A Multifunction Tool for ACR MRI QC & Accreditation Program

Jian-xiong Wang & Wlad T. Sobol
University of Alabama at Birmingham, Birmingham, AL, U.S.A.

INTRODUCTION

A software application has been developed to manage the datasets and automate data analysis associated with physicist's tasks within the ACR MRI Accreditation Program (MRAP).

AIM

To ease up the ACR MRI accreditation test and the annual QC test process. To standardize and improve the accuracy of the test measurement. To generate the test report in timely fashion. This software tool is designed innovatively to combine the test measurement, the automatic feature analysis, the database, and the report generation into one easy-to-use package with self-explained interface. This software tool is aimed to make great impact in our MRI accreditation and QC testing works and to provide a future direction for the medical imaging accreditation and QC testing procedures conducted by medical physicists.

METHOD

The application contains four major modules: a database repository for recordkeeping and historical data tracking, an automated image analysis kernel, an automated report-generating tool, and a front-end graphical user interface. It is designed to handle the major physicist's tasks within the ACR MRI accreditation program (ACR MRAP): acceptance testing, annual system evaluation, and phantom testing for accreditation or renewal. All measurement processes, parameter calculations, decision criteria, and reporting formats rigorously follow the ACR specifications, described in the website package https://accreditationsupport.acr.org/support/solutions/articles/11000063276-complete-accreditation-information-mri. In the analysis module, the images are identified with a convolutional neural network (CNN) to address MRI scanner platform-specific dependencies (such as acquisition order and labeling). The measurements in images are processed using advanced image processing algorithms (e.g. shape features and ROIs). Parameters can be retrieved from the database and analyzed for trends. The software was developed on Matlab platform and compiled as a standalone program for PC and Mac systems.

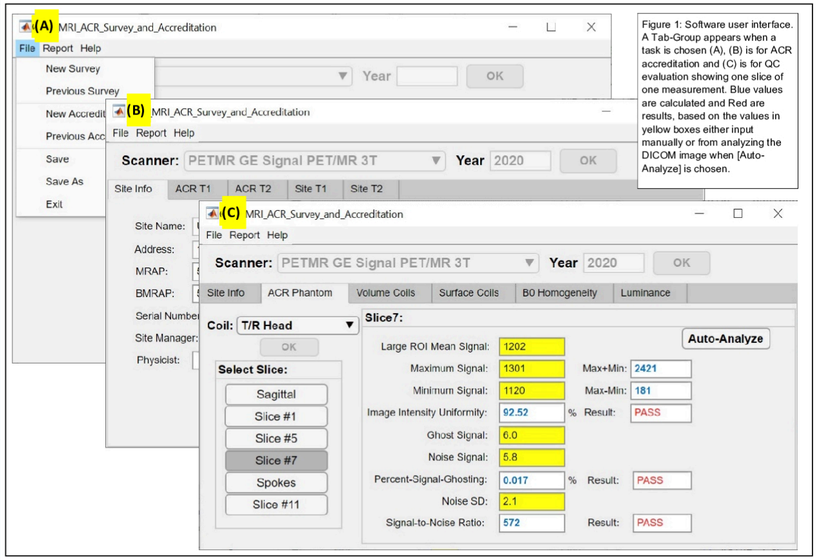

Figure 1: Software user interface. A Tab-Group appears when a task is chosen (A), (B) is for ACR accreditation and (C) is for QC evaluation showing one slice of one measurement. Blue values are calculated and Red are results, based on the values in yellow boxes either input manually or from analyzing the DICOM image when [Auto-Analyze] is chosen.

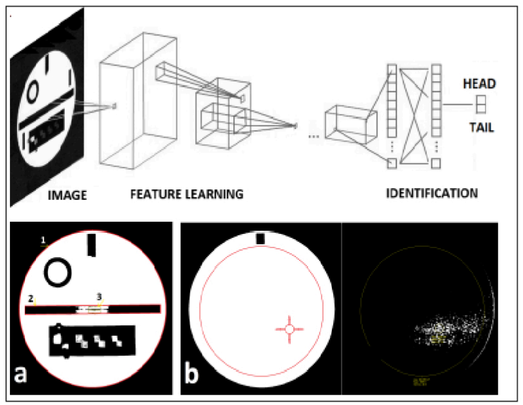

Figure 2. Top: Symbolic description of the CNN for identifying the order of the ACR phantom images. Bottom: Example of automatic image feature finding and ROI determination. (a) The slice #1 of the ACR phantom. The slice-position accuracy, slice-thickness accuracy, and geometry accuracy can be determined automatically. The final decision for the high contrast special resolution is still judged by human despite the automatic value is provided, so is for the low-contrast detectability from slice 8-11. (b) The slice #7 automatic analysis (also shown in Figure 1). The center and diameter of the large circle are found and the ROI is automatically determined. Two algorithms are used for maximum and minimum signal finding: (1) convoluting the image with a 1cm^2 area and max/min to find the max/min in the 1cm^2 ROI on un-convoluted image; (2) finding the max/min by scanning the 1cm^2 ROI within the large circle. The windowed image (c) can also be displayed as reference.

RESULTS

By using this software tool, the physicist's workflow becomes more convenient and better organized. Automated evaluation of ROI measurements is more consistent than manual one, mainly due to better consistency of ROI selection. The accuracy of measurements for Image-Intensity-Uniformity, Percent-Signal-Ghosting and Signal-to-Noise-Ratio is significantly improved. Reports generated using the software are standardized for all physicists and all MRI scanners within the entire medical system enterprise.

CONCLUSIONS

The software represents a significant improvement on data management and processing for routine physicist's tasks within the scope of the ACR MRAP.

REFERENCES

https://accreditationsupport.acr.org/support/solutions/articles/11000063276-complete-accreditation-information-mri

CONTACT INFORMATION

jxwang@uabmc.edu