QIICR Kickoff Boston

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DCMTK and QIICR

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Open Connections / OFFIS?

- OFFIS official maintainer of DICOM Toolkit „DCMTK“
- OFFIS is a research institute
  - About 20% of funding comes from Federal State of Lower Saxony, rest is 3rd party funding from research projects and some industry collaborations
  - Generally, researchers employed for about 6 years, i.e. no lifetime contracts
  - Leads to „brain-drain“
- DCMTK (co-)developed by OFFIS since 1993
  - Due to contract constraints changing OFFIS DICOM/DCMTK team (with few constant team members)
  - Idea: Keep people around OFFIS after they quit:
    - Open Connections GmbH: Company founded in 2013
    - Jörg Riesmeier: Freelancer since 2012
    - (ICSMED AG: OFFIS spin-off, currently does not offer DICOM services any more)
    - Goal: Offer DICOM/DCMTK training, consulting and software development services
    - All closely related to OFFIS and collaborating with each other

DCMTK – Overview

- C++ library and sample tools implementing parts of the DICOM standard
  - Open Source (BSD-style license, commercial extensions available)
  - Write access to code (currently) only OFFIS and affiliated persons
  - Started in the early 1990ies as one of two DICOM demo implementations for the DICOM committee
    - DCMTK is *not* a reference implementation!
  - Growth over the years
    - With research projects (like this!), PhD and student thesises, features sponsored for vendors, hobby, …
    - However, keeping up with the standard is challenging!
  - Functionality includes DICOM parsing, basic DICOM networking including TLS, specific network services, Structured Reporting, consistent presentation of images, signatures, ...
  - Works on variety of platforms (different flavours of Windows, Linux, Mac OS X)
  - Builds with CMake (Windows, Unix-like) and GNU automake (Unix-like)

QIICR Goals: What could be relevant for DCMTK?

- SA1: Workflows and tools for analyzing longitudinal imaging and derived data?
  - Probably not relevant for DCMTK
- SA2: Standards-based structured reporting and representation of the quantitative analysis results
  - SA2.1: Definition of Terminologies? Paperwork
  - SA2.2: Support of DICOM standard elements to enable communication of quantitative image analysis research results? Highly relevant!
    Implement API for creating, loading, modifying and saving...
    - DICOM SR objects replacing old MRML-based hierarchy (based on pre-defined templates)
    - DICOM Segmentation objects
    - DICOM Registration objects (rigid and deformable)
    - DICOM Real World Value Mapping (RWVM) objects
- SA3: User- and developer-level interfaces to data archives
  - SA3.1 and SA3.3: Probably nothing relevant for DCMTK
  - SA3.2: „DICOM to XML conversion tools provided by DCMTK will be used to generate XML representations of the structured analysis results stored in DICOM“

QIICR Goals: Current State of SR in DCMTK

- SA2.2: DICOM SR objects replacing MRML-based hierarchy
  - DCMTK has powerful SR library („dcmsr“)
  - Create, read, store, modify SR documents
  - Supports SR document management lifecycle (verification, completion)
  - Checks basic validity constraints for document nodes and their relationships
  - However, no dedicated template support so far!
    - Master thesis currently working on auto-generated code for DICOM part 16 templates
  - Tool support for converting DICOM SR to XML, HTML and text-based format
  - Jörg Riesmeier author and leading expert for this part of DCMTK

DCMTK dcmsr Code Example

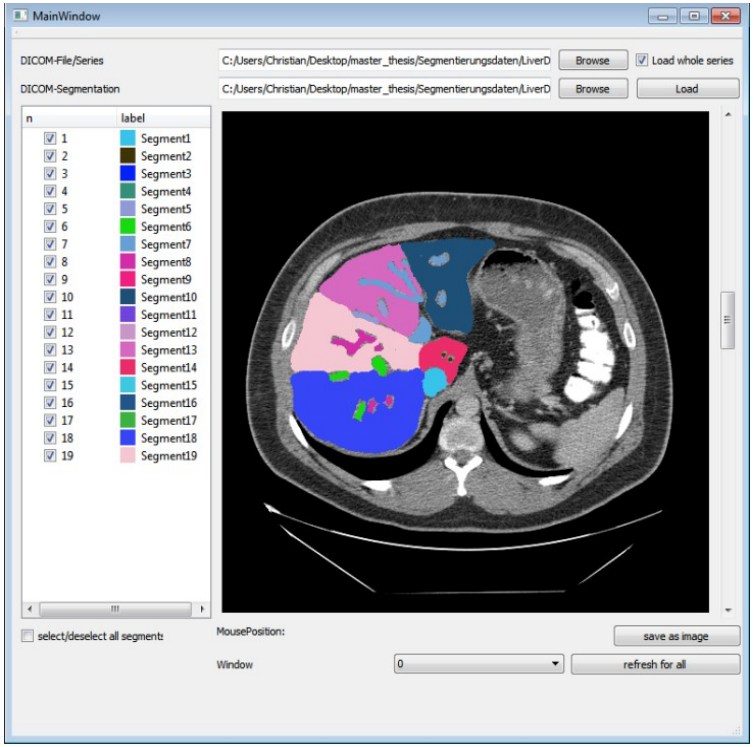
- Code example: Create minimal SR document and store it to disk

```
DSRDocument document;
document.setPatientName("Doe^John");
/* ... */
document.getTree().addContentItem(DSRTypes::RT_isRoot, DSRTypes::VT_Container);
document.getTree().getCurrentContentItem().setConceptName(DSRCodedEntryValue(/* some code */));
document.getTree().addContentItem(DSRTypes::RT_hasObsContext, DSRTypes::VT_Code, DSRTypes::AM_belowCurrent);
/* ... */
DcmFileFormat fileformat;
OFCondition status = document.write(*fileformat.getDataset())
if (status.good())
{
  status = fileformat.saveFile("test.dcm", EXS_LittleEndianExplicit);
  if (status.bad())
    cerr << "Error: cannot save DICOM file (" << status.text() << ")" << endl;
} else
  cerr << "Error: cannot write SR document (" << status.text() << ")" << endl;
```

Source: DCMTK online documentation at http://support.dcmtk.org/docs-snapshot/mod_dcmsr.html

QIICR Goals: Current State of Segmentation in DCMTK

- SA2.2: DICOM Segmentation objects
  - Internal proof-of-concept code:
    - Library for loading, creating, modifying, storing Segmentation objects („dcmseg“)
    - Tool „seg2dcm“ to convert NNRD segmentations (from Slicer3D output) to DICOM
    - Demo QT widget that applies segmentations visually to referenced images
  - Needs major review and some re-writing
    - Incomplete support of Segmentation object features
    - DICOM Enhanced SOP Classes' Rendering pipeline not generally supported
    - Code partly ineffective and inefficient
  - However, a base is there



Source: Master thesis of MSc Christian Herz
„Verarbeitung von medizinischen Segmentierungsdaten in DICOM“,
Carl-von-Ossietzky University of Oldenburg, 2013

QIICR Goals: Current State of Registration and RWVM in DCMTK

- SA2.2: DICOM Real World Value Mapping and Registration objects
  - No dedicated API support so far
  - However Basic parsing and networking should work out of the box
- Real World Value Mapping Objects:
  - Seem to be straight forward and easy to implement
- Registration Objects
  - Two types: Spatial Registration and Deformable Registration
  - Not too complex objects
  - Understanding and implementing (plus testing) computations – could mean a little more effort (wherever that code will live)
- General DICOM to XML conversion available in two flavours
  - DCMTK's traditional format based on a DCMTK-style DTD
  - DICOM's „new“ Native Model format (originally coming from DICOM's Application Hosting service)
    - Conversion does not include binary data so far but inserts unique references instead

Open Questions

- What to implement in which tool(kit): Slicer, CTK, DCMTK, …
- Other stuff that might be relevant?
  - DICOM Surfaces
  - New DICOM HTTP services for Storage and Query/Retrieve
- Timeline, priorities, …

Further Information / Contact

- http://www.dcmtk.org:Official DCMTK web site
- http://support.dcmtk.org: Lists various sources of DCMTK documentation
- http://forum.dcmtk.org: Official DCMTK forum
  (TODO posts, TODO users..., DCMTK developers active, too)
- http://git.dcmtk.org: Official git repository with latest DCMTK source code

- http://www.open-connections.de : Website of company Open Connections GmbH (Employees from OFFIS, offers services around DCMTK/DICOM)
- http://jriesmeier.de: Website of Jörg Riesmeier (DCMTK/DICOM freelancer and former OFFIS employee)

- General contact regarding DCMTK: info@dcmtk.org
- DICOM contact at OFFIS: dicom@offis.de
- Contact regarding QIICR: dicom@open-connections.de