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NEWS ITEM

Validating DICOM Transcoding with an Open Multi-Format Resource

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The Digital Imaging and Communications in Medicine (DICOM) standard has allowed wide-scale interoperability between medical imaging devices allowed for construction of large-scale radiological imaging system.[1] The DICOM standard provides for extensive structured meta-data ranging from the physical dimensions of the imaging data to patient military status. Moreover, "private" fields are permitted to store almost any additional data within DICOM datasets. These alternative fields are often used to store key acquisition parameters for new or emerging imaging sequence or assist interpretation of manufacturer specific settings. While DICOM provides for interoperability, there is ample room for interpretation or use of alternative coding strategies (e.g., storage of 3-D data in a light box array or as separate DICOM slices). Hence, interpreting DICOM data is a substantial process and can be manufacturer specific. The image processing research community has gravitated towards simpler but more explicit standardized research formats—first Analyze[2] and Minc[3], and more recently NIfTI.[4]

[1] Horii, S. C. (1997). Digital imaging and communications in medicine in 1997: an update. *Journal of Digit Imaging, 10*(3 Suppl 1), 3–4.

[2] AnalyzeDirect. Analyze 7.0. 2007 September 2007. Available from: http://www.analyzedirect.com/.

[3] MINC Medical Imaging NetCDF (2013) http://en.wikibooks.org.

[4] Cox, R., et al. (2004). A (sort of) new image data format standard: Nifti-1. *Human Brain Mapping, 25*.

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Converting between data formats (known as transcoding)—either between files or between files and an internal memory representation—is a constant concern for software engineers and image processers (Fig. 1). In medical imaging, it is critical that real-world orientation (e.g., right/left) and distances are preserved. Some image acquisitions have physical indications to allow orientation to be verified (e.g., using vitamin E capsules as fiducial markers in MRI), but these practices are inconsistent across sites. Software engineers have verified performance with the

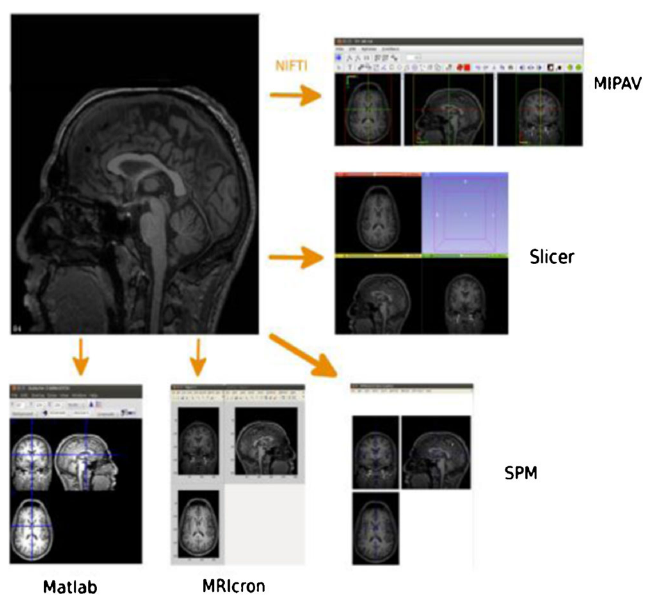

Fig. 1 DICOM can be converted into research file formats viewed with SPM (Friston, K. J., et al. (2011). Statistical parametric mapping: The analysis of functional brain images: The analysis of functional brain images. Academic Press), MIPAV. (McAuliffe, M. J., et al. (2001). Medical image processing, analysis and visualization in clinical research. in Computer-Based Medical Systems. CBMS 2001. Proceedings. 14th IEEE Symposium on. 2001. IEEE) 3D Slicer. (Kikinis, R., 3D Slicer. Faseb Journal, 2012. 26) MRIcron, (Rorden, C. (2007) MRIcron.) MATLAB (Mathworks, Natick, MA)

data that they have had available which can be limited in terms of manufactures and software release. Given typical research budgets, only data representative of current users is generally available and testing is difficult. Herein, we propose the "Rosetta bit" project to provide an open data resource to facilitate inter operability testing for image conversion in research software.

The Rosetta bit provides a set of anonymized DICOM images along with validated conversion of the images into research file formats. The validation step consisted of using different visualization tools such as MIPAV, Slicer, SPM, etc.… to check the orientation (e.g., left-right) of the converted data (Fig. 1). This project specifically does not promote any particular converters, but rather encourages the data sponsor to use whatever methods they can validate for their data. Once the data have been correctly converted, others can test their preferred tools.

Table 1 Initial release of data from four different devices

Devices	Contents	Sources	Formats
GENERAL ELECTRIC			
Signe-HD-Excite 3T	Twelve 4D EPI series, each with five volumes Imaging modalities: Area: brain Dim: 384x384 Type: Unsigned Short Orientation: • s26692 to s26695 Axial • s26696 to s26699 Sagittal • s26700 to s26703 Coronal Notes: water fiducial marker on the right temple, first volume marked with a 1	MRIcron: • LMU Grosshadern	DICOM (2D) NIFTI (3D & 4D)
SIEMENS			
Trio 3T	3 datasets: • B12: six 4D EPI volumes • B13: four 20 directions EPI datasets • B15: four DTI images Imaging modalities: Area: brain Dim: 64x64 Type: short Orientation: Axial/Sagittal/Coronal present Notes: Saline bag on left temple for B12	MRIcron: • GSU/GT Center for Advanced Brain Imaging • USC McCausland Center	DICOM (2D) NIFTI (3D & 4D)
PHILIPS			
Intera 1.5T	Six 4D EPI volumes, each with two volumes Imaging modalities: Area: brain Dim: 64x64 Type: Unsigned Short Orientation: Axial/Sagittal/Coronal present Notes: White line added at the bottom (shorter for earlier volumes) Five 4D EPI volumes for PARREC Image modalities: Notes: Same raw data as Philips Intera DICOM dataset, but only a single axial volume included	MRIcron: • MUSC Center for Advanced Imaging Research	DICOM (2D) PARREC (4D) NIFTI (3D & 4D)
Achieva 3T	Four 4D MRI images (T1, DTI, fMRI, b0map) Imaging modalities: Area: brain Dim: • T1: 256×256×170 • fMRI: 80×80×38×203 • DTI: 96×96×50×34 • b0map: 128×128×50×2 Type: Unsigned Short Orientation: Axial/Sagittal Notes: vitamin E capsules on right temple	Vanderbilt University PACS	DICOM (4D) PARREC (4D) NIFTI (3D & 4D)

We envision the Rosetta project as an evolving entity to which users can submit *validated* converted image sets and encourage software developers to support consistent image interpretation across data formats. A small logo can be used to designate that a software program has been tested with a specific release of the data resource. To test the converter, one developer can convert the raw data in the Rosetta bit project into his preferred converted format and validate it with the version present in the project.

The contributors of the Rosetta bit project have provided a series of structural brain images. The initial database (Table 1) is a release of data from 4 different devices: GE SignaHD Excite, Siemens Trio, Philips Intera, and Philips 3T Achieva. All the data have been converted into NIfTI. The database provides 3D and 4D NIfTI. Many of the datasets were contributed to the public domain along with the MRIcron utilities; these data were converted with dcm2nii.[5] The Philips 3T Achieva dataset has been converted from DICOM to Philips PAR/REC and then from PAR/REC to NIFTI with r2agui (http://r2agui.sourceforge.net/). For all the data, the conversion from 4D NIFTI to 3D NIFTI used the SPM function spm_file_split. The data in the project has been manually anonymized using the software DicomBrowser[6] (http://nrg.wustl.edu/software/dicom-browser/).

Information Sharing Statement

All data and resources referred in the article are available on the "Rosetta bit" project on NITRC at http://www.nitrc.org/projects/rosetta/. To download the dataset from NITRC, a user only needs to check out the svn repository for the project. On the project page on NITRC, go to the "Source Code" tab and follow the instructions. A copy of the dataset will be downloaded on the local machine.

To contribute data to the project, one must "join" the project using the NITRC web portal and certify that one has permission to release the data. Once the project has been joined, users can use standard subversion tools to add raw data or their converted format .

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[5] Rorden, C., Karnath, H., & Bonilha, L. MRIcron dicom to nifti converter. Neuroimaging Informatics Tools and Resources Clearinghouse(NITRC). (Accessed 2011 at http://www.cabiatl.com/mricro/mricron/index.html).

[6] Archie, K. A., & Marcus, D. S. (2012). DicomBrowser: software for viewing and modifying DICOM Metadata. *Journal of Digital Imaging, 25*(5), 635–645.