Phase Resolved Doppler Optical Coherence Tomography (prDOCT) Data Processing Guide

Jianbo Tang

Aug 7, 2019

Introduction:

This guide is for post data processing of prDOCT which outputs 3D vascular blood flow velocity.

Please cite the following references^{1,2}:

1. Tang, J., Erdener, S. E., Fu, B. & Boas, D. A. Capillary red blood cell velocimetry by phase-resolved optical coherence tomography. *Opt. Lett.* **42**, 3976–3979 (2017).
2. Tang, J., Erdener, S. E., Sunil, S. & Boas, D. A. Normalized field autocorrelation function-based optical coherence tomography three-dimensional angiography. *J. Biomed. Opt.* **24**, 036005 (2019).

I. Data acquisition

OCT-based M-mode data acquisition, i.e. repeat Ascan at each X-Y scanning location for a certain period. The data should be saved sequentially as a 1D array (ASCII int16) and named as: RAW-nk-nxRpt-nx-nyRpt-ny-iC, e.g. RAW-1024-100-00400-001-400-1.dat.

II. Input

```
% 1D array spectrum, nK*nXrpt*nX*nY, data format: ASCII int16
        % nK: spectrum pixel (camera elements); nXrpt: Ascan repeat;
        % nX: number of Ascans per Bscan; nY: number of Bscans for the whole volum
        % NOTE: the raw data for the whole volume is usually very large, it's
recommended to process chunk by chunk
    % PRSinfo: processing information
    % PRSinfo.FWHM: Full width at Half Maxim, Amplitude, [transverse, axial], m
    % PRSinfo.fAline: DAQ Aline rate, Hz
    % PRSinfo.Lam: [light source center, wavelength bandwidth], m
    % PRSinfo.Dim: [nz,nx,nyPchk,nTau]
    % PRSinfo.intDk: OCT lambda to k space interpolation factor (calibration is
required)
```

Example data:

https://drive.google.com/open?id=168HD4lKt0K97g09zus6H9h7lAyO0jOBZ
https://drive.google.com/open?id=1QvTO_41cPN3_wM9wxCh9NECv_hypVZPC

III. Output

```
 % Vz, [nz,nx,ny]
```

I. CPU calculation-based sub-functions

```
% subFunctions:
    % function [Dim, fNameBase, fIndex]=GetNameInfoRaw(filename0)
    % function DAT= ReadDat_int16(filePath, Dim, iseg, ARpt_extract,RptBscan)
    % function RR = DAT2RR(Dat, intpDk)
    % function GG = RR2g1(RR, PRSinfo)
    % function [Vz, aRBC]=RR2Vz(RR, PRSinfo)
```

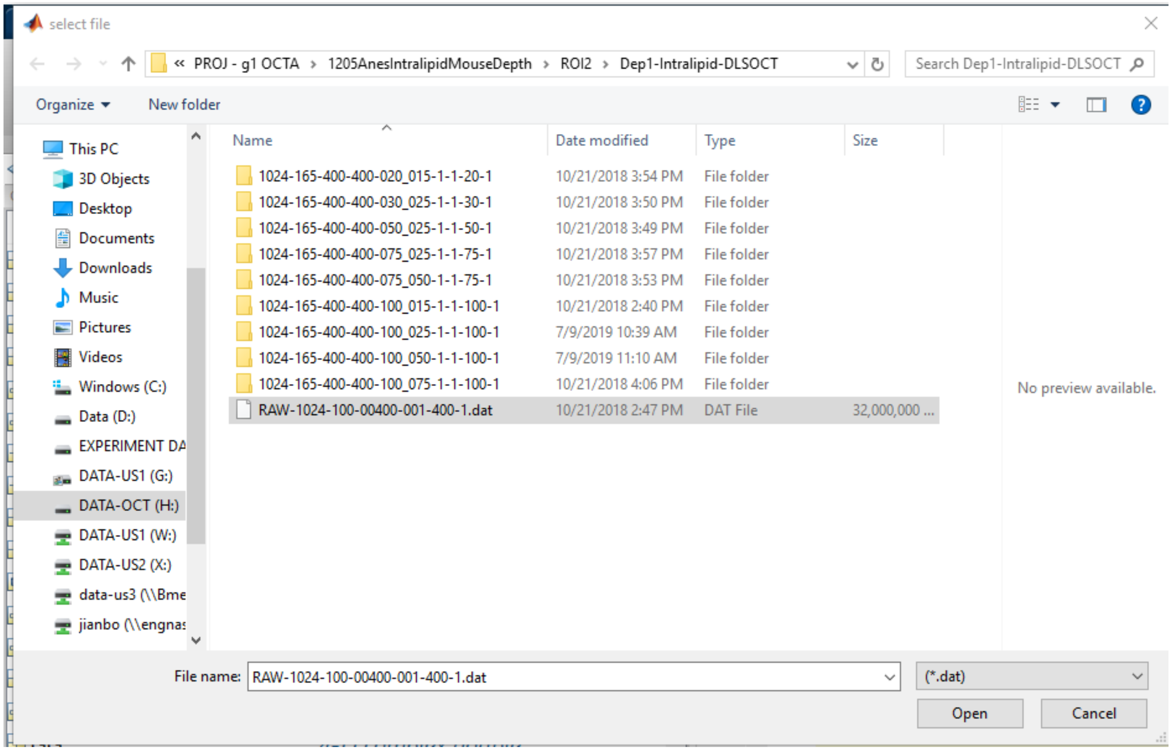
II. GPU calculation-based sub-functions

Note: the minimal GPU memory requirement is 16 GB.

```
% subFunctions:
    % function [Dim, fNameBase, fIndex]=GetNameInfoRaw(filename0)
    % function DAT= ReadDat_int16(filePath, Dim, iseg, ARpt_extract,RptBscan)
    % function RR = DAT2RR_GPU(Dat, intpDk)
    % function GG = RR2g1_GPU(RR, PRSinfo)
    % function [Vz, aRBC]=RR2Vz_GPU(RR, PRSinfo)
```

III. Main_g1OCTA data processing

III.1 select file



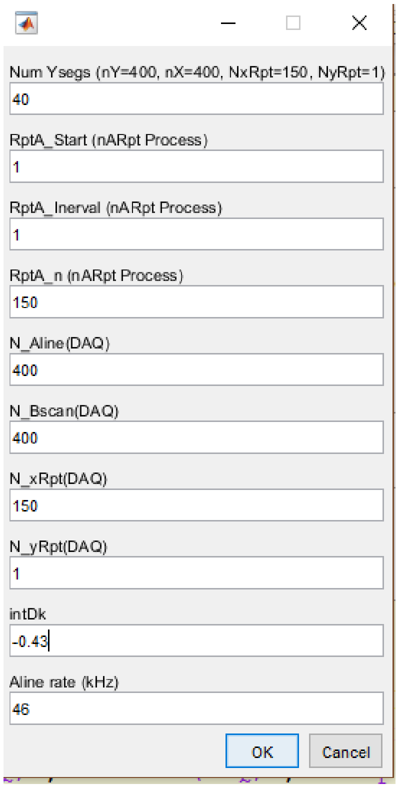
Name	Date modified	Type	Size
1024-165-400-400-020_015-1-1-20-1	10/21/2018 3:54 PM	File folder	
1024-165-400-400-030_025-1-1-30-1	10/21/2018 3:50 PM	File folder	
1024-165-400-400-050_025-1-1-50-1	10/21/2018 3:49 PM	File folder	
1024-165-400-400-075_025-1-1-75-1	10/21/2018 3:57 PM	File folder	
1024-165-400-400-075_050-1-1-75-1	10/21/2018 3:53 PM	File folder	
1024-165-400-400-100_015-1-1-100-1	10/21/2018 2:40 PM	File folder	
1024-165-400-400-100_025-1-1-100-1	7/9/2019 10:39 AM	File folder	
1024-165-400-400-100_050-1-1-100-1	7/9/2019 11:10 AM	File folder	
1024-165-400-400-100_075-1-1-100-1	10/21/2018 4:06 PM	File folder	
RAW-1024-100-00400-001-400-1.dat	10/21/2018 2:47 PM	DAT File	32,000,000 ...

File name: RAW-1024-100-00400-001-400-1.dat

(*.dat)

III.2 data processing parameter

Specify the number of chunks for data processing (split large data size into small chunks), and the g1 calculation parameters (nTau and nt). Double check the intDk and Aline Rate.



Num Ysegs (nY=400, nX=400, NxRpt=150, NyRpt=1)
40

RptA_Start (nARpt Process)
1

RptA_Inerval (nARpt Process)
1

RptA_n (nARpt Process)
150

N_Aline(DAQ)
400

N_Bscan(DAQ)
400

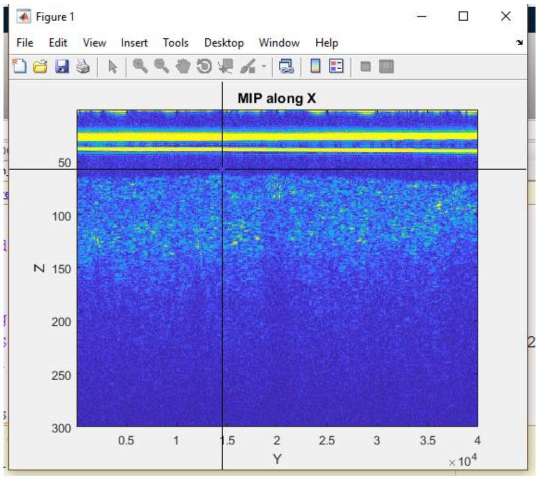
N_xRpt(DAQ)
150

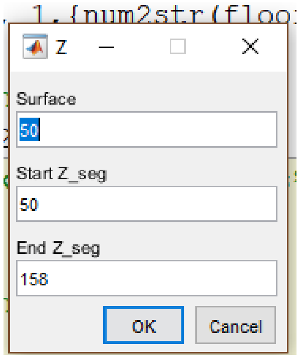
N_yRpt(DAQ)
1

intDk
-0.43

Aline rate (kHz)
46

III.3 select the axial data processing range [surface, zStart, zEnd]



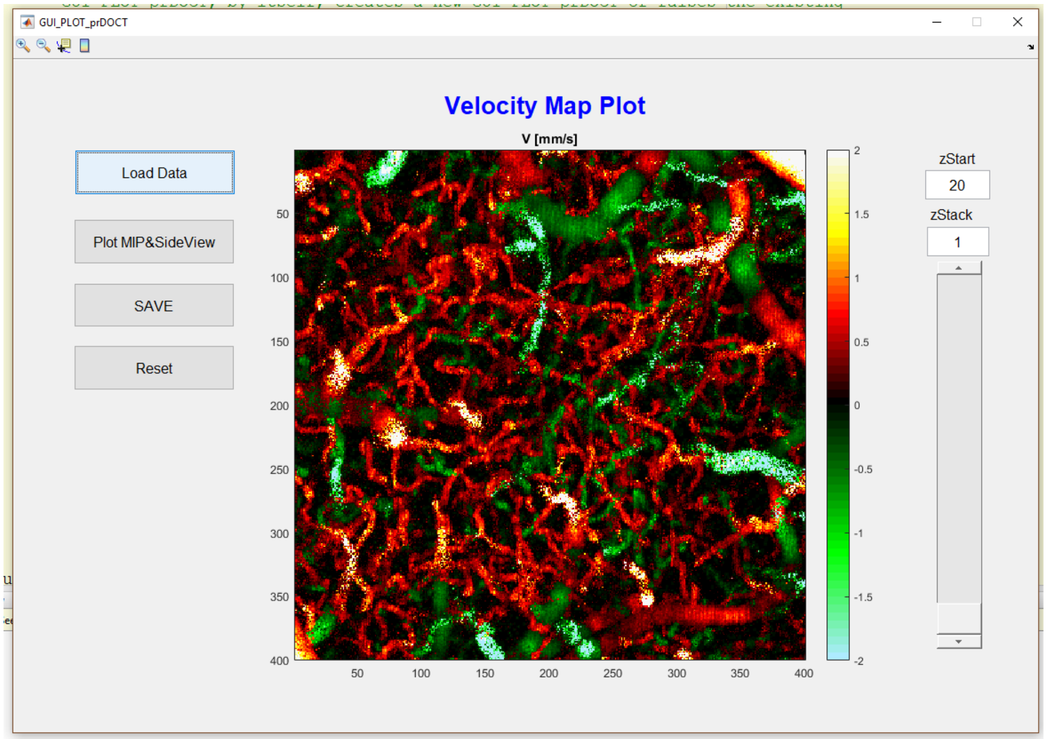


Surface
50

Start Z_seg
50

End Z_seg
158

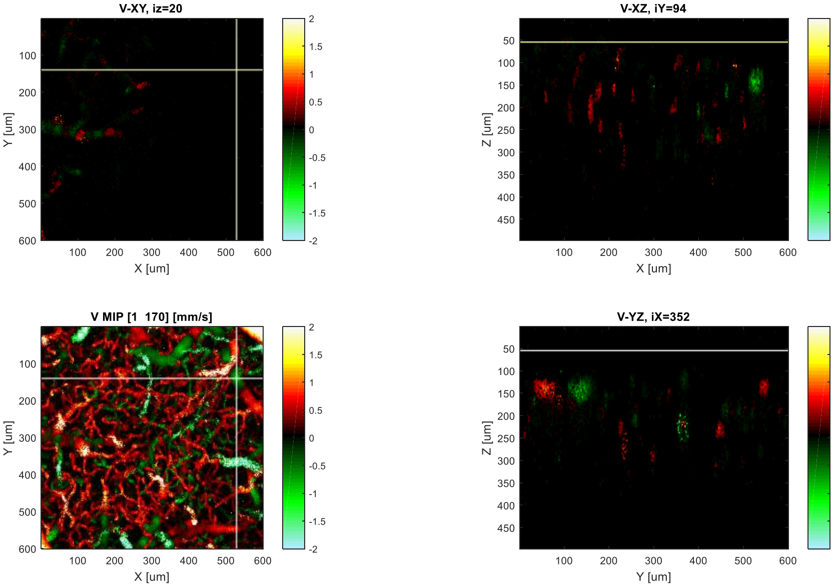
III.4 g1OCTA result plot (GUI_PLOT_DLSOCT)



zStart 20

zStack 1

1. Load the saved prVz data
2. Use the slider or zStart+zStack to check single or MIP (maxim intensity projection) en face plane. Cyan color means descending flow
3. Use ‘Plot MIP&SideView’ to plot a MIP for certain depth range (set SideView(N:0; Y:1) to 0). Or plot XY, YZ, XZ, and MIP figures by set SideView(N:0; Y:1) to 1.


V-XY, iz=20
Y [um]
100
200
300
400
500
600
X [um]
100
200
300
400
500
600
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
V-XZ, iY=94
Z [um]
50
100
150
200
250
300
350
400
450
X [um]
100
200
300
400
500
600
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
V MIP [1 170] [mm/s]
Y [um]
100
200
300
400
500
600
X [um]
100
200
300
400
500
600
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
V-YZ, iX=352
Z [um]
50
100
150
200
250
300
350
400
450
Y [um]
100
200
300
400
500
600
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2