HMRI-vQC : A visualization Quality Control toolbox for Multi-Parameter Mapping

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Introduction:

Quantitative MRI (qMRI) provides access to markers of biologically-relevant tissue features and offers a standardised approach to imaging that can improve comparability across sites and time points[1]. Image quality control (QC) is an integral preparatory step in the MRI data processing pipeline. QC tools are available for commonly used imaging modalities T1 and fMRI[2,3]. However, there is a lack of QC tools for qMRI.

Methods:

qMRI involve multiple images acquisitions (T1w/MTw/PDw/B1/B0) and combining these to generate parametric maps (MTsat, PD, R1, R2*). These maps represent tissue properties in (absolute) physical units. Visual inspection and quality control of the data are time-consuming, subjective and error-prone since the MPM acquisition and output include multiple images. Hence, we developed a tool to visualize all images and summaries in an easily accessible HTML format.

We used SPM12 and the hMRI-toolbox for processing the MPMs[4]. We estimated the following QCs to assess the quality of the images.
1. Coregistration parameters: MTw2PD and T1w2PD contain the co-registration parameters of MTw and T1w images to the PDw images respectively (3 translations in mm and three rotations in radians) provides estimates of head motion between the corresponding images. We computed the Euclidean norm of the translation part to estimate the absolute distance.
2. Standard deviation in the white matter of the R2* maps (SD-R2s), calculated from each individual multi-echo acquisition (PDw, T1w, MTw) . These parameters provide an estimate of image degradation due to head motion during the acquisition of the corresponding

echoes (intra-scan motion)[4–6]

3. The ratio of standard deviation and mean of the PD values in white matter. This value indicates the accuracy of the B1+ bias field correction[4,7]

4. GM, WM, CSF volumes and its ratio to the total intracranial volume (TIV) These values were estimated by multi-channel segmentation of MTw OLS fit and T1w OLS fit using SPM12 - unified segmentation[8]

5. Signal to Noise Ratio (SNR) for the GM and WM for the qMRI maps

6. Contrast to Noise Ratio (CNR) of GM and WM for the qMRI maps.

Figure 1 shows the image processing pipeline.

Figure 1: Flowchart showing the steps imvolved in the hMRI-vQC tool for estimating quality assement parameters and generating images.
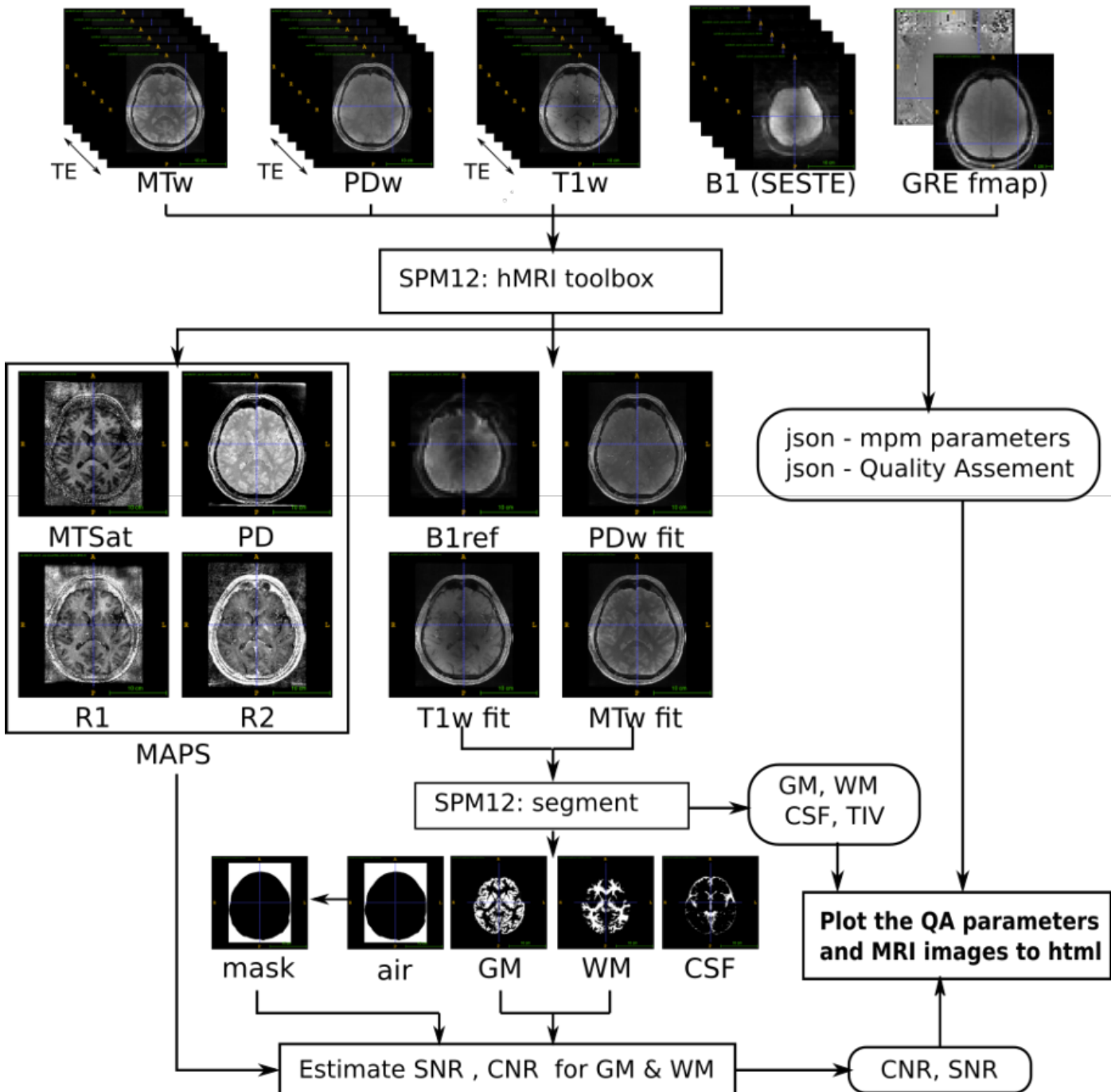
(https://files.aievolution.com/prd/hbm2201/abstracts/abs_1444/Figure01.png)

·Image processing pipeline

Results:

We used a subset of 7T multi-site MPM data acquired on a single subject and available in the lab to demonstrate the toolbox[9]. Fig 2 shows the screenshots of different parts of the sample HTML report for the subject/session produced by the toolbox. The top part of the HTML shows the summary plots, side-by-side box plots and scatter plots of the QA parameters for data acquired for all subject data (Fig

2A). The black circle in the box plot indicates the parameter's value for the particular subject/session, which aids in quickly assessing the QA level of the specific subject/session.

Fig 2 shows the screenshots of different parts of the sample HTML report for the subject/session produced by the toolbox. The top part of the HTML shows the summary plots, side-by-side box plots and scatter plots of the QA parameters for data acquired for all subject data. The black circle in the box plot indicates the parameter's value for the particular subject/session, which aids in quickly assessing the QA level of the specific subject/session. Fig 2B shows the MPM map (PD) screenshot in the axial plane. This session is customizable, i.e. the user can determine the axis and number of images to display. Individual images can be zoomed in by clicking on them. Figure 2C shows the screenshot of the GM image overlayed on the MTw(fit), which helps the rater visually assess segmentation quality.
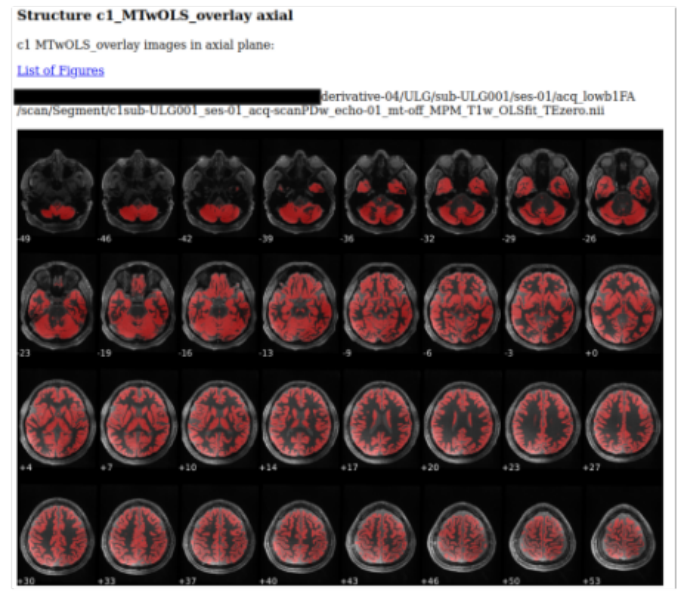

Figure 2: Shows the parts of HTML report .
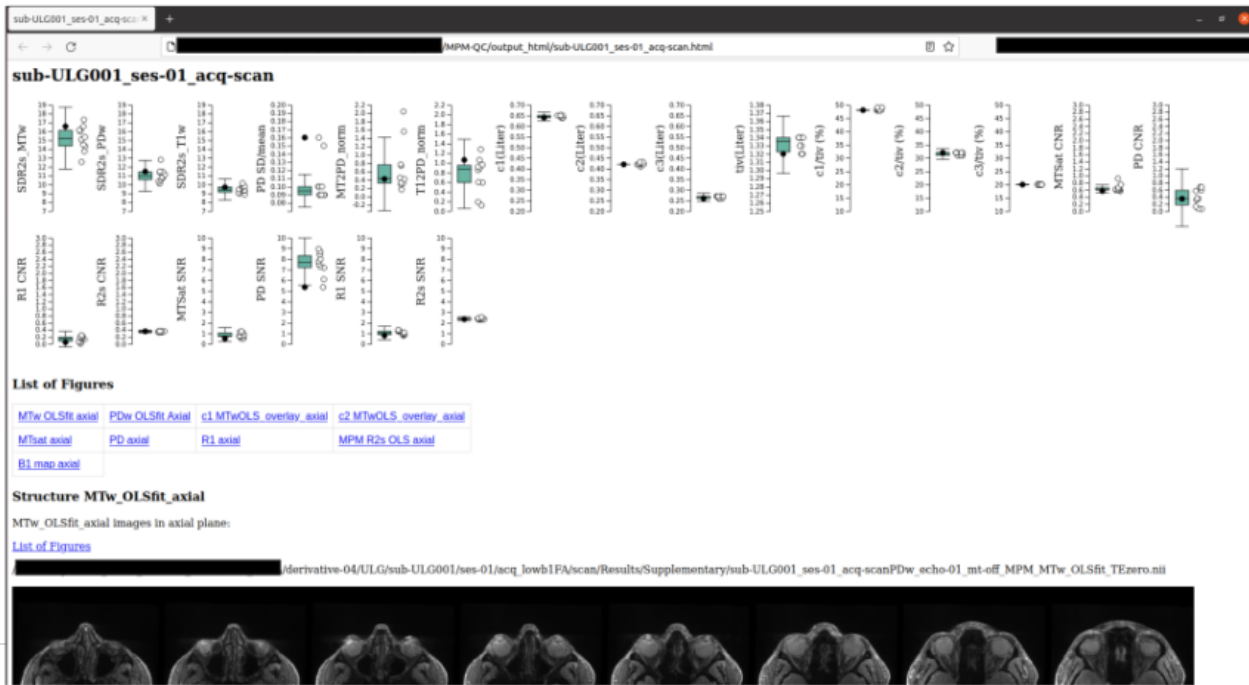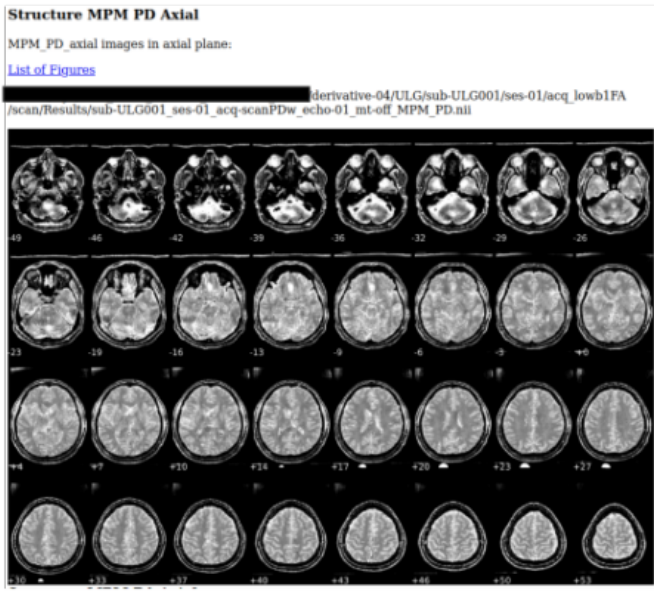
(https://files.aievolution.com/prd/hbm2201/abstracts/abs_1444/Figure02.png)
·Example of HTML report generated

Conclusions:

We present hMRI-vQC, a visual QC tool, which shows summary values in the scatter/boxplot in an efficiently interpretable form to aid the rater. It also helps visualise multiple qMRI images/maps easily and flexibly in HTML. Further analyses of large MPM datasets are required to validate the quality assessment parameters and automatic image quality assessment. The source code is available on Github[10].

Modeling and Analysis Methods:

Other Methods [2]

Neuroinformatics and Data Sharing:

Informatics Other [1]

Novel Imaging Acquisition Methods:

Imaging Methods Other

Keywords:

MRI
STRUCTURAL MRI
Other - quality control; quantitative MRI; multi-parametric mapping

[1|2]Indicates the priority used for review

My abstract is being submitted as a Software Demonstration.

Yes

Please indicate below if your study was a "resting state" or "task-activation" study.

Other

Healthy subjects only or patients (note that patient studies may also involve healthy subjects):

Healthy subjects

Was any human subjects research approved by the relevant Institutional Review Board or ethics panel? NOTE: Any human subjects studies without IRB approval will be automatically rejected.

Yes

Was any animal research approved by the relevant IACUC or other animal research panel? NOTE: Any animal studies without IACUC approval will be automatically rejected.

Not applicable

Please indicate which methods were used in your research:

Structural MRI

For human MRI, what field strength scanner do you use?

7T

Which processing packages did you use for your study?

SPM
Other, Please list - hMRI

Provide references using author date format

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