Application for QIBA Project Funding

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| Title of Proposal: Development of a tool to evaluate software using artificial DCE-MRI data and statistical analysis | |
| QIBA Committee/Subgroup: MR / PDF-MRI | |
| NIBIB Task Number(s) which this project addresses: Task 3 | |
| **Project Coordinator or Lead Investigator Information:** | |

| Last Name: Laue | First Name: Hendrik | Degree(s):PhD |
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| Institution/Company: Fraunhofer MEVIS, Bremen, Germany | | |
| Amount Requested: | | |

Please check the primary category for this proposal from among the following:

- ☑ 1. Identification of Technical Characteristics and Standards

    - ☑ a. Creation and refinement of protocols for image acquisition, analysis, quality control, etc., for specific clinical utility

    - ☐ b. Phantom development and testing

    - ☐ c. Identification and assessment of intra-reader bias (1) and variance across scanners and centers

    - ☐ d. Identification and assessment of inter-reader bias and variance across scanners and centers

    - ☐ e. Other

- ☐ 2. Clinical Performance Groundwork

    - ☐ a. Assessment of intra-reader sensitivity and specificity
    - ☐ b. Assessment of inter-reader sensitivity and specificity
    - ☐ c. Other

- ☐ 3. Clinical Efficacy Groundwork

    - ☐ a. Assessment of correlation between new biomarker and äaccepted-as-standardí method
    - ☐ b. Characterization of value in clinical trials
    - ☐ c. Characterization of value in clinical practice
    - ☐ d. Development/merger of databases from trials in support of qualification
    - ☐ e. Other

- ☑ 4. Resources (money and/or people) committed from other sources.

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    | Open Source Software Python (www.pyhton.org), numPy (matplotlib.sourceforge.net), matPlotLib (matplotlib.sourceforge.net), pydicom (code.google.com/p/pydicom) <br> Artificial DCE-MRI data from Duke Medical Center <br> Resulting parameter maps of DCE-MRI analysis from available tools |

**Please provide a one-page summary that includes the following information:**

Project Description

Artificial data based on underlying pharmacokinetics and MR physics allows for the evaluation of the accuracy and performance of complex analysis software for dynamic contrast enhanced (DCE-) MRI and similar measurement techniques, such as diffusion weighted imaging (DWI) and native T1 mapping. Besides the creation of test data, it is important to evaluate and compare the results from the different software packages tested. This is especially relevant since the results will most likely show deviations, even for more or less identical implementations, resulting from the underlying numerics and differing initial values. Consequently, it is not sufficient to simply compare the equality of parameter maps: a statistical comparison is needed, and we propose to build a tool to compare the results of parameter maps from different software packages with the reference parameter maps from the test data.
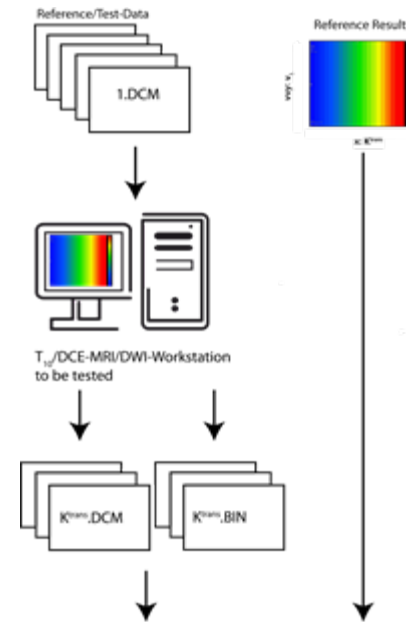
Therefore, we will provide a tool to compare results from software packages with the original artificial data using visualization of differences and statistical analysis.

The application will provide two different comparison methods:

1. Color-coded **difference/ratio maps** of result and simulated data.
2. **Histograms**, **scatter-diagrams** and **box-plots** between original and calculated parameters to allow a visual estimation of parameter differences and relations.
3. **Statistical comparison of parameters**
   a. Student's t-test, Mann-Whitney-U test
   b. Pearson and Spearman Rank Correlation to confirm linear dependency.
   c. Covariance analysis for all parameters.
   d. Principle component analysis between all parameters.
   e. Least square linear and logarithmic model to identify linear constant variations for the algorithms, e.g., usage large and small vessel hematocrit, tumor T1.
   f. Analysis of Variance (ANOVA).
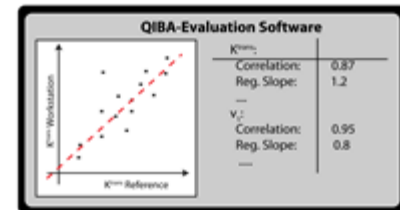
The list of statistical methods is strongly depended on the incoming type of data and will be adapted to the requirements, if necessary.

The software will be build using the open source development environment Python, using the (also open source) extensions numPy, matPlotLib, and pyDicom.

Primary goals and objectives:

Deliverables

The primary deliverable is a software platform that will allow one to:

1. Import 2D/3D-Dicom, binary, and image format data from DCE-MRI analysis-tools.
2. Create difference and ratio maps of result and reference map.
3. Create scatter diagrams, box plots and correlations analysis of parameters.
4. Implement ANOVA, and linear and a logarithmic model to compare the results quantitatively.

5.      Create PDF and Excel reports to document the comparison.

Timeline [must include intermediate measureable milestones.]:
The import function should be available after month two after project start.  There might be some additional work to be done in case of new data formats.  Difference and Ratio Maps and a first graphical user interface should be available after month four.  With the beginning of month six, the scatter diagrams and the correlation analysis should be available.   At end of month six, the linear and logarithmic modeling will be available.  The export of PDFs and Excel files will be available after month 8.  In month 9, the software will undergo the final testing.