

MRI Analysis Calculator Plugin

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The MRI Analysis Calculator is a plugin for the ImageJ framework designed for use with MRI data.

The MRI Analysis Calculator plugin provides a platform independent, zero cost solution for taking T1, T2, Perfusion and Diffusion calculations from MR data.

The software was produced in the HypX laboratory by the author and company. All feedback is welcome, please contact the author at will (kfschmidt@bwh.harvard.edu).

Release 1.0 features:

- Pixelwise T1 calculation on 2 or more slices using simplex algorithm for fit
- Pixelwise T2 calculation on 2 or more slices using simplex algorithm for fit
- Pixelwise Perfusion calculation on a T1 stack & ASL (Arterial Spin Labeled) stack
- Pixelwise ADC (Apparent Diffusion Coefficient) calculation on 2 or more slices
- Generate pixelwise R^2 image illustrating fit quality for verification purposes

1.0 Getting Started

1.1 SYSTEM REQUIREMENTS & RELEASE NOTES

- The MRI Analysis Calculator was developed under Java 1.4 and ImageJ 1.27z, although Java 1.4 may not be required to run this plugin, it is recommended
- The samples shown here all use Bruker data which is imported as RAW, 32 or 16 bit integer greyscale data; the plugin should work on any
- Development occurred on a PII 400 with 128MB RAM, performance should be acceptable on platforms with this

1.2 INSTALLATION

Install the JRE 1.4

If you do not have a recent version of Java installed on your system, download and install the JRE from www.javasoft.com.

Install ImageJ

Download and install ImageJ as described on the ImageJ website:

<http://rsb.info.nih.gov/ij/>

The directory under which you install ImageJ will be referred to as %IMAGEJ_HOME% in the remainder of this document.

Installing the MRI Analysis Calculator plugin

The plugin is archived in Zip and jar file format.

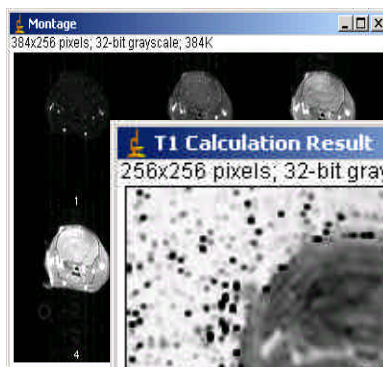
Unzip or unjar and copy the contents of the plugin folder to the plugin folder located in %IMAGEJ_HOME%.

Verify that the plugin are installed by starting ImageJ. You should see the MRI Analysis Calculator in the Plugins drop down menu.

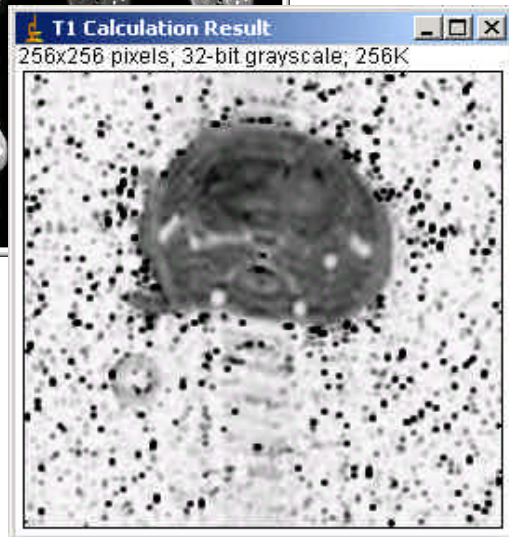
2.0 Quick Tour

The MRI Analysis Calculator is designed to perform T1, T2 Perfusion and Diffusion measurements on raw MR scan data.

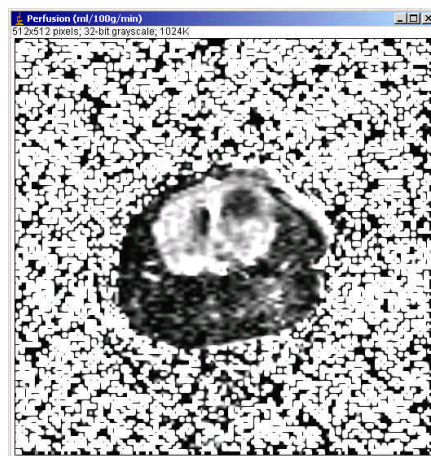
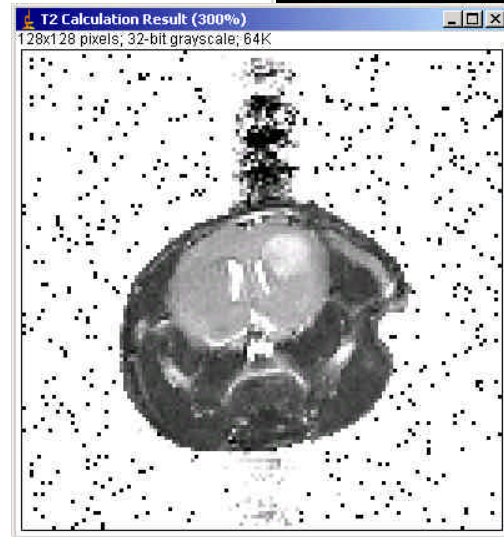
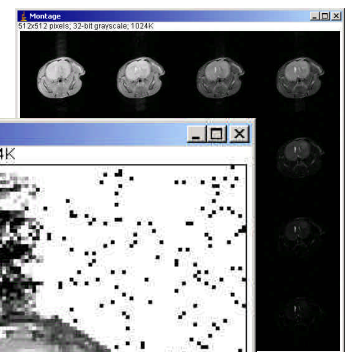
The measurements are performed on a pixelwise basis, on stacks of two or more slices. In most cases the associated R2 image, reflecting the fit quality at each pixel can also be produced during a calculation.



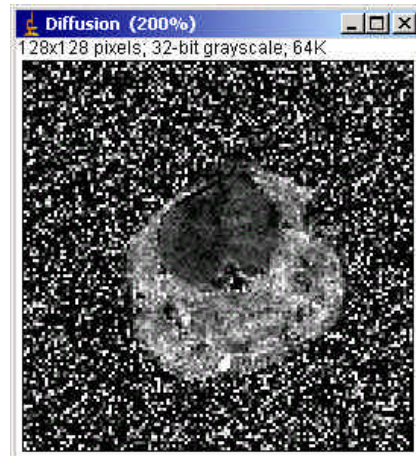
T1 Measurement
from 6 image stack



T2 Measurement
from 16 image stack



Perfusion image from ASL & T1 stack



Diffusion image

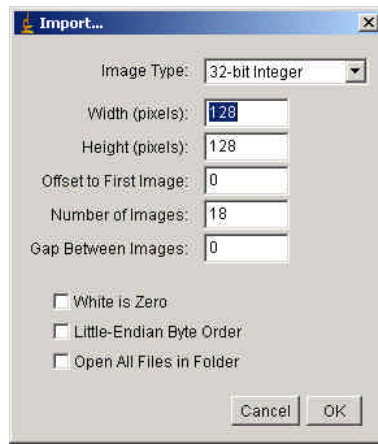
3.0 Loading Bruker MR Data

This section is specific to loading Bruker formatted MR data (2dseq files) but should be instructive in loading other formats as well.

LOADING BRUKER IMAGE STACKS

Open the T1 stack in ImageJ

File -> Import -> Raw -> ../bruker_sample_data/
T1_stack_subj01



The HypX group typically captures images with the following resolution:

- width: 128
- height: 128
- Data Type: 32 bit signed int (T1, T2, ASL) or 16 bit signed int (Diffusion)

Set the number of images to be larger than the max number of images in the stack (e.g. 20)

4.0 *Generating T1, T2, Perfusion & Diffusion Images*

The perfusion image calculation requires a T1 stack as well as an ASL (Arterial Spin Labeled) stack of two images for calculation.

T1, T2 & Diffusion curve fitting is implemented using a modified Simplex algorithm based on the class **ij.measure.CurveFitter**, and can complete the T1 calculation shown above (128x128x6 slices) in about 15 secs on modest hardware.

NOTE The diffusion calculation is not fully implemented - use at your own risk!

4.1 PERFUSION CALCULATION EXAMPLE

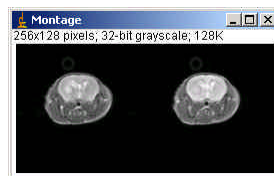
The following is a step by step example of a perfusion calculation using the sample data provided in the zip archive.

The details of steps 1 are specific to the type of data loaded. Here we use Bruker formatted data (2dseq files).

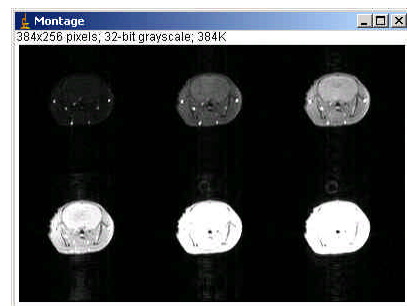
Once loaded as greyscale images, the MRI Analysis Calculator should function on any MR data. (Please send me verification or notification of problems if you attempt to use other data: kfschmidt@bwh.harvard.edu).

STEP 1

Load the ASL image stack & load the T1 image stack



Arterial Spin Labeled
Stack (2 images)



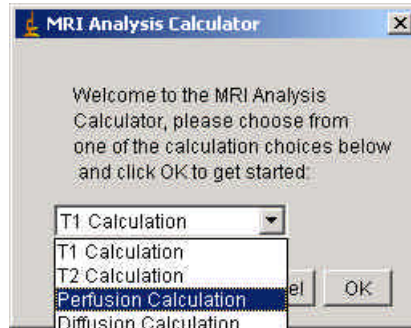
T1 Stack (6 images)

STEP 2 (OPTIONAL)

Use the Image Layering Toolbox plugin to check that the ASL and T1 images are correctly aligned.

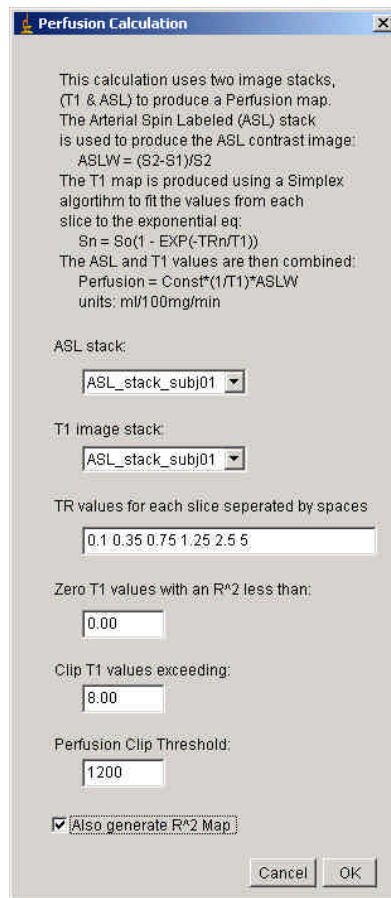
STEP 3

Start the MRI Analysis Calculator plugin and select the Perfusion calculation option.



STEP 4

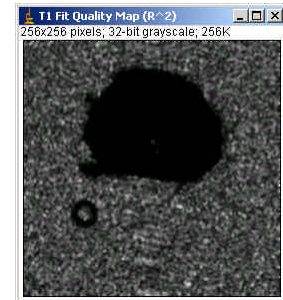
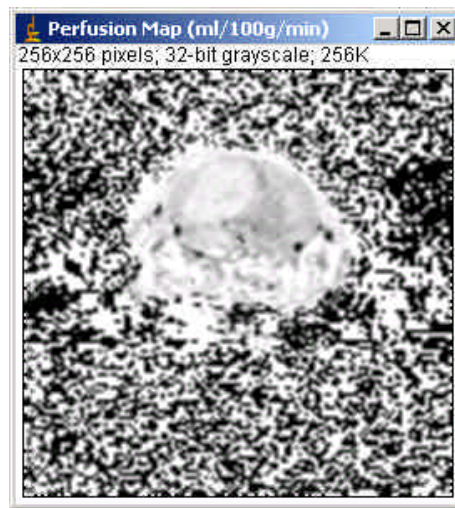
Fill in the appropriate fields and select OK to generate the perfusion map:



Notes on parameters:

- TR values for the T1 stack are in seconds, and separated by spaces
- T1 Clip and Perfusion threshold values are supplied to retain contrast through the range of interest, change them as you see fit
- The “Also generate R² map” option will open a second window illustrating the fit quality of each pixel as the R² value
- Click OK to generate the Perfusion image, typical rendering time for 128x128x6 T1 images is about 20s

**PERFUSION CALCULATION
RESULT**



R² map showing T1
fit quality by pixel