# MEG/EEG Signal processing GUI

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#### 1. Introduction

This document was written about signal processing GUI - "vb\_signal\_processor".

vb\_signal\_processor.m is a VBMEG function to launch the GUI.

It provides basic filtering functions for MEG/EEG file. Basic filters are "Bias correction", "Highpass", "Lowpass", "BandPass", "StopBand", "Downsampling", and "Common reference(for EEG)". For more information, see the Preferences of "Filters" section.

#### 1.1. MEG/EEG file

MEG/EEG file is created using VBMEG data import function, and you can make it by yourself by reference to a format of Standard MEG/EEG file. The format document file is placed in the VBMEG document directory.

These files have an extension ".meg.mat" or ".eeg.mat".

#### 2. WorkFlow

The workflow is very simple.

- (1) Specify MEG/EEG file(s) that you want to process.
- (2) Choose filters and modify these settings.
- (3) Push "Exec" button.

## 3. GUI

The GUI consists from three parts.

Data flow is top to bottom. [Input files]  $\rightarrow$  [Filtering]  $\rightarrow$ [Output files].

*		Sign	al processor for	r MEG/EEG file	_
File					•
Input M	EG/EEG fi	le(s)			
File type	MEG	file (.meg.mat)	●EEG file (.eeg	.mat)	
/home/	cbi-data5/r	hayashi/vb_signal_	processor_test/7	FS_20090319_1.eeg.mat	Add
			Input file	e list	Remove
					View
Process	sina —				
Process	sing tools			Processing order and	parameter
Bias corr Highpas Lowpass Bandpas	rection s s			Highpass Lowpass Bias correction Randpass	Edit
Stop-ba	nd			Stop-band	Remove
Common Common	mpling n reference			Downsampling Common reference	
			Add ->	Filter list	Filter response
					Upper
		-			Lower
- Output	MEG/EEG	file(s)			
Output	directory			/home/shi-da	ta5/rhavashi Select
/home/	/chi=data5/r	l rhavashi/TS_200901	319 1 filt een m:	at	
, noney	oor datao/i	nayasin; 10_20000.		<b>CI</b> 11 (	
			Output	file list	
					▼ View
					Exec

#### 4. Practical operation

So, let's try to process an actual EEG data.

1. Run the following script. The GUI appears.

🔸 Signa	al processor for MEG/EEG file	_ 🗆 🗙
File		۲. ۲
[Input MEG/EEG file(s)		
File type ( MEG file (.meg.mat)	⊖EEG file (.eeg.mat)	
	-	Add
		Remove
	<b>~</b>	View
Durana in a		
Processing		
Processing tools	Processing order and paramet	er
Bias correction		Edit
Lowpass		
Bandpass Stop band		Remove
Downsampling		
	Add ->	Filter response
		linner
		Lower
		Lowel
Output MEG/EEG file(s)		
Output directory		Select
	-	÷
		View
		Exec

\$>vb\_signal\_processor

2. Set File type to EEG file(.eeg.mat)



3. Click the "Add" button to specify EEG file.



4. Select EEG file in the appearing dialog.

2	Select EEG file 📃 🗖			
current directory	r.			
/home/cbi/rhay	ashi		•	
Extension	.eeg.mat 👻	Drive	~	
Directori	es	Files		
 .Trash .advt .advbe .anthy .bitrock .cache chewing filter Filter * selected file(s)				
Canc	el			

The selected file was added.

Signal processor for MEG/EEG file	_ O X
File	۲ د
_Input MEG/EEG file(s)	
File typeMEG file (.meg.mat)	
/home/cbi-data5/rhayashi/vb_signal_processor_test/TS_20090319_1.eeg.mat	Add Remove View

5. Click the "Highpass" from the list of processing tools and press the "Add->" Button.



file (e

Highpass filter was added to the list of "Processing order and parameter".

6. Press the "Edit" button to modify the setting of selected Highpass filter.

Processing			
Processing tools		Processing order and	parameter
Bias correction Highpass Lowpass Bandpass Stop-band Downsampling Common reference	Add ->	Highpass	Edit Remove Filter response
	<b>•</b>		Upper Lower

7. Setting dialog appears. Double-click the left item that you want to modify. (Or choose the item and press the "edit" button.) The description of the item can be seen on the lower right pane.

A.	Highpass	
Settings: 1.Cutoff frequency [Hz] 2.Impulse response 3.Filter order 4.Time delay correction	Highpass Value: 1 Description: Cutoff frequency for highpass filter [Hz].	
	Input sequencially OK C	ANCEL

8. Value input dialog appears. Enter a value and press the "OK" button.



9. In the same way, add "Lowpass" to the right list.



The filters will be applied from the top of the list. If you change the order, press the "Upper" and "Lower" button.

10. Finally press the "Exec" button. Output file will be created.

Output filename: fixed. (original filename+"\_filt")

If you want to change output directory, Press the "Select button" and choose an output directory. (Or enter it to the edit box directly.)

Output MEG/EEG file(s)	
Output directory	Select
/home/cbi-data5/rhayashi/vb_signal_processor_	test/TS_20090319_1_filt.eeg.mat
	View

[TIPS] If you want to specify the output filename, save parameters as M-script from the menu:[File]->save as batch file(M-script), then modify and execute it. "Now processing" dialog appears. When the processing finished, "View" button is



11. Press the "View" button to check the filtered EEG file.

The dialog appears as below. Specify channels to show by checkbox.

Then press the "OK" button.

-		Choose da	ta channe	i to display	
	_			-	
		Channel	ON/OFF		
	1	Fp1	<b>v</b>		<b>_</b>
	2	AF7	Image: A state of the state		
	3	AF3	Image: A start of the start		38 - C
	4	F1	Image: A state of the state		
	5	F3	Image: A state of the state		
	6	F5			
	7	F7	✓		
	8	FT7	✓		
	9	FC5	✓		
	10	FC3	✓		
	11	FC1	✓		
	12	C1	✓		
	13	C3	✓		
	14	C5	✓		•
					1
			С	K CAN	EL

12. And also Specify external channels to show by checkbox.

Then press the "OK" button.

31199993 31		ispisj -	
Channel	ONLIGEE		
1 Status			
			1
	ок	CANCEL	



13. Data Viewer appears. Set the display time and adjust the Time scale by slider.

Original EEG file can be seen from the "View" button as well.



### 5. Preferences

## 5.1. Filters

#### 5.1.1. Bias correction

parameter	commentary
mode	0: No Bias correction.
	1: Constant Bias correction by using all time samples.
	2:Linear trend removal and Constant Bias correction by
	using all time samples.
	[t1 t2]: Bias correction by time window [t1 t2] (msec). time
	is specified by [msec] from the begining of data.

#### 5.1.2. Lowpass

parameter	commentary
Cutoff frequency	Cutoff frequency for lowpass filter [Hz].
Impulse response	1:Finite impulse filter
	2:Butterworth filter
Filter Order	Filter order for Butterworth filter. For finite impulse filter,
	this value is not used.
Time delay correction	0: 'filter' is applied for online filter case,
	1: Time delay correction is applied by using 'filtfilt'

# 5.1.3. Highpass

01			
parameter	commentary		
Cutoff frequency	Cutoff frequency for highpass filter [Hz].		
Impulse response	1:Finite impulse filter		
	2:Butterworth filter		
Filter Order	Filter order for Butterworth filter. For finite impulse filter		
	this value is not used.		
Time delay correction	0: 'filter' is applied for online filter case,		
	1: Time delay correction is applied by using 'filtfilt'		

#### 5.1.4. Bandpass

parameter	commentary		
Lower cutoff frequency	Lower cutoff frequency for bandpass filter. [Hz]		
Higher cutoff frequency	Higher cutoff frequency for bandpass filter. [Hz]		
Impulse response	1:Finite impulse filter		
	2:Butterworth filter.		
Filter Order	Filter order for Butterworth filter. For finite impulse		
	filter, this value is not used.		
Time delay correction	ection 0: 'filter' is applied for online filter case,		
	1: Time delay correction is applied by using 'filtfilt'		

# 5.1.5. Stop-band

parameter	commentary		
Lower cutoff frequency	Lower cutoff frequency for stop-band filter.[Hz]		
Higher cutoff frequency	Higher cutoff frequency for stop-band filter. [Hz]		
Impulse response	1:Finite impulse filter		
	2:Butterworth filter.		
Filter Order	Filter order for Butterworth filter. For finite impulse		
	filter, this value is not used.		
Time delay correction	elay correction 0: 'filter' is applied for online filter case,		
	1: Time delay correction is applied by using 'filtfilt'		

### 5.1.6. Downsampling

S.I.O. Downsampning					
parameter	commentary				
New sampling frequency	New sampling frequency[Hz].				
	Before downsampling, lowpass filtering with cutoff				
	frequency less than 'New sampling frequency/2' should				
	be applied.				

#### 5.1.7. Common reference(for EEG)

parameter	commentary			
mode	0:OFF			
	1:ON.			
	Common reference is one way of EEG reference			
	channel specification. For EEG data, reference voltag			
	is assumed as the average of all channel data. Namely,			
	the average of all channel data is subtracted from each			
	channel data for each time sample.			

### 5.2. Batch processing

Once you decide filter settings, you may want to apply the same settings to the other MEG/EEG file(s). In such cases, you can use a function to save settings as MATLAB M-script file.

#### 1.Choose [File]->save as batch file(M-script)

1			Signal processor for MEG/EEG file	
F	le			r
	load settings	Ctrl+L		
	save settings	Ctrl+S		
	save as batch file(M <sub>T</sub> script)	Ctrl+B	at) (• EEG file (.eeg.mat)	
L	close *		_signal_processor_test/TS_20090319_1.eeg.mat 🛛 🔺 🛛 🗛	d

2.In the appearing dialog, enter the filename and press the "OK" button.

🛃 Sav	e bat	ch scr	ipt file(.m)	
current directory				
/home/cbi/rhaya	shi			•
Extension	.m	•	Drive	-
Directorie:	5		Files	
 .Trash .abrt .adobe .anthy .bitrock .cache .chewing Filter * selected file(s) eeg_file_filter.m		findjo make signa simpl test.r test_ test_ test_ vb_o	obj.m e_standalone.m I_processor.m lebdfreader.m m dicom_nifti.m hoge.m import_5shell.m import_omm.m et_error_msa.m	
Cance	1	_	ок	

3. Open the batch M-script file.

% Apply signal processing to MEG/EEG-MAT file(s). proc\_parm.input\_files{1,1} = '/home/rhayashi/test/test1.eeg.mat'; proc\_parm.output\_files{1,1} = '/home/rhayashi/test/test1\_filt.eeg.mat'; proc\_parm.process\_list{1,1}.type = 'highpass'; proc\_parm.process\_list{1,1}.cutoff\_freq = 1; proc\_parm.process\_list{1,1}.impulse\_response = 2; proc\_parm.process\_list{1,1}.order = 5; proc\_parm.process\_list{1,1}.filtfilt = 1; proc\_parm.process\_list{1,2}.type = 'lowpass'; proc\_parm.process\_list{1,2}.cutoff\_freq = 20; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,2}.order = 5; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,2}.order = 5; proc\_parm.process\_list{1,2}.impulse\_response = 2; proc\_parm.process\_list{1,3}.impulse\_response = 2; proc\_parm.process\_list{1,3}.impulse\_response = 2; proc\_parm.process\_list{1,3}.impulse\_response = 2; proc\_parm.process\_list{1,

vb\_signal\_processor\_batch\_exec(proc\_parm, 0)

proc\_parm.input\_files and proc\_parm.output\_files are one-to-one correspondence. Please modify these files and run it as MATLAB script.

proc\_parm.process\_list(highpass and lowpass) will be applied to input\_files.