**3-D Modular MBIR System Specification**

2019-07-31

**Parameter Files and their contents:**

*File types:*

<sino-fname>.sinoparams - Sinogram parameters file

<sino-fname>.2Dsinodata - 2D Sinogram data file

<wght-fname>.2Dweightdata - 2D weight matrix data file

<image-fname>.imgparams - Image parameter file

<image-fname>.2Dimgdata - 2D image data file

<params-fname>.reconparams - Reconstruction parameters file

<fname>.2Dsysmatrix - 2D system matrix file in sparse matrix format

ViewAngleList.txt - A text file contains all view angles.

*Sinogram parameters file:*

File: <sino-fname>.sinoparams

Files Contents:

Geometry: 3DPARALLEL

NChannels: <integer> /\* Number of channels in detector \*/

NViews: <integer> /\* Number of view angles \*/

NSlices : <integer> /\* Number of Slices \*/

DeltaChannel: <double> /\* Detector spacing (mm) \*/

CenterOffset: <double> /\* Output: Offset of center-of-rotation (Computed from center of detector) \*/

/\* Units is the number of channels, and it can be fractional\*/

DeltaSlice: <double> /\* Spacing between slices (mm) \*/

FirstSliceNumber: <integer> /\* Index of first slice\*/

ViewAngleList: <char string> /\* A path to ViewAngleList.txt, list of view angles (relative to sinoparams) \*/

*3D Sinogram data file list:*

Sinogram parameter files may have associated data files in the same directory.

File: Data stored slice by slice

For SliceIndex = FirstSliceIndex to FirstSliceIndex+NSlices-1

<sino-fname>\_slice<SliceIndex>.2Dsinodata

Files Contents:

Binary IEEE single precision floating point format

Sino[i] for i= 0 to NViews\*NChannels -1;

*Image parameters*

Center of first pixel is assumed to be at ( -((Nx-1)/2.0)\*Deltaxy mm, -((Ny-1)/2.0)\*Deltaxy mm).

Center of rotation (without any offset) is assumed to be at (0mm, 0mm).

File: <image-fname>.imgparams

Files Contents:

Nx: <integer> /\* Number of pixels along x axis (fast variable in storage) \*/

Ny: <integer> /\* Number of pixels along y axis (slow variable in storage) \*/

Nz: <integer> /\* Number of Slices \*/

FirstSliceNumber <integer>/\* Index of first slice \*/

Deltaxy: <float> /\* Spacing between pixels within a single slice in x and y direction (mm) \*/

DeltaZ: <float> /\* Spacing between slices \*/

ROIRadius: <double> /\* radius of the reconstruction (mm) \*/

*3D Image data file list:*

Image parameter files may have associated data files in the same directory

File: Data stored slice by slice

<image-fname>\_slice<SliceIndex>.2Dimgdata

For SliceIndex = FirstSliceIndex to FirstSliceIndex+NSlices-1

Files Contents:

Binary IEEE single precision floating point format

Xaxis[0,Nx-1] (fastest), Yaxis[0,Ny-1] (slowest)

*2D Sparse System Matrix data file:*

File: <system-matrix-fname>.2Dsysmatrix

Files Contents:

Binary IEEE single precision floating point format

for i= 0 to Ncolumns-1

(int) Nnonzero[i] (int) RowIndex[j=0 to Nnonzero[i]] (float) Value[j=0 to Nnonzero[i]] ;

*Reconstruction parameters:*

File: <reconparams-fname>/rparams

Prior model: <string> /\* Options: “QGGMRF”. (Other options to follow) \*/

InitImageValue: <double> /\*Initial image Pixel Value. Unit is mm-1\*/

p: <double> /\* q-GGMRF p parameter [suggested = 1.2] \*/

q: <double> /\* q-GGMRF q parameter [suggested = 2] \*/

T: <double> /\* q-GGMRF T parameter [suggested = 0.1] \*/

SigmaX: <double> /\* q-GGMRF sigma\_x parameter (cmmm^-1) [suggested = 0.02 cmmm-1] \*/

SigmaY: <double> /\* Scaling constant for weight matrix (W<-W/SigmaY^2); \*/

/\* If SigmaY=0, then it is estimated [suggested = 1] \*/

b\_nearest: <double> /\* Relative nearest neighbor weight [default = 1] \*/

b\_diag: <double> /\* Relative diagonal neighbor weight in (x,y) plane [default = 1/sqrt(2)] \*/

b\_interslice: <double> /\* Relative inter-slice neighbor weight along z axis [default = 1] \*/

Positivity: <int> /\* Options: MBIR\_MODULAR\_YES or MBIR\_MODULAR\_NO \*/

StopThreshold: <double> /\* Stopping threshold in percent [suggested = 1%] \*/

MaxIterations: <integer> /\* Maximum number of iterations, [suggested = 20] \*/

MuAir : <double> /\* set to zero as default value, not an input in .reconparams file \*/

**Prior model parameterization:**

The reconstructions use a prior model with the form:

where is specified by SigmaX and is specified by T. Also, we assume that for a pixel, , with all its neighbors in the image, that

with the nearest neighbor, diagonal, and -neighbors proportional to the values specified in <InputFileName.reconparams>

**Programs and their command structure:**

*This program generates the sparse system matrix:*

./GenerateSystemMatrix3DParallel -i <InputFileName>[.imgparams] -j <InputFileName>[.sinoparams] -m <OutputFileName>[.2Dsysmatrix]

Description: This function generates a system matrix in sparse column format. It determines the geometry from the image parameters and the sinogram parameters. It need only be run once for a specific geometry.

Inputs:

InputFileName[.imgparams] - Input file containing parameters of reconstructed image

InputFileName[.sinoparams] - Input file containing sinogram parameters

Outputs:

OutputFileName[.2Dsysmatrix] - Output file containing the sparse system matrix

Note: The necessary extensions for certain input files are mentioned above within a "[ ]" symbol. However, they are NOT to be included as part of the file name in the command line arguments.

*This program performs 3D MBIR reconstruction:*

./MBIR\_3DCT -i <InputFileName>.[imgparams] -j <InputFileName>.[sinoparams] -k <InputFileName>.[reconparams] -m <InputFileName>.[2Dsysmatrix] -s <InputProjectionsBaseFileName> -w <InputWeightsBaseFileName> -r <OutputImageBaseFileName>

# Additional option (for initial image input): -v <InitialImageBaseFileName>

Description: This function performs 3DMBIR reconstruction using following inputs and outputs. It is designed to reconstruct in units of mm-1 without any initialization. However, an option is provided to provide an initial reconstruction.

Inputs:

InputFileName[.imgparams] - Input file containing image parameter file

InputFileName[.sinoparams] - Input file containing sinogram parameters

InputFileName[.reconparams] - Input file containing sinogram reconstruction parameters

InputFileName[.2Dsysmatrix] - Input file containing sparse system matrix data

InputProjectionsBaseFileName - Base Name for list of input files containing projection data slice by slice

InputWeightsBaseFileName - Base Name for list of input files containing weight data slice by slice

Optional Input:

InitialImageBaseFileName - Base Name for list of input files containing initial image data slice by slice (mm-1)

Outputs:

OutputImageBaseFileName - Base Name for list of output files containing reconstructed image data slice by slice (mm-1)

Note: The necessary extensions for certain input files are mentioned above within a "[ ]" symbol. However, they are NOT to be included as part of the file name in the command line arguments.