Open Source DICOM Projects in Korea

2015.08.27

IRM Inc.
Samuel Choi, Ph.D.
Acknowledgement

This projects have been

- Parts of the following research grant
  - Title: Development of 'medical equipment using (ionizing or non-ionizing) radiation'-dedicated R&D platform and medical device technology (10049785)
  - Period: 2014.09.01 – 2019.08.31
  - Principal Investigator: Prof. Hak Jong Lee M.D.
  - Principal Organization: Seoul National University Bundang Hospital
  - Supporting Organization: Korea Ministry of Trade, Industry and Energy
  - And, developed and maintained by IRM Inc.
  - Through the contract with SNUBH
Project Goal and Scope

**Goal**

- Develop a standard-supporting medical imaging system software platform to improve the competitiveness of Korean medical imaging system manufacturers

**Scope**

- Develop and open a standard-supporting medical imaging system software
  - Developing DICOM library
  - Developing medical imaging system software platform
  - Making them open source
Conceptual Diagram of Acquisition Modality

- **X-ray Tube**
- **HV Generator**
- **X-ray Detector**
- **X-ray System**

**Acquisition Modality**
- **HV Generator**
- **X-ray Detector**
- **X-ray System**

**BEST Tools:**
- **X-ray Imaging Modality**
- **Image Viewer**
- **Data Manager**
- **Acquisition Manager**

**Database**

**Digital Imaging and Communications in Medicine (DICOM)**
- **DICOM CD/DVD**
- **RIS/PACS**
- **Open-Source**

**Software Platform for Imaging Modality**
- **DTK: DICOM Library**
- **Image Viewer**
- **Data Manager**
- **Acquisition Manager**
Standard-supporting Medical Imaging System Software

Developing DICOM library
- Cross-platform environment
- DICOM NLS (National Language Support)
- Various image compression

Developing medical imaging system software platform
- Cross-platform environment
- Basic workflow and database for medical imaging system
- IHE Profiles (SWF, CPI, ARI, PDI)

Making them open source
- Source-code repository
- Distribution web site
- License for open source software
DTK – Open Source DICOM Library

- Overview
  - Open Source DICOM library for medical imaging software

- Key Features
  - DICOM Application Entity Management
  - DICOM Dataset Management
  - DICOM Message Management
  - DICOM File Management
  - DICOM Tag Management
  - DICOM Service Management
  - DICOM Directory Management
  - String and NLS Management
  - Log Management
  - Security Management
DCMTK-based extended DICOM library

### Existing DICOM libraries
- **DCMTK**
  - Written in C/C++
  - Powerful
  - Not support for IHE Profiles
  - Good for imaging modality
- **dcm4che**
  - Written in Java
  - Powerful
  - Support for IHE Profiles
  - Not good for imaging modality

### Goal of DTK
- DCMTK-based
- Easy and intuitive class library
- Support for IHE Profiles
  - SWF: Basic radiology workflow
  - ARI: Query & Retrieve of images, etc.
  - CPI: Consistent Presentation of Images
  - PDI: Exporting images to CD/DVD
- Multi-language support

### Table 1: Excerpt of data collected during the Evaluation Process
(ICCAS Winter 2006)

<table>
<thead>
<tr>
<th></th>
<th>DCMTK</th>
<th>DCMTK-CHEE</th>
<th>CONQUEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Documentation</strong></td>
<td>Comprehensive</td>
<td>Not-enough</td>
<td>Poor</td>
</tr>
<tr>
<td><strong>Maintainability</strong></td>
<td>High</td>
<td>High</td>
<td>Lower</td>
</tr>
<tr>
<td><strong>Programming Language</strong></td>
<td>C/C++</td>
<td>Java, XML</td>
<td>C/C++</td>
</tr>
<tr>
<td><strong>Extendibility</strong></td>
<td>Add new SOP's, requires modify and rebuild the source code</td>
<td>Add new SOP's don't always require modify the source code</td>
<td>Add new SOP's requires modify and rebuild the source code</td>
</tr>
<tr>
<td><strong>Operating Systems</strong></td>
<td>UNIX, Linux, Windows</td>
<td>Multiplatform</td>
<td>Windows, UNIX</td>
</tr>
<tr>
<td><strong>Client/Server PACS Model</strong></td>
<td>As Server: Modality Worklist and Storage</td>
<td>Provides complete support</td>
<td>As Server: Modality Worklist and Storage</td>
</tr>
<tr>
<td><strong>IHE Integration Profiles</strong></td>
<td>None</td>
<td>Several</td>
<td>None, but support some HL7 messages</td>
</tr>
<tr>
<td><strong>DICOM Services</strong></td>
<td>No Hanging Protocol support</td>
<td>Hanging Protocol, Storage Commitment, Basic Worklist</td>
<td>No Hanging Protocol support</td>
</tr>
<tr>
<td><strong>DICOM IOD’s (Image Types)</strong></td>
<td>US, CT, MR, SC, DX, XA, VL, RT</td>
<td>US, CT, MR, SC, DX, XA, VL, RT</td>
<td>US, CT, MR, SC, DX, XA</td>
</tr>
</tbody>
</table>
Support for cross-platform (Windows, Linux, MacOS)
DICOM NLS – All the western languages + Korean, Japanese, Chinese, Unicode

* NLS: National Language Support
Image compression

Comparing file sizes
- Original: 13,815KB
- Uncompressed (EVR): 13,815KB
- 8bit lossy JPEG: 848KB
- 12bit lossy JPEG: 3,882KB
- Lossless JPEG: 6,500KB
BEST Tools – Medical Imaging System Console Software

Overview

- Console software for medical imaging system

Key Features

- Patient registration: manual patient info. Entry
- Patient selection: patient info. retrieval by MWL
- Image acquisition
- Study management
- Sending images or creating CD/DVD
- Settings
Support for DICOM and IHE Profiles

- **DICOM Services**
  - DICOM Verification SCU
  - DICOM Storage SCU, SCP
  - DICOM Modality Worklist SCU
  - DICOM Modality Performed Procedure Step SCU
  - DICOM Storage Commitment SCU
  - DICOM Query/Retrieve SCU
  - DICOM Grayscale Print Management Meta SCU

- **IHE Profiles**
  - IHE SWF (Scheduled Workflow)
  - IHE ARI (Access to Radiology Information)
  - IHE CPI (Consistent Presentation of Images)
  - IHE PDI (Portable Data for Imaging)
Workflow and database for imaging modality

Workflow design for imaging modality

Database schema for imaging modality
Patient Registration: Scheduled & Unscheduled

1. Scheduled patients (MWL)

2. Unscheduled (manual entry)
Image Acquisition

Acquiring images
BEST Tools

Acquired Study List

Study list

Series list

Preview images
BEST Tools

Image Review

Reviewing images
Support for IHE Profiles

MESA/Acquisition Modality

Contents

1 Modality Tests
   1.1 Introduction
   1.2 Message Attributes
   1.3 Message Values
   1.4 Configuration
   1.5 Starting the MESA Servers
   1.6 Submission of Results

2 Individual Tests
   2.1 Modality Worklist Values
   2.2 Seeding Modality Worklist Values
   2.3 General Test Instructions
   2.4 Modality Test 200: Connection Codes for Orders and Procedures
   2.5 Modality Test 201: Unscheduled Case
   2.6 Modality Test 210: Simple Case, One SPS
   2.7 Modality Test 210: Simple Case, Two SPS
   2.8 Modality Test 214: Simple Case, Two SPS
   2.9 Modality Test 215: Perform Different Procedure
   2.10 Modality Test 216: Assisted Protocol, One SPS
   2.11 Modality Test 218: Billing and Material Option
   2.12 Modality Test 221: Group Case, One Scheduled Procedure
   2.13 Modality Test 222: Group Case, Two Scheduled Procedure
   2.14 Modality Test 231: Append Case
   2.15 Modality Test 241: Abandoned Case
   2.16 Modality Test 242: Exception Management
   2.17 Modality Test 251: Storage Commitment Association Negotiation
   2.18 Modality Test 271: Patient Update Tests
   2.19 Modality Test 281: Example Images and other DICOM objects
   2.20 Modality Test 282: Example GSOPS Objects
   2.21 Test 285: DICOM SOP Classes
   2.22 Test 511: Key Image Note 511
   2.23 Test 512: Key Image Note 512
   2.24 Test 513: Key Image Note 513
   2.25 Test 552: Example Key Image Note

3 Consistent Presentation of Images Tests
   3.1 Modality Test 521: Consistent Presentation of Images

4.1x Series Modality Tests (PGP Tests)
   4.1 Modality Test 106: Presentation of Grouped Procedures
   4.2 Modality Test 108: PGP Test Data

5 Charge Processing Tests

http://wiki.w3.org/index.php/MESA-Acquisition Modality

IHE MESA Test Procedures

IHE MESA Test Result

IHE MESA Test Results
Distribution Web Site

Besttools.snubh.org

Source-code repository (GitLab)

Technical documents
License

- **LGPL + Commercial**
  - Basically LGPL (Lesser General Public License)
    - Should notify that the application program is using open source software and distributed by LGPL
    - Can be used for commercial software in case that the application program is dynamically linked to the library
    - Should open the application program source in case that the library itself was modified
  - **Step-by-step open**
    - First, open to Korean medical imaging system manufacturers only, and then open to the world because this projects have been funded by Korean government
  - **Possible Commercial License**
    - In the future, possible Commercial License applicable for some newly added parts
    - May charge a little after the completion of this research grant