pvmatlab

MATLAB package for handling ParaVision data

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1 Introduction

The pvmatlab package is a collection of tools for Bruker users who wish to use MATLAB for processing ParaVision raw data, for performing basic image reconstruction of Cartesian k-space data and for importing/exporting ParaVision images.

To get started, it is recommend to read at least section 2.2 (Installation) and to work through chapter 3 (Quick start), which addresses the most common functions of pvmatlab using a test data set included in the package.

Chapters 4 to 6 are dedicated to a somewhat more detailed description of the structure of pvmatlab, its functions and conventions. Some common warnings and error messages and what to do about them are listed in chapter 7.

A word of caution: pvmatlab is distributed 'as is' without any warranty and without any claim of being bug-free or complete. The output produced by pvmatlab should always be checked thoroughly, otherwise the results based on it might be wrong or meaningless.

Bruker does not provide customer support for pvmatlab like for a regular product and does not service the package regularly. However, if you notice bugs or malfunctions you may get a fix and also help other users of pvmatlab by notifying Bruker software support (see chapter 8).

The pvmatlab package is provided for non-commercial use only, at your Bruker client site, and may not be modified or redistributed to other institutions. Requests for pvmatlab can be made via email at: mri-software-support@bruker.com. See also chapter 10.

2 Requirements and Installation

2.1 System requirements

As pvmatlab is a collection of MATLAB functions, the minimum system requirements are determined by MATLAB (see http://www.mathworks.de/support/sysreq/). MATLAB is available for Windows, Linux and Mac platforms, therefore pvmatlab can be run on all these platforms, however, it has only been tested on Linux.

A basic MATLAB installation, release R2008a or later, is required. Earlier releases do not support the object oriented code used in pvmatlab. No additional MATLAB toolboxes are needed. However, the core functions of pvmatlab could be used with earlier MATLAB releases or with Octave 3.6 or later, see chapter 6.

Data sets generated by ParaVision version 4.0 up to ParaVision 360 V2.0 have been tested, but data acquired with different versions of ParaVision may work, too.

If large data sets need to be processed, additional memory requirements can be estimated as follows: For each double precision complex value of raw data, 16 bytes of memory are needed. For example, a 3D raw data set with a matrix size of 256 x 256 x 256, acquired with a four-channel receive array and four repetitions uses

4 GB of memory. Reducing the data precision to “single” (see chapter 5), will bring the additional memory requirement down to 2 GB. During the processing, copies of the data need to be made, so the recommended additional RAM size is two times the required memory for the biggest raw data set, at the very least.

If the memory requirements exceed the available RAM, MATLAB will use swap space on the file system which will slow down data processing considerably. Exceeding the swap capacity will cause MATLAB to stop with an “out of memory” error.

2.2 Installation

1. Extract the archive pvmatlab.tar.gz into a folder of your choice. For example copy pvmatlab.tar.gz to the MATLAB working folder `/home/nmrsu/matlab`, and run

   ```
   [nmrsu@host matlab]$ tar xvzf pvmatlab.tar.gz
   ```

   By extracting the archive, the subfolder `pvtools` will be created. This path will be referred to as “the pvmatlab folder” in the following, for this example it reads `/home/nmrsu/matlab/pvtools`.

2. Add the pvmatlab folder including its subfolders to the MATLAB path:

   For adding the paths permanently, use the MATLAB command

   ```
   >> pathtool
   ```

   Select “Add with Subfolders”, choose the pvmatlab folder and then select “Save”.

   For adding the pvmatlab folder only temporarily, run

   ```
   >> addBrukerPaths
   ```

   or include the command inside MATLAB scripts that use pvmatlab functions.

3. For information about the installed version of pvmatlab use

   ```
   >> bruker_version
   ```

This completes the installation of pvmatlab. The file pvmatlab.tar.gz can be deleted or moved to a different location.

3 Quick start

In this chapter, the main functions are presented as one would typically use them. With the MATLAB script `BrukerExample.m` provided in the pvmatlab folder, the steps of this quick start guide can be reproduced in MATLAB. A sample data set of a kiwi is used in these examples, which is also contained in the pvmatlab folder.

1. Launch MATLAB and change into the pvmatlab folder

2. In the Command Window run

   ```
   >> edit BrukerExample
   ```

   MATLAB will open the example script.

3. Initialization of paths

   Evaluate the initialization cell with <Ctrl+Enter>. This code sets the paths to the pvmatlab functions and to the test data set:

   ```
   addBrukerPaths;
   baseDir = fileparts(mfilename('fullpath'));
   pathTestData = fullfile(baseDir,'TestData/2/pdata/1');
   ```

4. Importing raw data

   The next set of commands demonstrates how raw data are imported into a raw data object (for more details concerning objects see chapter 5):

   ```
   rawObj = RawDataObject(pathTestData);
   numSlices = rawObj.Acqp.NI;
   plot(real(rawObj.data{1}(1,:,319)));
   ```

   The raw data of experiment number 2 can now be accessed (in this example by plotting echo number 319) as well as the associated method and acquisition parameters (in this example the number of images, Acqp.NI)

5. Preparing image reconstruction

   Before the raw data can be reconstructed, they need to be sorted into k-space correctly. This is done by creating and initializing a `CKDataObject`. Also, the reco parameters need to be read from disk:

   ```
   kdataObj = CKDataObject(pathTestData);
   kdataObj = kdataObj.readReco;
   ```

6. Reconstructing images from Cartesian k-space

   The k-space object provides a reconstruction method `.reco` that operates on the raw data it has been initialized with and creates an image object as output. Both objects provide a viewer to visualize the k-space data and the image, respectively:

   ```
   kdataObj.viewer;
   imageObj = kdataObj.reco('all', 'image');
   imageObj.viewer;
   ```

7. Importing / Exporting ParaVision images

   The image object can also be used to import images created by the ParaVision reconstruction pipeline:

   ```
   imageObj = ImageDataObject(pathTestData);
   imageObj.viewer;
   ```

   For exporting an image, the path must be specified and visualization parameters need to be generated. Then the writeImage routine can be called:

   ```
   imageObj = imageObj.setDataPath('imagewrite','export/2/pdata/1');
   imageObj = imageObj.genExportVisu('genmode','auto');
   imageObj.writeImage;
   ```

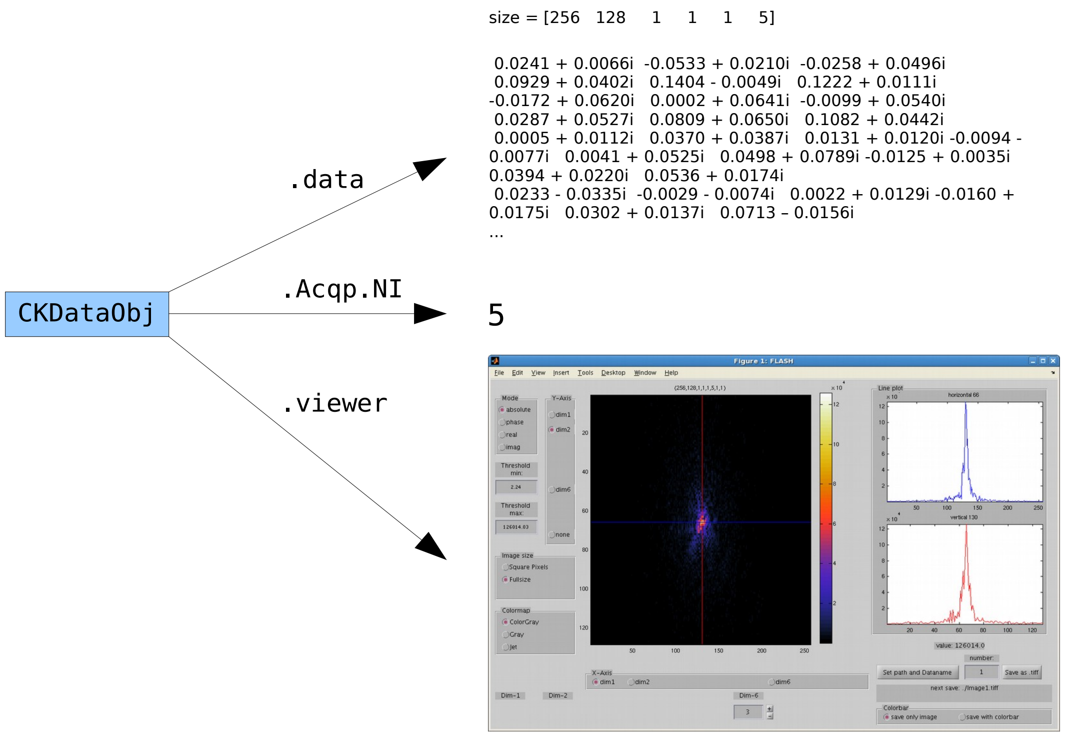
   pvmatlab will then generate a subfolder in the `export` folder, named <subjectID>_<studyID> followed by the specified expno/pdata/procno. In this case the image (`2dseq`) and visu parameters (`visu_pars`) are exported to `export/Kiwi_pvmatlab/2/pdata/1/`

4 Overview

This chapter contains a brief overview of how the pvmatlab package is organized and how it interacts with the ParaVision data structure. Effectively, pvmatlab translates the ParaVision data stored in the file system into MATLAB objects and vice versa.

4.1 Data objects

The MATLAB components handling the raw data and image data are implemented as objects. Apart from the actual data, an object can contain additional information about the data (acquisition parameters, method parameters, etc.). In addition, the object contains matlab code (“methods”) working with its data, e. g., an import routine and a data viewer.



```
size = [256   128    1    1    1    5]

 0.0241 + 0.0066i  -0.0533 + 0.0210i  -0.0258 + 0.0496i
 0.0929 + 0.0402i   0.1404 - 0.0049i   0.1222 + 0.0111i
-0.0172 + 0.0620i   0.0002 + 0.0641i  -0.0099 + 0.0540i
 0.0287 + 0.0527i   0.0809 + 0.0650i   0.1082 + 0.0442i
 0.0005 + 0.0112i   0.0370 + 0.0387i   0.0131 + 0.0120i -0.0094 -
0.0077i   0.0041 + 0.0525i   0.0498 + 0.0789i -0.0125 + 0.0035i
0.0394 + 0.0220i   0.0536 + 0.0174i
 0.0233 - 0.0335i  -0.0029 - 0.0074i   0.0022 + 0.0129i -0.0160 +
0.0175i   0.0302 + 0.0137i   0.0713 – 0.0156i
...
```

There are three types of raw data objects, “RawDataObject”, “FrameDataObject” and “CKDataObject” and one image object, “ImageObject”.

4.2 File structure

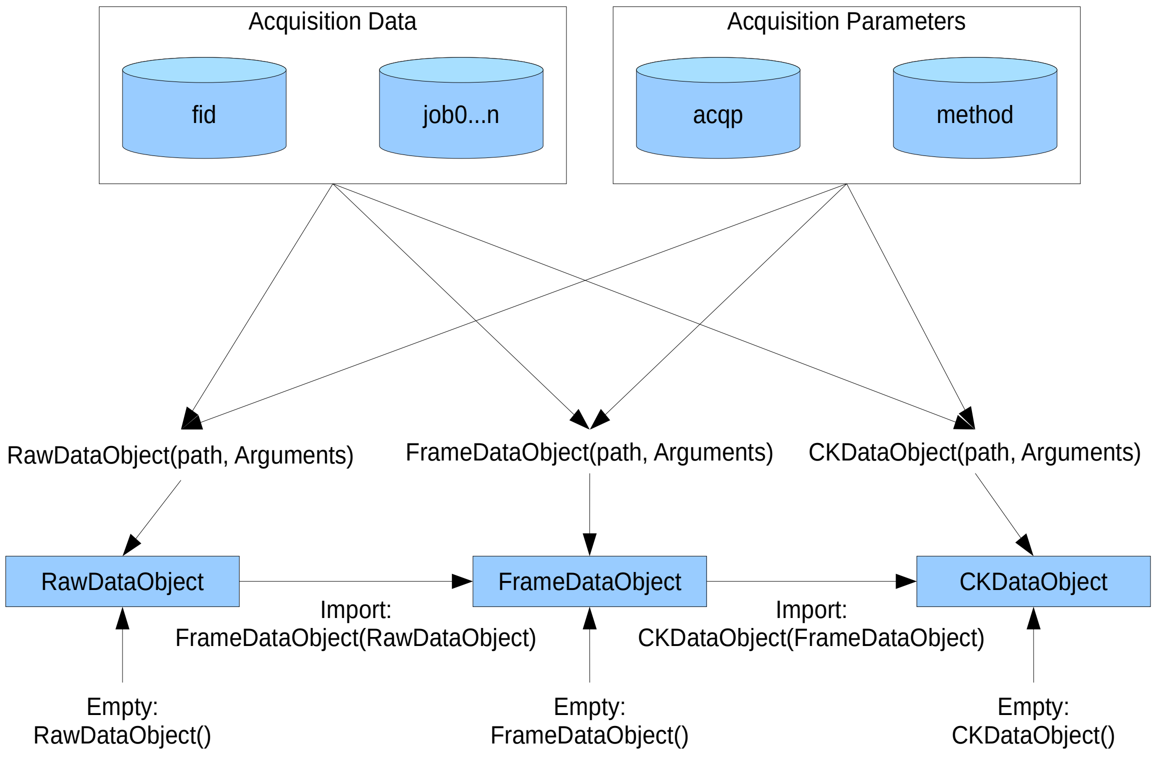
ParaVision stores all data associated with an MR experiment in a file system tree. Each study (with raw data, image data, parameters) is stored in a separate folder (for example `/opt/PV5.1/data/nmrsu/nmr/TestData`) and can be copied to any other location for processing with MATLAB.

There are binary files containing the actual raw or image data, and parameter files in text format, containing all necessary parameters to interpret the binary data. For a detailed description of all parameters please refer to the ParaVision manual. A small selection of parameters most relevant to pvmatlab is given in section 9.1.

The files that are relevant for pvmatlab can be found in the following locations in the ParaVision data tree:

TestData/	study folder	
↳ subject	subject parameters	text
2/	folder for each experiment (expno)	
↳ acqp	acquisition parameters	text
fid	acquired raw data	binary
rawdata.job0, .job1, ...	acquired raw data	binary
method	method parameters	text
pdata/	folder for processed data	
↳ 1/	folder for processed data set (procno)	text
↳ 2dseq	reconstructed image	binary
reco	reconstruction parameters	text
visu_pars	visualization parameters	text

The following sketch shows how the data objects and files depend on each other:



For example, a FrameDataObject can be created from an fid file and an acqp parameter file, and a CKDataObject can then be created from this FrameDataObject by calling

```
frameObj = FrameDataObject(pathTestData);
kdataObj = CKDataObject(frameObj);
```

5 Data objects

Usually, the data objects can be used as described in chapter 3. In that case, they automatically take care of setting paths, reading the parameter files and then loading the data. This chapter briefly describes the variables and routines of the data objects in case you would like to control this process manually.

5.1 Common properties and methods

The data objects “RawDataObject”, “FrameDataObject”, “CKDataObject” and “ImageObject” have common fields (properties), and matlab code (methods) to contain and load data and parameters. These are

property	method	responsible for
Filespath	setDataPath	Paths to parameter and data files
Acqp	readAcqp	Acquisition parameters
Method	readMethod	Method parameters
Visu	readVisu	Visualization parameters
Reco	readReco	Reconstruction parameters
Subject	readSubject	Subject parameters
HeaderInformation	-	-
-	setPrecision	Internal representation of data
data	specific, see sections 5.2-5.5	Actual data

For example, after creation of an object anyObj, the function

```
myObj = myObj.setDataPath('auto','/home/nmrsu/TestData/2/pdata/1');
```

will set the paths to all parameter files automatically. With the command

```
myObj = myObj.setDataPath('acqp','/home/nmrsu/myacqp');
```

only the acqp path is set. The property Filespath.path_to_acqp then contains '/home/nmrsu/myacqp', the other paths are empty. A subsequent call of readAcqp

```
myObj = myObj.readAcqp;
```

will result in “myacqp” to be read to `myObj.Acqp` instead of the acqp file created by ParaVision in the expno folder. Other parameter structs in `myObj` remain unchanged.

All objects also provide a function for setting the precision of the data. In case memory is a limitation, consider setting the precision to 'single' (8 bytes per complex data point instead of 16 bytes) on initializing. Default is 'double'.

```
myObj = RawDataObject(pathTestData, 'dataPrecision', 'single' );
```

To reduce the precision of an existing object, use:

```
myObj = myObj.setPrecision('single');
```

5.2 Raw data object

The RawDataObject represents the original raw data as an unsorted sequence of acquired scans of length ScanSize. The data from an fid or job file is stored in a matrix with dimensions

Raw data sizes
(numReceiveChannels, ScanSize, numScansPerChannel)

These matrices are stored in the data property in a 1D Cell-Array.

The following code creates a raw data object, sets the paths to the parameter files and to the fid file, reads the acquisition parameters and calls the specific method “readRaw” to load the raw data:

```
rawObj = RawDataObject;
rawObj = rawObj.setDataPath('auto','/home/nmrsu/TestData/2');
rawObj = rawObj.readAcqp;
rawObj = rawObj.readRaw;
```

The fid data matrix is now located in `myRawObj.data{1}`.

For a minimum set of acqp parameters required for loading raw data see section 9.2.

5.3 Frame data object

The FrameDataObject represents the raw data as a set of frames, i. e., the data are put into an imaging context. For converting data from a RawDataObject into frames, more acquisition parameters are required, namely the ACQ_dim, ACQ_phase_factor, and ACQ_obj_order. Based on these parameters, the scans are sorted into separate objects (e. g. slices), and reordered in case the acquisition was interleaved. The resulting data matrix reflects this structure and the number of repetitions:

Frame data sizes
(ScanSize, numScansPerFrame, numReceiveChannels, numObjects, numRepetitions)

A FrameDataObject can be generated from a RawDataObject

```
frameObj = FrameDataObject(rawObj);
```

or directly from disk

```
frameObj = FrameDataObject('/home/nmrsu/TestData/2');
```

5.4 Cartesian k-space data object

The CKDataObject represents the raw data in Cartesian k-space according to the encoding scheme used in the acquisition method. For converting data from a FrameDataObject into k-space, method parameters are required, namely 'PVM_Matrix', 'PVM_EncSteps1', and, for 3D, 'PVM_EncSteps2'. Currently, the methods RARE, FLASH, MSME and FISP are supported. The sizes of the data matrix are:

Cartesian k-space sizes
(dim1, dim2, dim3, dim4, numReceiveChannels, numObjects, numRepetitions)

A CKDataObject can be created directly from disk as described in chapter 3 or from a FrameDataObject

```
kdataObj = CKDataObject(frameObj);
```

The CKDataObject provides a viewer method (`.viewer`) to display the k-space data in a MATLAB figure, and a `.reco` method to perform basic Fourier reconstruction. The reconstruction requires a set of parameters in the Reco property.

Usage of `.reco` method

```
outObj = kdataObj.reco(recopart,
             ['image'], ['RECO_Parametername',ParameterValue], ...);
```

Input (optional in square brackets)

recopart	A string or cell array of strings of reconstruction steps to perform. 'all' = {'quadrature', 'phase_rotate', 'zero_filling', 'FT', 'sumOfSquares', 'transposition'}
'image'	If given, outObj is of type ImageObject (see section 5.5)
'RECO_Parametername', ParameterValue	Additional reconstruction parameters

Output

outObj	A CKDataObject, in which the specified recoparts have been performed on the data. If the argument 'image' is provided, outObj is an ImageObject

Example

```
kdataObj = kdataObj.setDataPath('reco','TestData/2/pdata/1/reco');
kdataObj = kdataObj.readReco;
imageObj = kdataObj.reco('all','image');
```

5.5 Image data object

The ImageObject contains a set of reconstructed images in its “data” property, which can be created by reconstructing k-space data of a CKDataObject (see section 5.4), or by loading images reconstructed by ParaVision (see chapter 3). In the latter case, the data representation as frame groups is read from the visu_pars parameter file. The sizes of the image matrix in the `data` property are:

Image sizes
(dim1, dim2, dim3, dim4, FrameGroupDim1, FrameGroupDim2, ...)

The ImageObject provides a viewer method (`.viewer`) to display the images in a MATLAB figure, and a `.writeImage` method to write the image data into the ParaVision files 2dseq and visu_pars.

For writing images to the disk, a path needs to be set by calling `.setDataPath`

```
imageObj = imageObj.setDataPath('imagewrite', 'export/2/pdata/1');
```

Note: The target folder will not be the exact path specified to setDataPath, but a folder “<subjectID>_<studyID>” based on the subject and study parameters will be created above the expno folder. For example, with subjectID “Kiwi” and studyID “pvmatlab”, the target folder is `export/Kiwi_pvmatlab/2/pdata/1`

In addition, a valid set of visu parameters in the `exportVisu` property of the ImageObject is required, which can be generated via

```
imageObj = imageObj.genExportVisu('genmode',genmode,
                                   ['TemplatePath',path]);
```

Input (optional in square brackets)

genmode	Parameter source for generating the exportVisu struct. Options:'Visu', 'Template', 'Subject', 'auto', default is 'auto'.
'TemplatePath', path	Path to a visu template file. Default is expno/visu_pars

The exportVisu parameters are based on the structure of `data` and on all available parameter structs (genmode 'auto') or on the parameter source specified in genmode.

Alternatively, the Visu parameters can be set manually using `.setExportVisu`

```
imageObj = imageObj.setExportVisu(parameterName,parameterValue);
```

To clear all or one specific parameter, use

```
imageObj = imageObj.setExportVisu('all','clear');
imageObj = imageObj.setExportVisu(parameterName,'clear');
```

With the path and visu parameters set, the image data can be exported by calling

```
imageObj.writeImage;
```

6 Core data handling functions

This chapter lists the core functions of pvmatlab that are used by the methods of the data objects. They can also be used on their own and do not require object support, therefore these functions also work with MATLAB releases earlier than R2008a and possibly also with Octave.

6.1 readBrukerParamFile

Reads Bruker JCAMP parameter files (subject, acqp, method, reco, visu_pars) into a struct.

Usage

```
paramStruct = readBrukerParamFile(filename,updateWithOutputFiles);
```

Input

filename	Full path and name of the parameter file
updateWithOutputFiles	[optional] If false, only read the parameter file as specified, do not try to update parameters by interpreting any accompanying .out result file. The default is true.

Output

paramStruct	Structure containing parameter variables. The parameter names are derived from the JCAMP tags.

Example

```
Acqp = readBrukerParamFile('TestData/2/acqp');
```

Please note: Starting from ParaVision 360 V2.1, all parameter files may have an accompanying result / output parameter file. For example, next to the acqp file, a file called acqp.out may be present. Parameters from the result / output parameter files always take precedence over the values stored in the original parameter file. The readBrukerParamFile function implicitly reads the result / output file (if present) and updates the parameters accordingly. Set the updateWithOutputFiles argument to false to skip reading the output file. To switch off output files globally, e.g. when using the data objects, set updateWithOutputFiles=false in the base workspace.

6.2 readBrukerRaw

Reads Bruker raw data (fid or rawdata.job*) into a matrix or cell array of matrices.

Usage

```
data = readBrukerRaw(Acqp, path_to_dataFile,
                        ['specified_NRs', NR_array],
                        ['specified_Jobs', job_array],
                        ['precision', precision_str]);
```

Input arguments (optional in square brackets)

Acqp	An acqp struct as generated by the function readBrukerParamFile('path/acqp')
path_to_dataFile	Full path and name (fid/rawdata.job0) of the raw data file
'specified_NRs', NR_array	A list of repetitions to be read, starting with 1, when using a standard fid file
'specified_Jobs', job_array	A list of jobs to read, the first job being job number 0. If only the fid-file should be read use 'specified_Jobs',[-1]
'precision', precision_string	Precision of the imported data: 'single' or 'double'. Single precision uses 4 bytes to represent a (real) floating point number, 'double' uses 8 bytes. Default is 'double'.

Output

data	• If path_to_dataFile contains only an fid file, or an fid file plus job files and 'specified_Jobs' is set to [-1], data is a cell with a 3D matrix of size (numChannels, ScanSize, numScans) • If path_to_dataFile contains job files, data is a cell array with {job0, job1, job2, ...}, in which job* are 3D matrices of size (numChannels, ScanSize, numScans)

Example

```
data = readBrukerRaw(Acqp,'TestData/2/fid','precision','single');
```

6.3 readBruker2dseq

Reads Bruker images (2dseq files) into a matrix

Usage

```
image = readBruker2dseq(path_to_2dseq, Visu,
                  ['imageType', ForceType],['dim5_n', DimArray]);
```

Input arguments (optional in square brackets)

path_to_2dseq	Full path and name of the 2dseq image file
Visu	A visu struct as generated by the function readBrukerParamFile('path/visu_pars')
'imageType', ForceType	Force image type to be 'complex' or 'real'. Default is 'auto', which reads the image type from the visu parameters
'dim5_n', DimArray	Increase output dimensionality. Normally all frames are indexed in the 5th dimension. dim5_n expands the 5th dimension, e. g., with 24 visuFrames: 'dim5_n', [3 4 2]

Output

image	complex or real image matrix with dimensions (dim1, dim2, dim3, dim4, dimVisuFrame). With 'dim5_n' option, the dimensions are (dim1, dim2, dim3, dim4, dim5_n(1), dim5_n(2), dim5_n(3), ...)

6.4 convertRawToFrame

Sorts the scans read by readBrukerRaw into frames

Usage

```
frame = convertRawToFrame(data, Acqp, ['specified_NRs', NRarray]);
```

Input arguments (optional in square brackets)

data	A raw data matrix (fid/rawdata.job*), as read by the function ReadBrukerRaw. Make sure it is not a cell or cell array.
Acqp	An acqp struct as generated by the function readBrukerParamFile('path/acqp')
'specified_NRs', NRarray	A list of repetitions to be converted.

Output

frame	5D frame matrix with size (ScanSize, numScansPerFrame, numReceiveChannels, numObjects, numRepetitions)

6.5 convertFrameToCKData

Sorts the frames generated by convertRawToFrame into a k-space matrix. The methods currently supported are RARE, FLASH, MSME and FISP.

Usage

```
ckdata = convertFrameToCKData(frame, Acqp, Method,
              ['specified_NRs', NRarray], ['useMethod',useMethod]);
```

Input arguments (optional in square brackets)

frame	Frame data as generated by convertRawToFrame
Acqp	An acqp struct as generated by the function readBrukerParamFile('path/acqp')
Method	A method struct as generated by the function readBrukerParamFile('path/method') . This input is only required if useMethod is true
'specified_NRs', NRarray	A list of repetitions to be converted.

useMethod	Indicates if parameters from the method file should be used. Default is true.

Output

ckdata	7D matrix with Cartesian k-space data, with dimensions (dim1,dim2,dim3,dim4,numChannels,numObjects,numRepetitions)

For more functions see

```
>> doc Contents
```

and the MATLAB source code documentation.

7 Warnings and Error messages

- Warning: Template can't be read. Proceeding without template

  During image export, the method ImageDataObject.writeImage tries to read a template visu parameter file in the expno path. If there is none, the remaining parameter files are used to generate the visu parameters.

- Warning: You are using an unsupported acquisition method. Most probably your result will be incorrect.

  This warning occurs during conversion of frame data k-space data for methods other than RARE, MSME, FLASH, FISP. Check results carefully!

- Cannot open parameter file. Problem opening file /opt/PV5.1/.../visu_pars

  A set of parameters is required for the operation but the parameter file is missing.

- Warning: It's recommended to read the reco-file first. ??? Reference to non-existent field 'RECO_transposition'.

  For running the CKDataObject.reco function, a set of reco parameters is needed. Either call kdataObj.readReco to read an existing reco parameter file, or specify the kdataObj.Reco structure yourself.

8 Feedback

If you notice a problem with a pvmatlab function that is not addressed in this manual, you should first make sure that the problem persists after reinstalling pvmatlab (see section 2.2) and is thus not caused by any adaption of the pvmatlab code.

If this is the case, verify that the problem is reproducible and send an email with a description of the issue to the software support (mri-software-support@bruker.com), including

- Circumstances in which the malfunction occurs
- Computer platform, ParaVision version, MATLAB version
- Exact contents of error messages (if any)
- Anything else that could help reproduce the problem, e. g. sample data or saved MATLAB workspace. Attachments should be smaller than 10 MB, send larger files only when Bruker software support requests them.

9 Appendix

9.1 Some important parameters

Parameter name	In file	Description
ACQ_method	acqp	Name of the acquisition method e. g. RARE, FLASH
ACQ_dim	acqp	Acquisition dimension, 1D / 2D / 3D
ACQ_size	acqp	Dimensions of each object, e. g. [128 128 64] for 3D
NI	acqp	Number of objects (slices)
NR	acqp	Number of repetitions
ACQ_obj_order	acqp	Order in which the objects are measured
ACQ_jobs	acqp	Size of each job and more
ACQ_jobs_size	acqp	Number of jobs
PVM_Matrix	method	Dimension of encoding matrix
PVM_EncSteps1	method	Phase encoding steps
PVM_EncSteps2	method	Phase encodings in second phase encoding direction (3D)
VisuCoreFrameType	visu_pars	Type of the image: complex / real
VisuFGOrderDesc	visu_pars	Contains the FrameGroup dimensions
VisuCoreDim	visu_pars	Image dimension 1D / 2D / 3D
VisuCoreSize	visu_pars	Dimensions of each visuFrame e.g. [128 128 64] in 3D
VisuCoreFrameCount	visu_pars	Number of visuFrames in one data set.
VisuCoreDataSlope	visu_pars	Scaling factor of image data
VisuCoreDataOffs	visu_pars	Scaling offset of image data

9.2 Required parameters

The following table lists the minimum set of parameters that are required for the respective functions

Functions	Condition	Parameter struct	Required parameters
ReadBrukerRaw RawDataObject.readRaw		Acqp	GO_raw_data_format BYTORDA NI NR ACQ_size GO_data_save GO_block_size AQ_mod
	raw data in job files	Acqp	ACQ_jobs ACQ_jobs_size
convertRawToFrame FrameDataObject.calcFrameData		Acqp	NI NR ACQ_size ACQ_phase_factor ACQ_obj_order ACQ_dim
convertFrameToCKData CKDataObject.calcKData		Acqp	NI NR ACQ_size ACQ_dim AQ_mod
	useMethod == true	Method	PVM_Matrix PVM_EncSteps1
	PVM_Matrix is 3D	Method	PVM_EncSteps2
readBruker2dseq ImageDataObject.readImage		Visu	VisuCoreWordType VisuCoreByteOrder VisuCoreSize VisuCoreFrameCount VisuCoreDataSlope VisuCoreDataOffs VisuCoreDim VisuCoreDimDesc
	ImageType not set OR ImageType == 'auto'	Visu	VisuCoreFrameType

10 Legal matters

In the following, the term “BRUKER” refers to Bruker BioSpin MRI GmbH, Rudolf-Plank-Str. 23, 76275 Ettlingen, while the term “CLIENT” refers to the person or institution receiving the MATLAB package for handling ParaVision data, pvmatlab.

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