3D Slicer and QIIICR as a resource for QIN

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2014 QIN Face-to-face meeting, March 27-28, 2014
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“Enhance the value of quantitative imaging (QI) in clinical trials for prediction and/or measurement of response to cancer therapies”

- "emphasize the development, optimization and validation of state-of-the-art QI methods and software tools for potential implementation in single site phase 1 or 2 clinical trials”
- "address the challenges of integrating existing and or new QI methods as required for multicenter phase 3 clinical trials”
- "harmonization of image data collection, analysis, display and clinical workflow methods across imaging platforms, or testing their performance across different cancer sites”
- "provide an improved means to have these advanced methods adopted into single site (i.e. phase 1-2) clinical trials, and further optimized or multi-site (phase 3) clinical trials”
- "extend initial software tool development and optimization to analyze performance in the multisite clinical trial, where multiple platforms are used for data collection”
From Research prototypes to Clinical tools

Questions and answers
- Can it be done?
  - Research prototypes
- Is it worth doing?
  - Clinical research tools
- Standard of care
  - Commercially available “clinical devices” with regulatory approvals
Easy to use, Easy to extend, for Research

3D Slicer: a cross platform system for translating innovative algorithms into tools for clinical research applications

What does a user expect?
- Easy Install and Upgrade
- “Standard” Clinical Behavior
- Advanced Functionality
- Consistent Interface
- Easily Deployable
- Extensible and Reconfigurable
- Rich Utility Libraries

What does a developer need?
- Easily Deployable
- Extensible and Reconfigurable
- Rich Utility Libraries
- Stable Base
Slicer overview

- Since circa 2000
- Multi-modality visualization, Segmentation, Registration
- Free open source
  - no reciprocity requirements
  - you choose what to share
- Cross-platform
  - “One-click” installers for Windows, Mac and Linux
- Support and training
- Industry-strength engineering
- Extensible
  - Community “App store”
- Research software
  - not FDA approved
Slicer community at a glance

3D Slicer project analysis from Ohloh.net  http://www.ohloh.net/p/3376

In a Nutshell, Slicer...

- has had 33,653 commits made by 91 contributors representing 1,427,063 lines of code
- is mostly written in C++ with an average number of source code comments
- has a well established, mature codebase maintained by a large development team with decreasing Y-O-Y commits
- took an estimated 403 years of effort (COCOMO model) starting with its first commit in January, 2006 ending with its most recent commit about 20 hours ago

Slicer version 4 re-architecture and cleanup

3D Slicer mailing list messages posted 2000-2013

http://massmail.spl.harvard.edu/public-archives/slicer-users/
http://massmail.spl.harvard.edu/public-archives/slicer-devel/

Total number of 3D Slicer downloads in 2013: 61463

http://download.slicer.org/stats
Slicer and QIN

- QIN teams using Slicer in their research *
  - BWH, Iowa, MGH, Stanford, OHSU, Mayo
- QIN “Grand Challenges”
  - Participated in DCE analysis, Intensity scaling, PET segmentation challenges
  - DICOM Segmentation object conversion tools
- Slicer QIN paper
  - over 50 citations since published in 2012
- Available on NCIP Hub (no GPU acceleration)

* Source: “QIN Matrix” summary spreadsheet, as of March 2014
“Lessons learned” from Slicer user community

- many algorithms, few end-to-end solutions
- standards-based interoperability is limited
- tools for longitudinal and quantitative analysis are needed
- integration with community imaging archives is limited
“Lessons learned” from QIN interactions

- Individual sites are not tasked with the development of the platforms to facilitate sharing
- Insufficient understanding of the capabilities and limitations of DICOM, limited support to encourage adoption of relevant parts of DICOM
- Repositories of annotated image data are severely limited

We shall not fail or falter; we shall not weaken or tire...Give us the tools and we will finish the job.

(Winston Churchill)
Quantitative Image Informatics for Cancer Research (QIIICR)

U24 CA180918
http://qiicr.org

- QIN Slicer “birds of a feather” U24
  - NCI ITCR PAR-12-287
- Based on the needs of BWH, Iowa and MGH QIN projects:
  - identify image informatics needs
  - harmonize data sharing by using DICOM and implement supporting toolset
  - demonstrate software tool sharing
  - facilitate adoption of the toolset
- Use DICOM as much as possible, propose improvements as needed
- Free open source
QIICR Aim 1: Solutions and tools

- Standardize on 3D Slicer as the delivery platform
- Implement missing “building blocks” as needed
  - segmentation
  - PK analysis
  - ...
- Integrate “building blocks” into end-to-end solutions
- Standardize on DICOM for input images and output results serialization
- **WG interactions: try our tools, give us your feedback!**

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QIICR Aim 2: Interoperability

- Standardize on DICOM for
  - image analysis results
  - parametric maps
  - measurements and quantitative indices
  - structured reports
  - terminologies
  - data provenance
  - clinical data
- propose amendments as necessary
- demonstrate applicability
- improve toolkit support
- facilitate adoption
- WG interactions: focused presentations on the use of DICOM, feedback on broader applicability of use cases

David Clunie

http://dicom.offis.de/dcmtk
http://slicer.org
http://itk.org/
QIICR Aim 3: Sharing

Simplify interaction with public repositories to facilitate sharing of the analysis results:

- focus on 2 most popular repositories:
  - NCI TCIA
  - XNAT Central
- integrate developer API into 3D Slicer
- provide user-level “data browsers”
- support 2-way communication, when possible
- WG interactions: try our tools, give us your feedback!
QIICR current progress and near-term plans

Talk to me in person for details and demos!

Aim 1: Solutions and tools

- PET SUV and quantitative index extraction tools
- Improvements to DCE analysis tools
- Slicer interface improvements to simplify user experience
- Next 6-12 months: Slicer extensions to do PET and DCE MRI analysis (as required for QIICR QIN projects) and store all processing results in DICOM

Aim 2: Interoperability / DICOM

- Prototype DICOM implementations to explore capabilities of SR, SEG, RWVM objects
- A number of DICOM correction proposals under development
- Improvements to DCMTK to support QIN use cases
- Next 6-12 months: improve DICOM SEG support, support selected SR templates, floating point parametric maps, RWVM

Aim 3: Sharing

- Slicer TCIABrowser extension released (google “slicer tciabrowser”)
  - TCIA image and TCGA clinical data access integrated via APIs
Summary

● Our approach: Demonstrate by example
● Improving infrastructure to facilitate method sharing and data harmonization
  ○ prioritize the BWH/MGH/Iowa QIN efforts
  ○ welcome feedback from other QIN stakeholders
● DICOM is here to stay
  ○ learn and teach how it can help QIN
● Leverage decades of prior open source contributions
  ○ maintain compatibility with existing platforms
  ○ learn lessons for the next generation of solutions
QIICR team

Leadership: Brigham and Women’s Hospital, Boston

● Ron Kikinis, MD
● Andrey Fedorov, PhD

Driving Biological Projects

● Quantitative MRI of Glioblastoma response: Massachusetts General Hospital
  ○ Jayashree Kalpathy-Cramer, PhD
  ○ Elizabeth Gerstner, MD
  ○ Karl Helmer, PhD
● Head and Neck cancer response assessment with PET/CT: University of Iowa
  ○ Reinhard Beichel, PhD
  ○ Milan Sonka, PhD
● Quantitative MRI of prostate cancer: Brigham and Women's Hospital
  ○ Fiona Fennessy, MD, PhD
  ○ Andrey Fedorov, PhD

3D Slicer

● 3D Slicer lead architect: Steve Pieper, PhD - Isomics Inc., Cambridge

DICOM

● Technical lead: David Clunie - PixelMed Publishing, LLC
● DCMTK Development lead: Michael Onken - OFFIS and Open Connections, Germany
Where to learn more

3D Slicer
● try it out: http://download.slicer.org
● tutorials, documentation etc: http://slicer.org

QIICR
● home page: http://qiicr.org
● github QIICR organization: http://github.org/QIICR
● NCIPHub QIICR group: https://nciphub.org/groups/qiicr

Contact me directly fedorov@bwh.harvard.edu