DICOM Support in 3D Slicer and CTK

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Topics

• Some History
• Current Slicer DICOM Architecture
• Current Use Cases / Related Projects
• Wishlist

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DICOM in Research

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- Laziness?
- Burned by Vendor Incompatibilities?
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• In QIICR we hope to help researchers use DICOM correctly for certain well-defined use cases (three QIN trials)
DICOM for Image Analysis

- **Insight Toolkit**
  - ITKv3: GDCMImageIO (Malaterre, GDCM)
  - ITKv4: GDCMImageIO + DCMTKImageIO (Williams, Iowa)

- **Visualization Toolkit**
  - vtkDICOMImageReader (Turek, Miller, GE)
  - vtkDICOM* (Gobbi, Promising new work in progress)

- **Difficult for GUI-less Libraries to Handle Generality of DICOM**
  - Very CT/MR-centric
  - Many hard-coded assumptions about mapping of slices to volumes
  - No networking support
  - Sometimes the user just has to tell you how she wants to use the data
DICOM in Slicer2

- Custom VTK Classes and Tcl GUI, Reader Only
- Written by Attila Tanacs, then at JHU now at University of Szeged
- Early 2000s
DICOM Readers in Slicer3

- vtkITK based parser
- ITK GDCM ImageIO to load volumes
- GDCM-based Diffusion Tool (DicomToNrrd)

DICOM Writer in Slicer3

- ITK/GDCM Based Command Line Module
- Manual Parameters
- Everything is a CT
  - Designed as the minimal set of DICOM tags to successfully push ITK results to the GE PACS

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http://www.slicer.org/slicerWiki/index.php/Modules:Loading-Data-3.6
Slicer4 DICOM Goals

• Interoperability with Clinical Systems
  – PACS
  – Scanners
  – Workstations (Navigation, Dosimetry, CAD…)
• Networking: Query/Retrieve/Listen (FIND, MOVE, STORE)
• DICOM Describes Acquisitions, not What the Data IS
  – Interpret Acquisition Context
  – Route to Analysis Modules
  – Display
• Encapsulate Results as DICOM Objects
DICOM Implementation

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DCMTK

- Widely Used BSD-licensed C++ DICOM ToolKit from OFFIS at University of Oldenberg
- CMake-ified in the Past Few Years
  - First Passes by David Gobbi and Julien Jomier, Catalyzed by NA-MIC
- Supports
  - Data Objects
  - Networking, File I/O
- DCMTK-build Shared with ITKv4

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Common ToolKit: CTK

- Over a Dozen US and European Collaborators
  - Avoid Duplication of Effort in Medical Image Software Development
- High Level DICOM Classes
  - DCMTK for Implementation
  - Qt for OS Abstractions, Object Structures, GUI, Database
  - Application Hosting
  - Python Wrapped

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Slicer DICOM Module

- Glue Between DICOM and Slicer
  - Core DICOM Parsing in DCMTK/CTK
  - Data Pre-Cached in Database
  - MRML Manipulation in Slicer Module Logic
  - Python Classes to Connect the Pieces
- Patient/Study/Series Browser
  - Offers Slicer Interpretation of Selected Data
  - Multiple Interpretations where DICOM Data is Ambiguous
  - Loaded Data Retains UID Link
Anatomy of DICOM Plugins

- Provided by Extensions for Custom DICOM Acquisitions
- DICOMPlugin Methods
  - examine
  - load
  - exportOptions
- DICOMPlugin Properties
  - tags
- DICOMLoadable Properties
  - name
  - fileList
  - warnings
  - confidence
Bundled DICOM Plugins

- **Scalar Volume Plugin**
  - Most Common: maps DICOM Series to Scalar Volume
  - Warns for inconsistent slice spacing, sheared directions, …

- **Diffusion Volume Plugin**
  - Routes a Diffusion Scan to DicomToNrrd (DWICConvert)

- **Multivolume Plugin**
  - Routes Image Sequences to Load as Multivolumes

- **Slicer Data Bundle Plugin (Work in Progress)**
  - Zipped MRML Directories in DICOM Private Tags
  - Screenshot Image as Secondary Capture

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Extension DICOM Plugins

- SlicerRT
  - DICOM RT Import/Export
  - Dose, Beam, Contour...
- Longitudinal PET/CT
  - Access All Studies for a Patient
  - PET SUV Calculations, etc
- Reporting
  - QIN Workflows
  - SR, SEG

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Related Projects: mi2b2 (babybrains)

- Combines Harvard Hospital Databases with PACS for Research
- IRB Controlled Process, Audit Trail
- Delivers DICOM Transfer and Database/CSV
  - Prescriptions, Lab Results, Procedures, Reports...

Related Projects: NCIGT, NAC, Siemens

• NAC: Funded effort for next 5 years to improve data handling in image guided neurosurgery
  – AMIGO
  – CaseHub
  – Steered Segmentation
  – Steered Registration

• Siemens collaboration to improve syngo.via for interventional procedures
  – Interoperability
  – Point of Care Interfaces

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Architecture: Review

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Wishlist

- Improved documentation
  - Hyperlinked and Annotated Specification (with Examples)
- Fix missing pieces (Float volumes?)
- Better testing infrastructure: Server
  - Public, Query-able, Broad Range of Sample DICOM
- Enhanced functionality at appropriate levels of generality
  - DCMTK, CTK, ITK, Slicer, Extensions
- Incorporate newer DICOM standards
  - Registration Transforms, Hanging Protocols, Structured Reports…
- Improved DICOM database
- Faster DICOM parsing
  - Adding to database, caching tags, loading images
- Ultimately make DICOM the default save option for Slicer
  - Track provenance

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