Implementing clinical applications using 3D Slicer (slicelets and guidelets)

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http://perk.cs.queensu.ca

Right tool for the job

Jalopnik.com

Can it be done?

Technological prototype:
innovative,
not robust,
usually single developer
supported

www.unusuallocomotion.com

Should it be done?

Research tool:
robust and *usable enough* for
clinical evaluation, *flexible*, open,
portable, community supported

Clinical tool

Patient ready:
FDA approved, company
supported, closed source

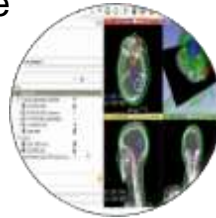www.senkox.com

Customization options – Level 1

- Adding new **module**: adds new features to 3D Slicer, may contain new data types (MRML nodes), algorithms (logic class), user interface (widget class, displayable manager class)
- Adding new **extension**: package of related modules that users can install
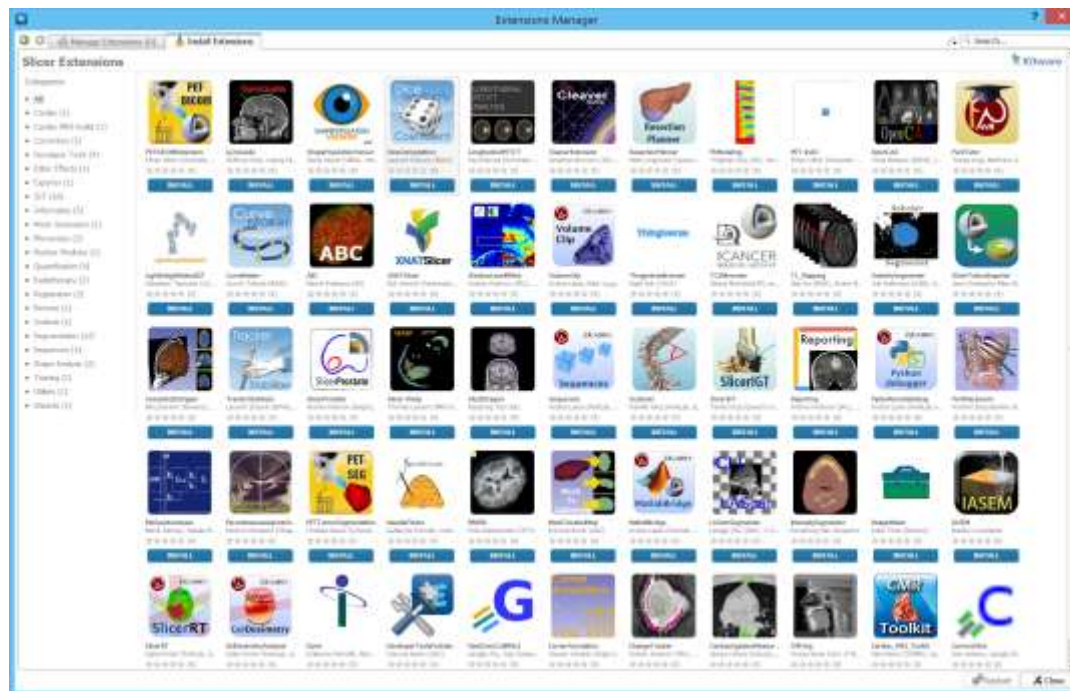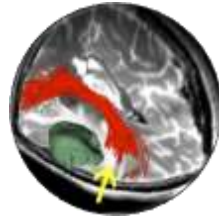
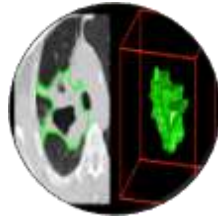# 3D Slicer in clinical use

Radiation dose calculations

MRI-guided prostate biopsy

Tracking peritumoral white matter fibers

Breast cancer surgery guidance

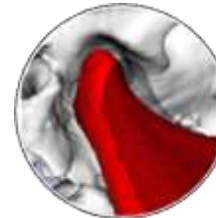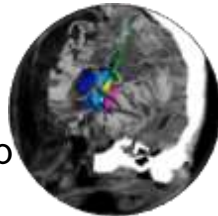Diagnosis of Different Tumors in Lung Cancer

Clinical users drive creation of technology
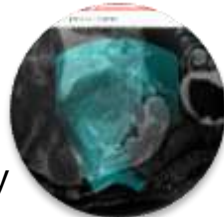
Diagnosis of Osteoarthritis Degeneration

Model-Guided Deep Brain Simulation

Quantitative assessment of COPD

Brain surgery

Surgical navigation

Customization options – Level 2

- **Slicelet**: module that draws its entire user interface – it can run without creating a 3D Slicer main application window or hiding the main application window, can toggle between full Slicer GUI/simple GUI (www.slicer.org/slicerWiki/index.php/Documentation/Nightly/Developers/Slicelets)
- **Guidelet**: slicelet for interventional guidance applications – has built-in support for tool navigation, real-time imaging control (ultrasound), touch-optimized, workflow-based user interface (www.slicerigt.org)

https://www.slicer.org/slicerWiki/index.php/Documentation/Nightly/Modules/GelDosimetry

http://www.slicerigt.org/wp/breast-cancer-surgery/
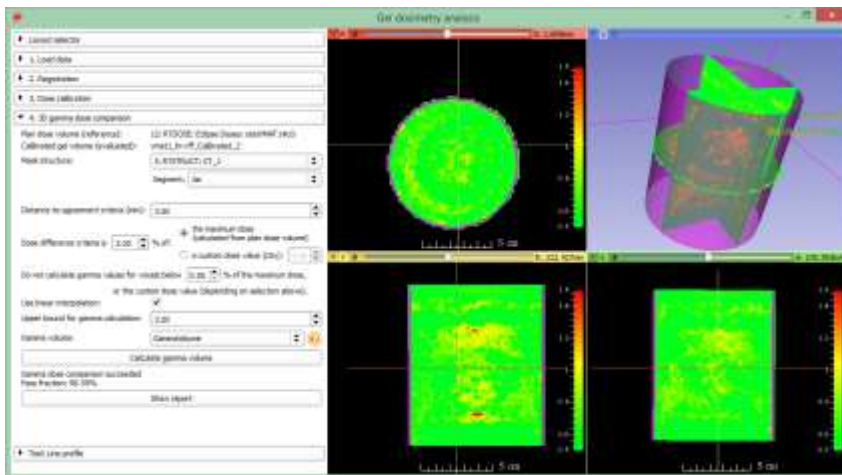
Commercial use

Known commercial activities range from use "as is" to full blown product development:

- Xstrahl (small animal radiation product)
- mebio (radiology product, prostate guidance)
- SonoVol (ultrasound product) (R43CA192482...)
- Novartis (quantitative imaging clinical trials)
- New Frontier (navigation system)
- KUKA (surgical robotics)
- Siemens (diagnostic and interventional research)
- Canon (robotic interventions)
- GE (research and products)
- NDI (trackers for surgical navigation)
- Isomics (research, consulting)
- Kitware (research, consulting)
  - 10+ Slicer based projects in the past two years
  - 5 commercial products being launched

Customization options – Level 3

Custom application: 3D Slicer installation packages can be built with customized branding and feature set – custom modules can be included, some default built-in modules excluded, custom application name, startup message, splash screen, startup module, user preferences, etc.

- Customization of existing binary package:
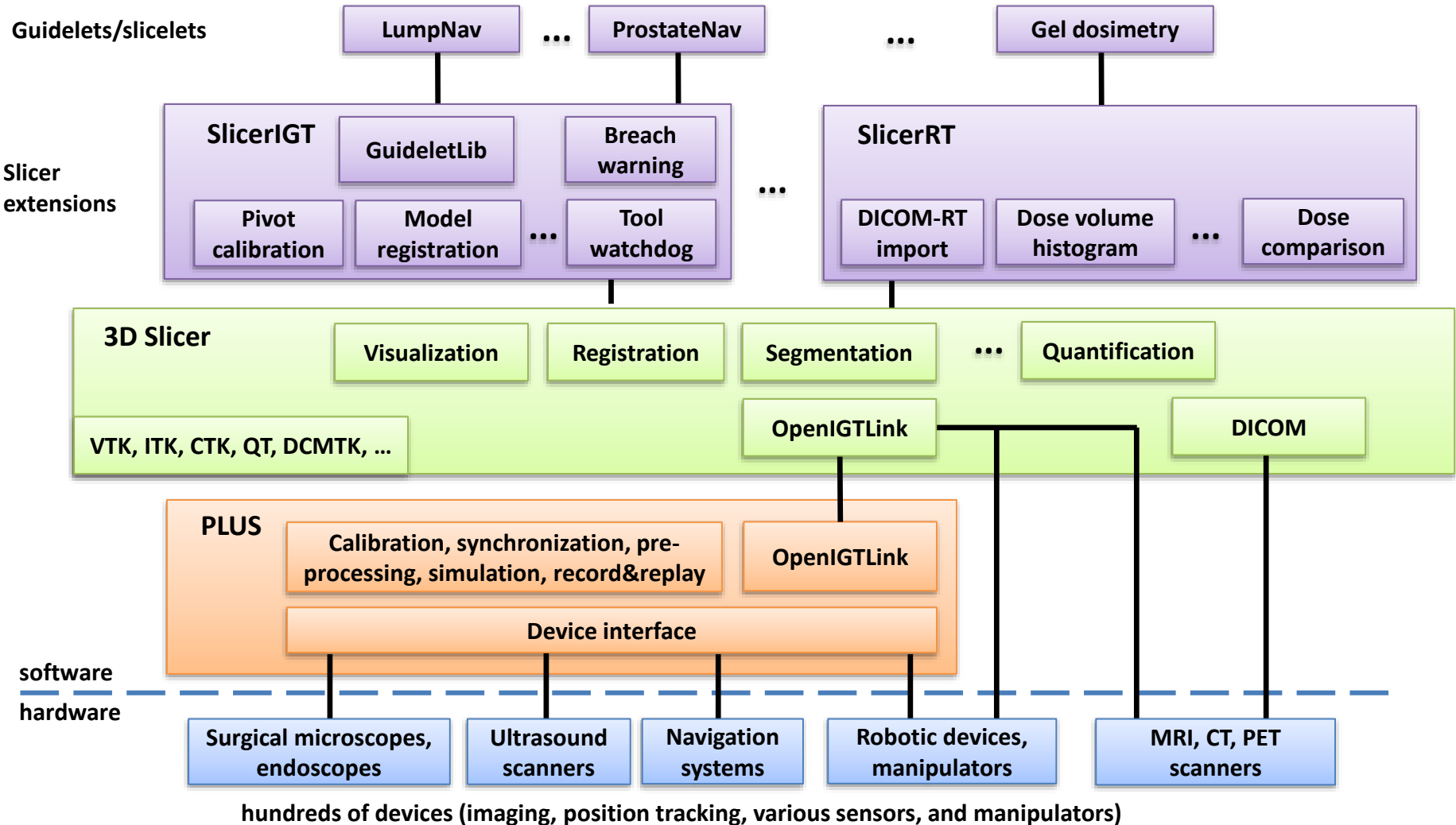 https://www.slicer.org/slicerWiki/index.php/Documentation/Labs/CustomSlicerGenerator
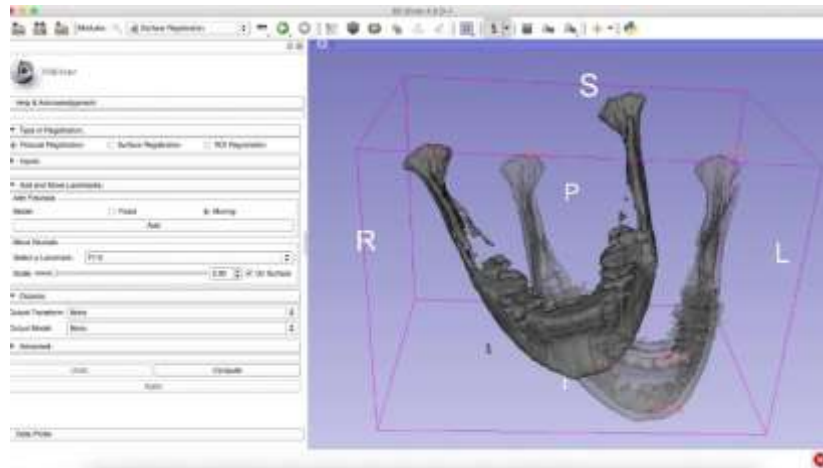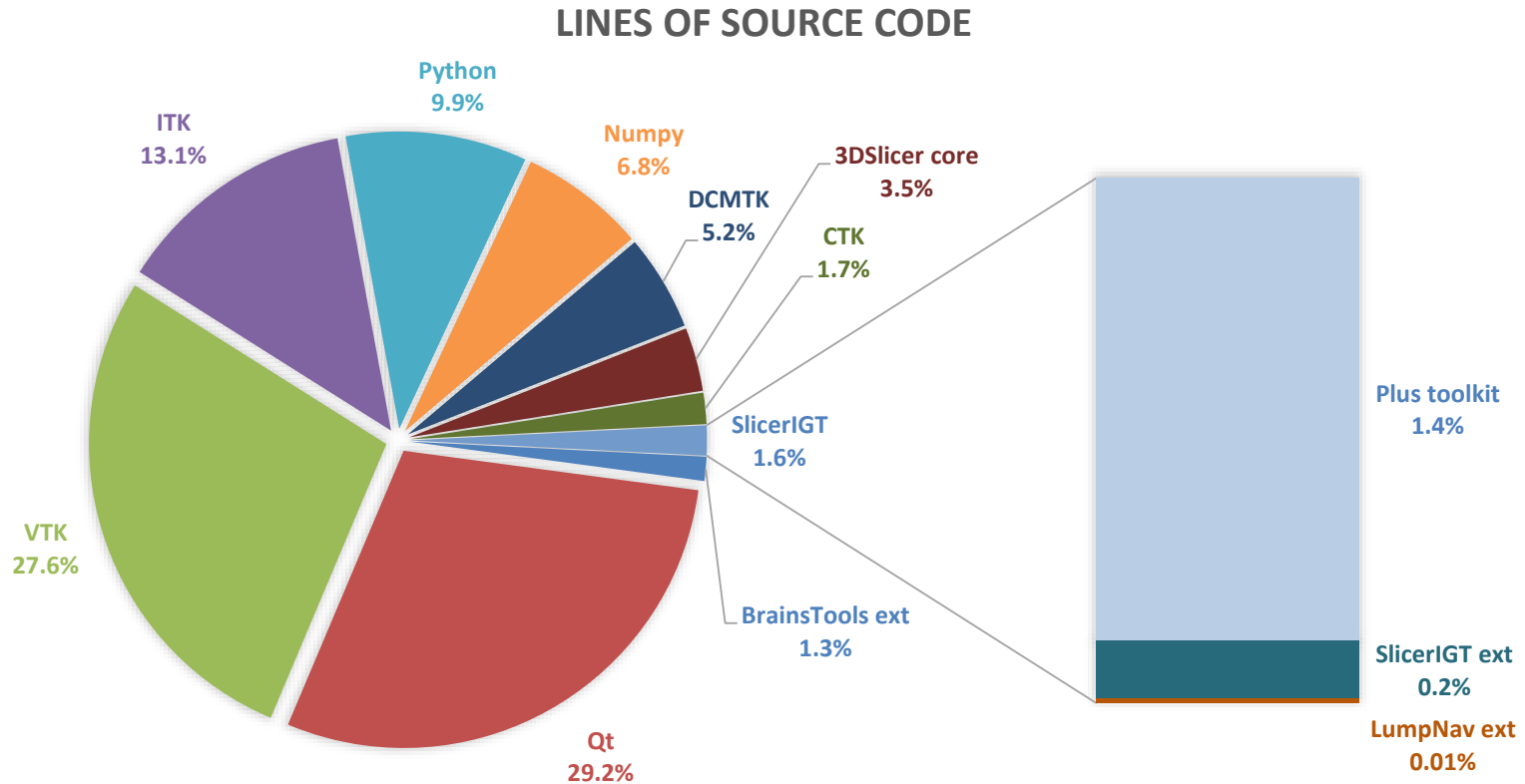

SlicerCMF

- Custom Slicer build:
  https://www.slicer.org/slicerWiki/index.php/Documentation/Nightly/Developers/Build_Instructions/Configure

System implementation overview

Guidelets/slicelets

| LumpNav | ... | ProstateNav | ... | Gel dosimetry |

Slicer extensions

SlicerIGT
- GuideletLib
- Breach warning
- Pivot calibration
- Model registration
- ... Tool watchdog

...

SlicerRT
- DICOM-RT import
- Dose volume histogram
- ... Dose comparison

3D Slicer
- Visualization
- Registration
- Segmentation ... Quantification
- OpenIGTLink
- DICOM

VTK, ITK, CTK, QT, DCMTK, ...

PLUS
- Calibration, synchronization, pre-processing, simulation, record&replay
- OpenIGTLink
- Device interface

software
hardware

| Surgical microscopes, endoscopes | Ultrasound scanners | Navigation systems | Robotic devices, manipulators | MRI, CT, PET scanners |

hundreds of devices (imaging, position tracking, various sensors, and manipulators)

Software size statistics

LINES OF SOURCE CODE

Custom slicelet/guidelet code is around 0.01%
It is not a problem if it is complex, changing frequently, etc. – the application may still work very robustly.

Summary

- Customization options at several levels, they may be all combined
- Very small amount of custom code need to be developed, changed, maintained.

PerkLab: http://perk.cs.queensu.ca
3D Slicer: www.slicer.org