

# Bringing Quantitative Clinical Routine MR-Spectroscopy and Clinical MR-Image Viewing Together: Novel jMRUI plug-ins for DICOM-Network File Transfer DICOM Image Stack Analysis

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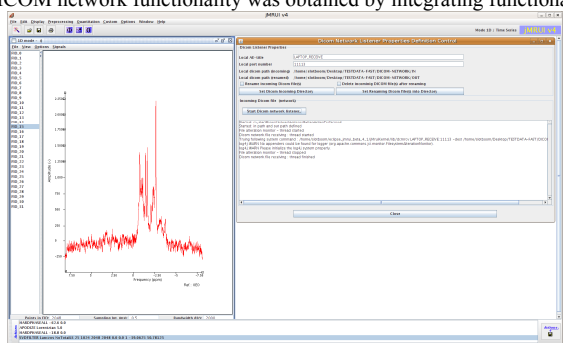
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## Introduction

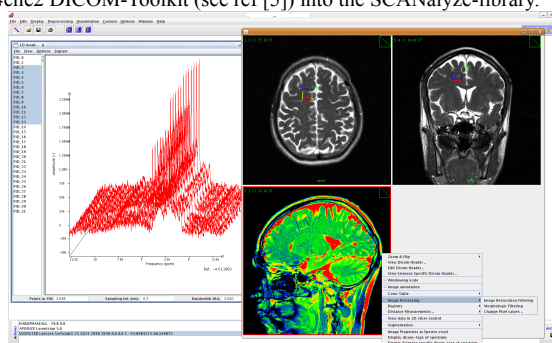
For several reasons, most state-of-the-art applications (e.g. refs. [1-4]) for quantitative MRS can poorly be integrated in a clinical work flow. The reasons for this are: (1.) most applications have very rudimentary image display possibilities or totally lack the functionality of offering the clinician the possibility to study the clinical spectra *simultaneously* with the other MR-image series of the same patient examination. (2.) Although these programs may be able to open advanced DICOM spectroscopy-files (like e.g. jMRUI version 4) they have no DICOM-network capabilities for receiving and sending spectroscopy/image files using the DICOM network protocol; the data must manually be exported to off-line files which is tedious, time consuming and error prone. (3.) related to (2.) is the fact that these advanced applications are file oriented, i.e. the user is asked to open a file in the file system, whereas clinical users are used to work study-oriented, which means that they search for patient studies of a certain date, and loads one or more series of this study, without needing to bother about their location in the file system. Since jMRUI v4.0 (ref. [2]), it is possible to add plug-ins to the systems kernel. This paper reports on the plug-in functionality which has been developed to make advanced quantitative MRS more attractive in a pure clinical setting, i.e. can easily be integrated in the clinical work flow.

## Method

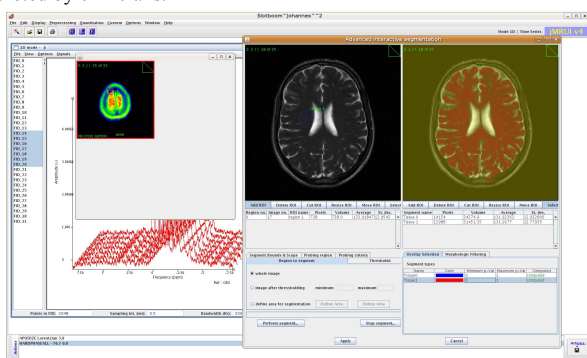
We developed a JAVA library named SCANalyze which provides graphical controls for DICOM-file manipulation/display/ processing and DICOM network transfer functionality. The controls for DICOM manipulation/display/processing have completely been developed in our lab from scratch and are totally developed in JAVA. The DICOM network functionality was obtained by integrating functionality from the dcm4che2 DICOM-Toolkit (see ref [5]) into the SCANalyze-library.



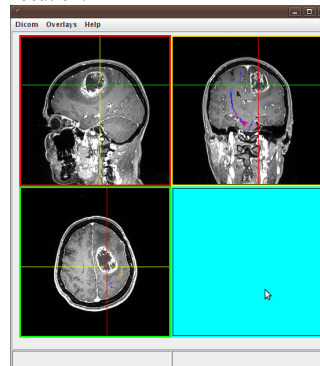
**Figure 1:** jMRUI with DICOM network listener frame of the new plugin. The control enables the user, apart from starting the DICOM-network listener, to set the directory for the incoming DICOM files, and the directory where jMRUI should locate the renamed DICOM files. After renaming, the files can easily be interpreted by clinicians.



**Figure 2:** jMRUI with the novel image display frame enabling DICOM image-stack display and image analysis. By default the spectroscopic voxel is projected within the image stacks; image properties at the location of the spectroscopic voxel and displayed image are computed automatically, ideal for studying image properties at the voxel location.



**Figure 3:** Additionally complete image stacks can be segmented within jMRUI now.



**Figure 4:** In jMRUI also 3D-image stacks can be viewed in a simple slicer control. The control allows the draw coloured image overlays with fMRI activation maps and DTI-fiber maps (currently only from Brainvoyager.)

## Results

We realized the following new functionality for jMRUI v4.1: (i.) DICOM network listener (Fig. 1), (ii.) Multiple image stack displayer with automatic spectroscopy voxel projection with computation of image properties at the cross-section volume of the voxel and image. Multiple MR-image stacks can be viewed simultaneously (free ROI drawing/simple image segmentation/several colour maps) (Fig. 2), (iii.) a control for simple image segmentation (Fig. 3); (iv.) Viewing of 3D images in an image slicer tool (Fig.4); and (v.) DICOM-formatted “jMRUI-spectroscopy-report” senders (graphical/numerical) for PACS-reporting (no figures available).

## Discussion and Conclusion

The plug-in functionality of jMRUI v4.0 (ref. [2]) enables easy extension of core functionality of jMRUI. We added plugins to jMRUI that enable the easy and time efficient usage of jMRUI in a pure clinical setting.

## References

1. S.W. Provencher, Magn.Reson.Med (1993) 30, 672. 2. D. Stefan, *et al.*, Meas. Sci. Technol. (2009), 20 104035 (9pp) 3. Poulet, J.-B.. (2007), NMR in Biomed, 20: 493–504. 4. J. Slotboom, *et al.* (1998), Magn.Res.Med., 39: 899–911. 5. DCM4CHE2: <http://www.dcm4che.org/confluence/display/d2/dcm4che2+DICOM+Toolkit>