

功能性近紅外光訊號處理

fNIRS Signal Processing

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本週課程內容

- fNIRS analysis package: HOMER2
 - <http://www.nmr.mgh.harvard.edu/PMI/resources/homer2/home.htm>
- Signal Processing
 - CV calculation, Bad channel/trial removal
 - Motion correction
 - Bandpass filtering
 - OD and ΔHb
 - Block averaging

Please download the materials_L12.zip from
http://www.ym.edu.tw/~cflu/CFLu_course_fnirs.html

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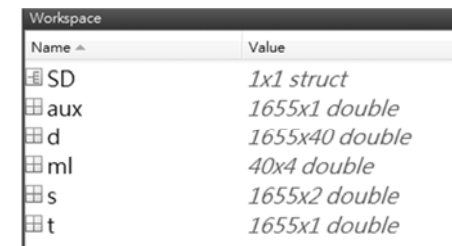
分析軟體HOMER2介紹

HOMER2 package

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Required Raw Data for HOMER2

- MATLAB mat-file format (*.nirs)
- SD: source/detector geometry
- d: dual-wavelength raw signals for all channels
- s: event time points
- t: time axis in second
- ml: lists of source-detector channels
- aux: auxiliary signal



Name	Value
SD	1x1 struct
aux	1655x1 double
d	1655x40 double
ml	40x4 double
s	1655x2 double
t	1655x1 double

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HOMER2_UI

Processing Setup

Signal Figure

Channel Figure

Additional Functions

File List

Processing Control

Display Control

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procStreamGUI

Tool → process Stream GUI

Function Library
(output, name, input)

Employed Function
(output, name, input)

Function Description

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ProcessOpt

Processing Control → Options

Function name

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Input Variable	Parameters
Intensity_to_OD	
Motion_Artifacts_By_Channel	tMotion: 0.5 tMask: 1.0 STDEVthresh: 50.0 AMPthresh: 5.0
Spline_Motion_Correction	p: 0.99
Bandpass_Filter	hpf: 0.000 lpf: 3.00
OD_to_Conc	ppf: 6.0 6.0
Block_Average	trange: -2.0 20.0

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Bilateral Arm lifting

2015-05-07_002

● sources

● detectors

No. Rows: 4, No. Columns: 6

Export to NLAB

Signal Levels

1-3	1-1	2-2	2-4
5-3	5-1	3-1	4-2
5-7	5-5	3-5	4-6
7-7	7-5	8-6	8-8

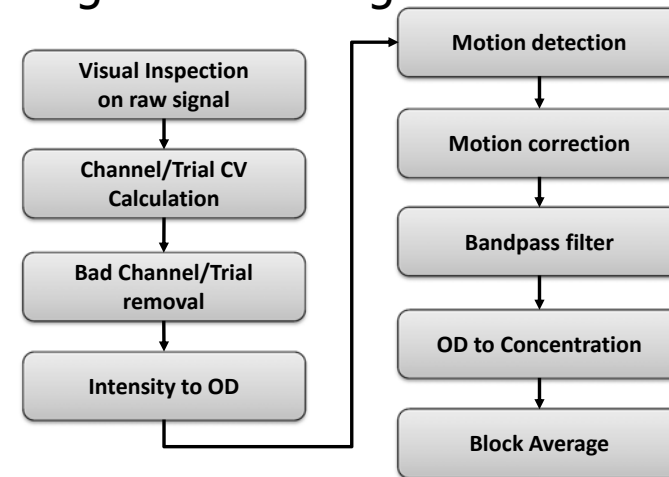
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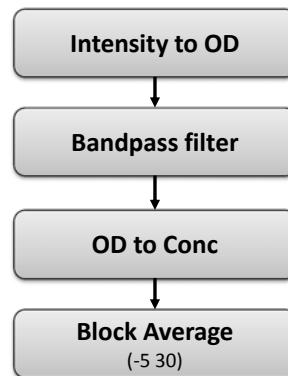
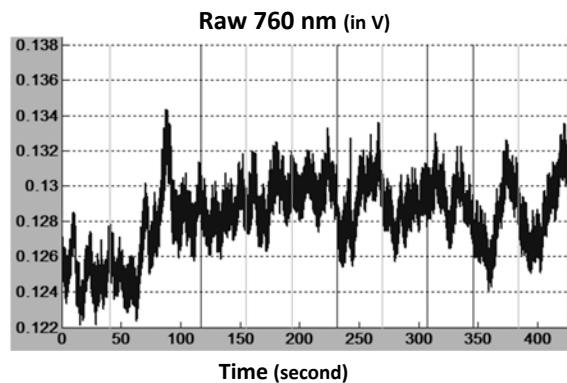
<http://www.ym.edu.tw/~cflu>

訊號處理流程 fNIRS signal processing

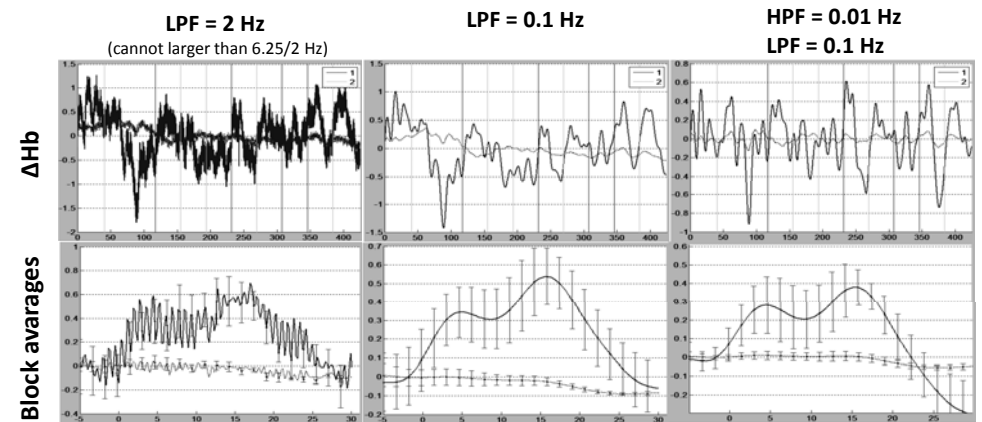
fNIRS Signal Processing Flow



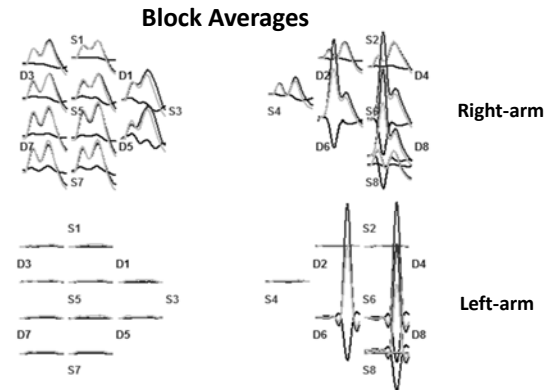
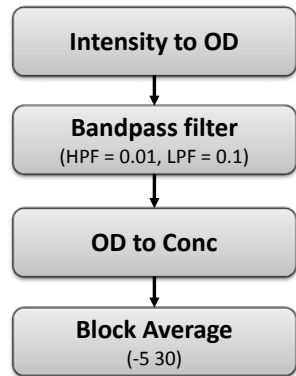
Signals in S1-D1



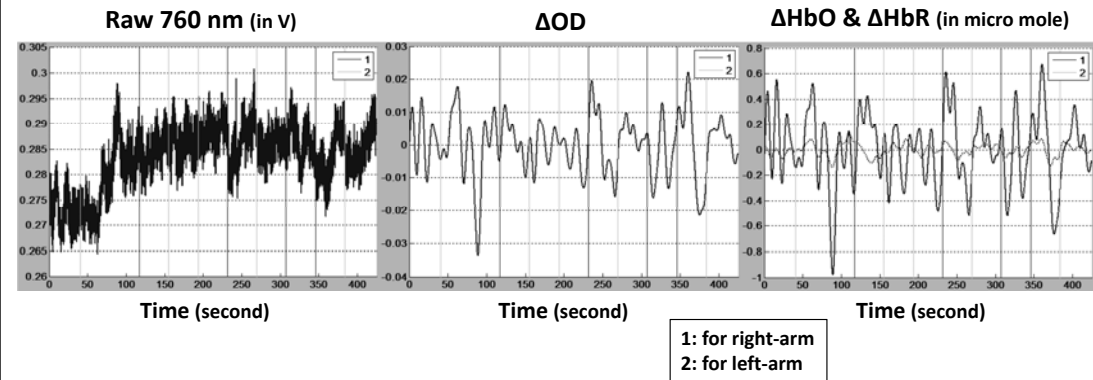
Effects of Bandpass filter



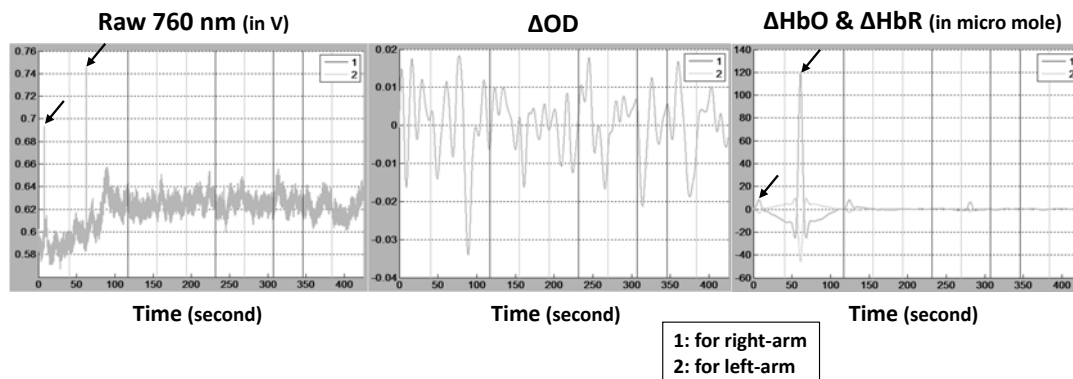
Without Motion corrections



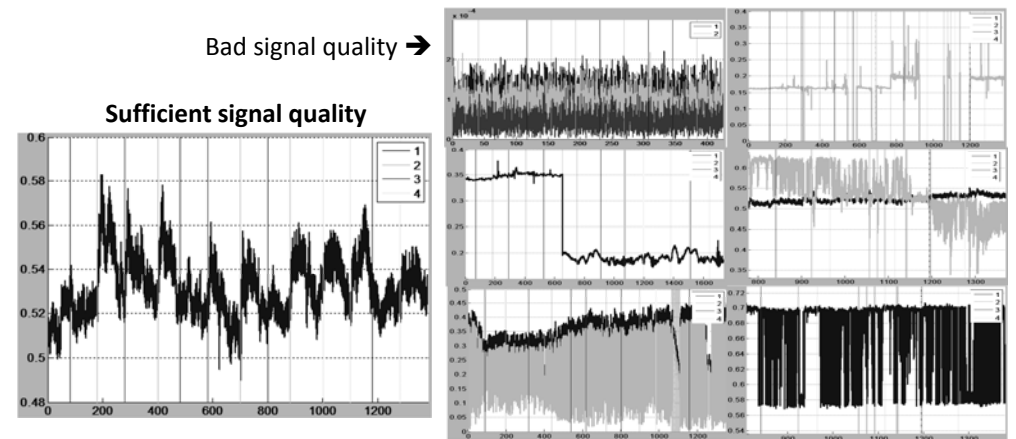
Signals in S1-D3



Motion artifacts in S6-D4



Visual Inspection



Channel/Trial CV

- Coefficient of variation (CV)
 - $CV = \frac{\sigma}{\mu} \times 100\%$
- Channel CV (CV_{chan})
 - Reject channels with $CV_{chan} > 15\%$
- Trial CV (CV_{trial})
 - Reject trials with $CV_{trial} > 5 \sim 10\%$

Run CalculateCV.m and select a data folder with HOMER files

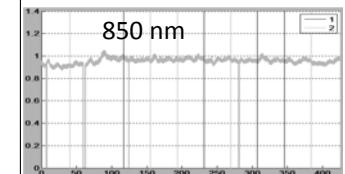
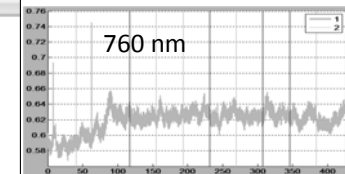
CV in S6-D4

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Rejection_2015-05-07_002.txt - 記事本
檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)
The rejection thresholds are:
CVchannel > 15%
CVtrial > 5%
The group averaged CVstandstill_w1 = 7.27%, CVstandstill_w2 = 6.70%

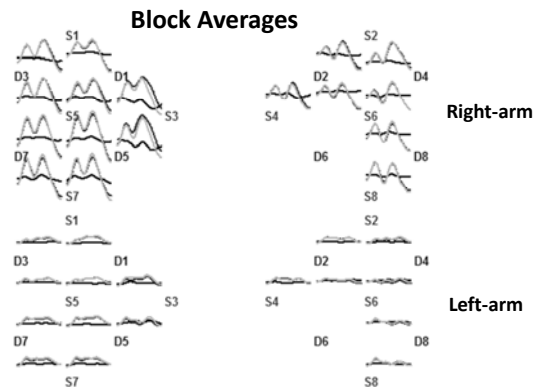
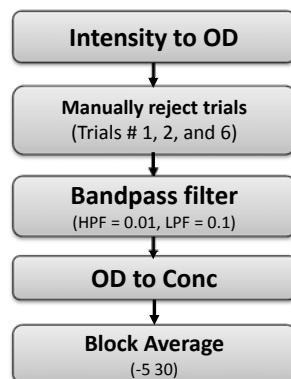
The channels have to be rejected based on criteria are listed as belows.
[Subject #1]: NIRS-2015-05-07_002.nirs
Channel #8 S4-D6, CVchannel_w1 = 28.96%, CVchannel_w2 = 27.46%
Channel #15 S6-D6, CVchannel_w1 = 34.56%, CVchannel_w2 = 19.76%
Channel #19 S8-D6, CVchannel_w1 = 52.38%, CVchannel_w2 = 52.47%

The trials have to be rejected based on criteria are listed as belows.
[Subject #1]: NIRS-2015-05-07_002.nirs
Channel #8 S4-D6, Trial #1, CVtrial_w1 = 28.33%, CVtrial_w2 = 28.17%
Channel #8 S4-D6, Trial #2, CVtrial_w1 = 31.09%, CVtrial_w2 = 29.25%
Channel #8 S4-D6, Trial #3, CVtrial_w1 = 28.86%, CVtrial_w2 = 25.11%
Channel #8 S4-D6, Trial #4, CVtrial_w1 = 26.93%, CVtrial_w2 = 27.08%
Channel #8 S4-D6, Trial #5, CVtrial_w1 = 28.17%, CVtrial_w2 = 27.95%
Channel #8 S4-D6, Trial #6, CVtrial_w1 = 27.36%, CVtrial_w2 = 24.58%
Channel #8 S4-D6, Trial #7, CVtrial_w1 = 28.47%, CVtrial_w2 = 25.27%
Channel #8 S4-D6, Trial #8, CVtrial_w1 = 29.16%, CVtrial_w2 = 27.19%
Channel #8 S4-D6, Trial #9, CVtrial_w1 = 29.75%, CVtrial_w2 = 29.78%
Channel #13 S6-D2, Trial #1, CVtrial_w1 = 1.93%, CVtrial_w2 = 35.57%
Channel #13 S6-D2, Trial #2, CVtrial_w1 = 1.09%, CVtrial_w2 = 7.42%
Channel #13 S6-D2, Trial #6, CVtrial_w1 = 1.01%, CVtrial_w2 = 7.22%
Channel #14 S6-D4, Trial #1, CVtrial_w1 = 2.43%, CVtrial_w2 = 35.60%
Channel #14 S6-D4, Trial #2, CVtrial_w1 = 1.24%, CVtrial_w2 = 7.22%
Channel #14 S6-D4, Trial #6, CVtrial_w1 = 1.09%, CVtrial_w2 = 7.47%
    
```



High CV in trial #1 at 850 nm !!

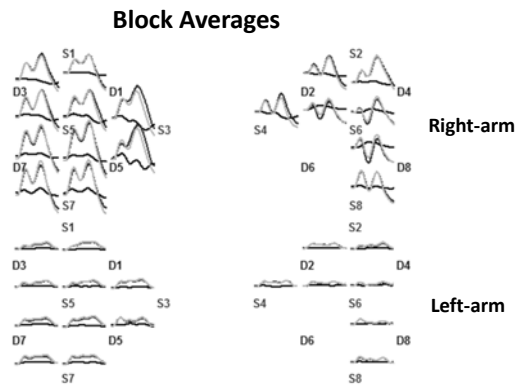
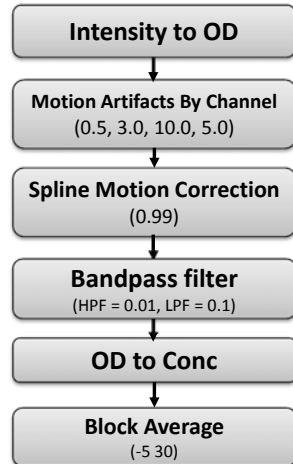
Bad Trial/Period Removal



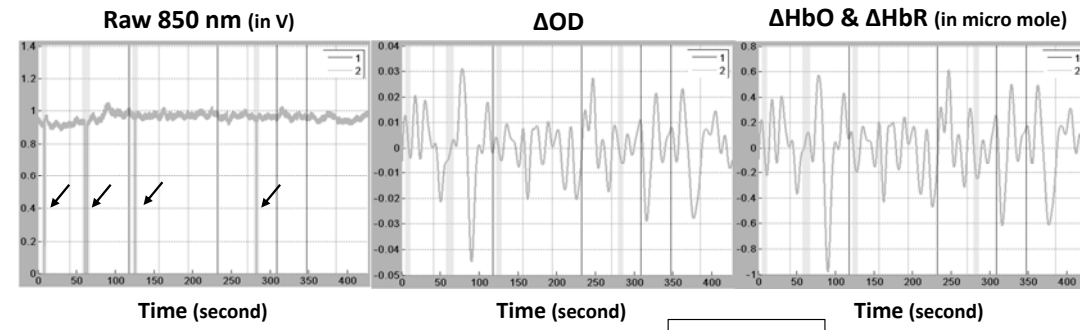
Post-processing Techniques

- Spline interpolation
 - hmrMotionCorrectSpline.m
- Principal component analysis (PCA)
 - hmrMotionCorrectPCA.m
- Wavelet filtering
 - hmrMotionCorrectWavelet.m
- Correlation-based signal improvement (CBSI)
 - hmrMotionCorrectCbsi

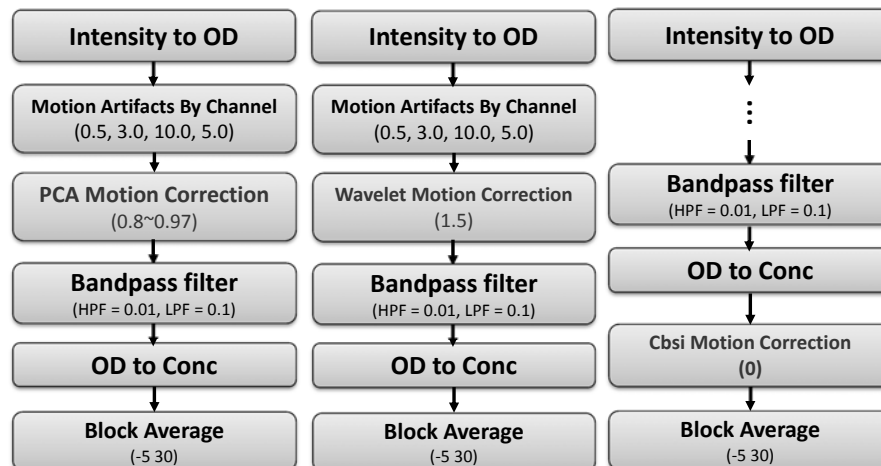
Corrected by Spline Correction



Spline Corrected Signals



Other Correction Flows



THE END
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