Software Development for Analysis of QIBA DCE-MRI Phantom Data

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1.0 Introduction

This project is intended to address the development of a distributable software package to allow the analysis of QIBA DCE-MRI phantom data. Requirements for this package are as follows:

Inputs: a) multi-flip angle fast gradient echo T1 mapping data, b) multi-TR T1 mapping data, c) multi-TI T1 mapping data, d) source fast gradient echo phased array and body coil images to be used for phased array intensity correction calculations, and e) DCE-MRI fast gradient echo data.

Outputs: a) T1, R1, and M0 measures for each ROI from both the raw and signal intensity corrected data, b) DCE-MRI signal-to-noise ratio (SNR) measures and DCE-MRI signal intensity data for all ROIs, and c) summary statistics for all relevant measures.

The primary deliverable will be a freely distributable executable file with instructions for installation and use. Deliverables will also include documentation of all algorithms/processes used in this software package at a level of detail sufficient to permit those algorithms/processes to be reproduced independently.

2.0 Project Outline and Status

2.1 Graphical User Interface Development

The first requirement for this project is a graphical user interface (GUI) which allows the user to conveniently load, view, modify, and save DICOM images and associated region of interest information. This interface is to serve as the platform upon which the required image processing algorithms will be built. Development for this portion of the project is complete. Testing is on hold pending completion of all processing algorithms (see Section 2.2). A screenshot of the GUI window is given in Figure 1 below.

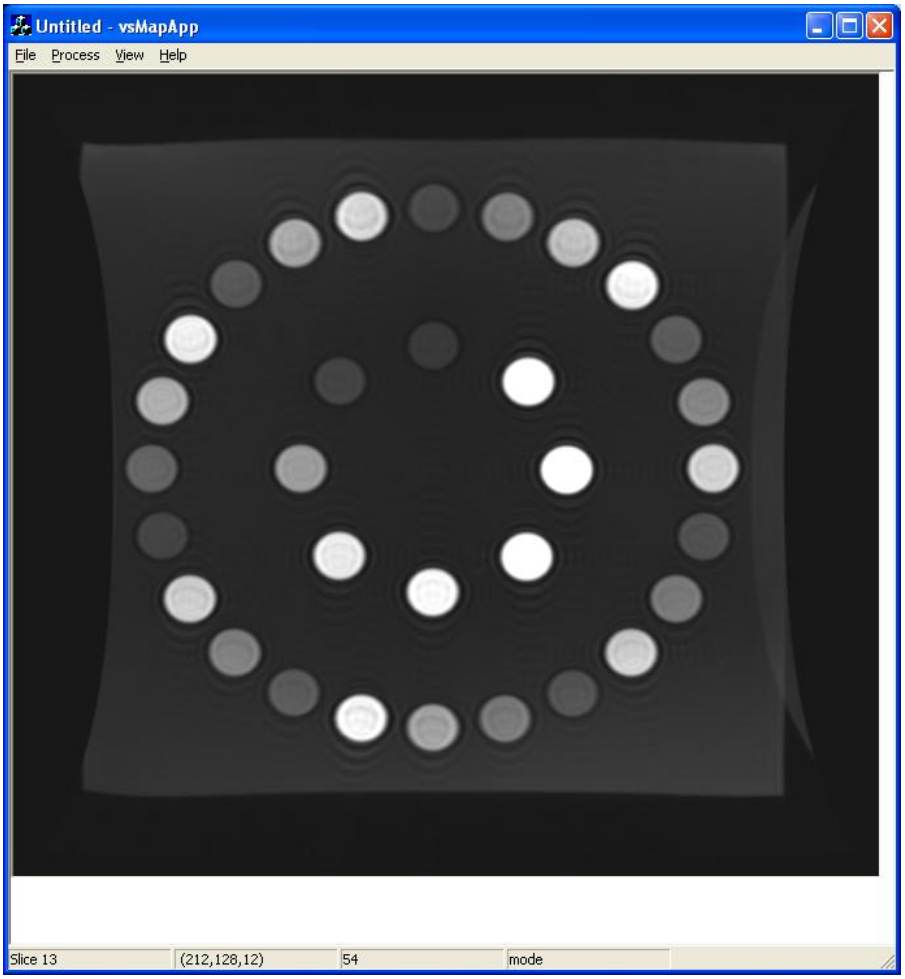

Figure 1: GUI for QIBA Phantom Analysis.

2.2 Processing Algorithm Development

2.2.1 ROI Identification

Two methods are provided for identification of regions of interest in this software package. The first method is semi-automated. The user is required to click once in the center of a given phantom sphere, causing the generation of a spherical region of interest 2cm in diameter centered on that point. The user is also able to select a label for that region. A maximum of 40 distinct region labels are permitted. This method is complete and fully tested.

The second method for region identification is fully automated. The user is required to select the "Identify Phantom Regions" option from the "Process" menu. The method then co-registers a phantom template against the currently loaded phantom scan and uses this to identify all regions of interest in a uniform way. This method has been prototyped, but has not been finalized pending the completion of the final second generation phantom. Data have been acquired

for the prototype phantom (see above) but the geometry of this phantom will not be identical to that of the final phantom.

2.2.2 Signal Intensity Correction

One method is provided for generation of signal intensity correction maps for phased array data. The user is required to load data acquired with both the body coil and the phased array coil. The user is then required to select "Calculate Ratio Image" from the "Process" menu. The software then generates a ratio image, which is saved out as a DICOM file. The user is then required to load the data which is to be corrected (correction may be applied to either the T1 mapping data or the dynamic data) and select "Apply Ratio Image" from the "Process" menu. The data may then be saved out as a corrected image or processed further (by calculating T1 values, for example). This method is complete and fully tested.

2.2.3 T1 Mapping

Three methods are provided for calculating T1, R1, and M0 values for all identified regions of interest. These methods are also located on the "Process" menu. They differ only in the required input data, i.e. multiple flip angle, multiple TR, or multiple TI. These methods may be applied to either raw data or data which have been processed using the Signal Intensity Correction method. The multiple flip angle method is complete and fully tested. The multiple TI method and the multiple TR method are complete in preliminary form but are still undergoing testing and refinement.

2.2.4 Dynamic Signal Evaluation

One method is provided for evaluating signal quality for dynamic data. This method is selected from the "Process" menu. This method generates the mean, median, and standard deviation for the raw signal values as well as the SNR for each identified region of interest at each acquired phase for the dynamic data. Results are output into a tab-delimited text file which can be conveniently loaded into Excel or another analysis package. This method is complete and fully tested.

2.3 Software Packaging and Delivery

The final requirement is that the resulting software package must be provided with a freely distributable installer together with a user manual outlining requirements for installation and use as well as documenting the algorithms described above in sufficient detail to allow their independent re-creation. This final step has not been completed, but has been scheduled with the VirtualScopics software group. Work on this is tentatively scheduled to begin in mid-August.