Dynamic Cardiac SPECT with continuous gantry rotation

A 4-dimensional maximum likelihood expectation maximization (ML-EM) algorithm applicable to spatiotemporal image reconstruction in emission tomography using B spline is developed.

The code is intended for Ge infinia hawkeye dual-head gamma camera (SPECT). But the developed tool is applicable to any system that is capable of continuous image acquisition (with/without rotation). *The direct application of the method could be in the measurement of quantitative myocardial or cerebral blood flow and their reserves.*

1. **Data acquisition**

SPECT data for each rest/stress pair can be acquired by rotating gamma camera with patient in the supine position. A detail of patient position and data acquisition is described in the @Documentation-SM folder*.*

1. **Preprocessing**

First, the camera generated dicom data should be converted to binary format (float 32 bit).

For batch processing using Fiji (ImageJ), load the ImageJ macro file *ProcessPatientDICOMData.txt*.

Fiji>Plugins>Macros>Install..

Save the data and run the macro. The output file will be saved in the selected folder \*Patient\_Data\_Preprocessed*.

Also convert attenuation map from float (f32) to double (d64) using c++ code *readAttenuationMap.cpp:*

$g++ *readAttenuationMap.cpp -o …*

1. **System matrix generation**

Before generating the system matrix check the detector parameters in *parameter.txt* file.

Particularly, detector coordinates and rotation direction must match with scan setup. A detail is provided in the @Documentation-SM folder*.* Use attenuation map for attenuation correction and to avoid reconstruction outside the body. Attenuation cutoff should be less than attenuation coefficient of air to reconstruct lungs.

Once parameter and amap files match detector-acquisition setup, run the script:

$\. sm\_script\_4D\_test.sh

The output file (system matrix) will be saved in the chosen folder.

Following files are needed to run the code:

Input parameter file & Attenuation map.

1. **Basis function**

Generate a set time B splines basis functions that matches the patient’s tracer washin and washout rates and convert it to binary format. You can use matlab code *BSpline.mat* to generate 3D B-splines by varying nodes and save them in a csv file. Use python code to convert it into binary:

*$python time\_basis\_file\_generator\_new.py*

The output will be saved as *singlehead\_my\_spline\_9basis\_stress.bin.*

1. **Reconstruction**

Reconstruction requires following files:

System matrix SMFILE

Time basis function TBFILE

Preprocess Tomographic data TOMOFILE

Once all the pre-processing is done and system matrix is correctly generated, run the script in the use\_sm folder for the reconstruction:

$\. recon\_script\_4D\_test.sh

The code can perform both 3D and 4D reconstruction. Simply do the following:

for 3d put *R*

for 4d put *r*

in the script.

The reconstructed file will be saved in Patient\_Data\_Reconstructed folder.

The following files are needed to run the code:

System matrix, tomographic data file, and basis function file.

1. **Time series**

The reconstructed data is not the image data perse but the fitting coefficients (**a**). For detail see the reference *Shrestha et al (2017).* The coefficient matrix can be converted into time dynamic activity at each 3D voxel. Compile and run the c++ code

$g++ time\_series\_generator\_test.cpp -o ..

Or use the shell script to run the compiled code:

$ \. time\_series\_generator\_test.sh

1. **Post processing**

The reconstructed time dynamic activity needs to be postprocessed and filtered. Use 4D gaussian filter using MATLAB code for batch processing or use code *gaussianFilter4D.cpp* for single file processing. The output will give you time activity in each voxel.