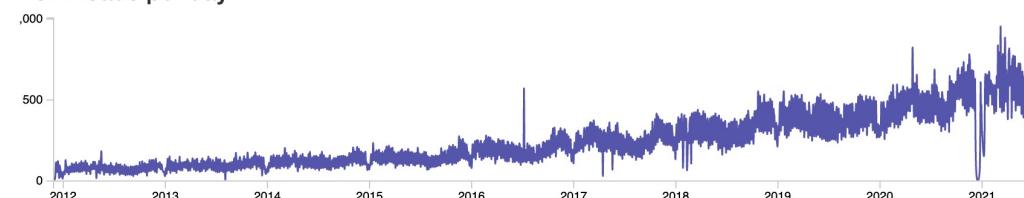
Operating system



Stability



Downloads per day



Region



Country



899,450



Acknowledgements

This seminar is hosted by BMPE Lab., University of Tokyo and National Center for Image-Guided Therapy, Brigham and Women's Hospital, and supported in part by The U.S. National Institutes of Health (R01EB020667, R01CA235134, P41EB028741, and P41EB015902).

3D Slicer is developed by the 3D Slicer community. SlicerIGT and PLUS Toolkit are developed at Perk Lab., Queen's University, Canada. OpenIGTLink is developed by the OpenIGTLink community.

