Physiocrate plugin library for SignalPlant

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"Physiocrate" library consits of three plugins aimed to analysis of continuous blood pressure, respiratory signals and electromyographic signals . The library is available free and open-source under MIT license as part of the SignalPlant project.

Blood pressure analysis plugin

The plugin allows computing of specific features from blood pressure signal. It detects systoles and diastoles in predefined window or in the whole signal length, excluding locations marked as artificial. Then, statistical results of systolic and diastolic values are found and printed in a table. Furthermore, detected systoles and diastoles positions as well as systolic and diastolic curves may be exported back to the SignalPlant.

Usage

Attach channel to the plugin using button (Fig-A). The source signal and filtered signal are shown in panel (Fig-D).To show "overall results" from the whole signal change page to "Statistics" (Fig-F). Beat-to-beat results are shown in the "Tables" page. If the source signal contains any artificial areas that distort your results, they may be excluded from analysis by selecting artificial marks (Fig-B). It is also possible to analyse specific time interval only. To do so, it's needed to select start mark (Fig-B) and set the length of the time window Plugin may be called from SignalPlant command line by "PRESSURE" command with required parameter CHANNEL(name); other parameters are optional.

Batch processing parameters

`CHANNEL(channel_name)`	channel to be executed
`AREA(START_MARK_NAME;WINDOW_LENGTH;ART_MARK)`	window length, start mark and artificial marks names
`EXPORT(FiltSig;Marks;SysFnc;DiaFnc,FreqFnc)`	export settings

Batch processing reserved words for EXPORT

`FiltSig`	exports filtered signal to SignalPlant
`Marks`	exports marks
`FreqFnc`	exports Systole to systole heart rate variability function
`SysFnc`	exports systolic function
`DiaFnc`	exports diastolic function

Example command for batch processing

```
PRESSURE CHANNEL(BP) AREA(start;30;artifact) EXPORT(FiltSig)
```

executes blood pressure analysis using channel BP. Filter (always FIR) is set to 50th order and 10Hz cut-off frequency. The analysis is executed in 30s window starting with mark labeled "start" (i.e. its info-field is set to "start"). Areas containing "artifact" in info field will be excluded. Filtered signal will be exported back to SignalPlant. Statistical results of systolic and diastolic values will be printed in SignalPlant variables.

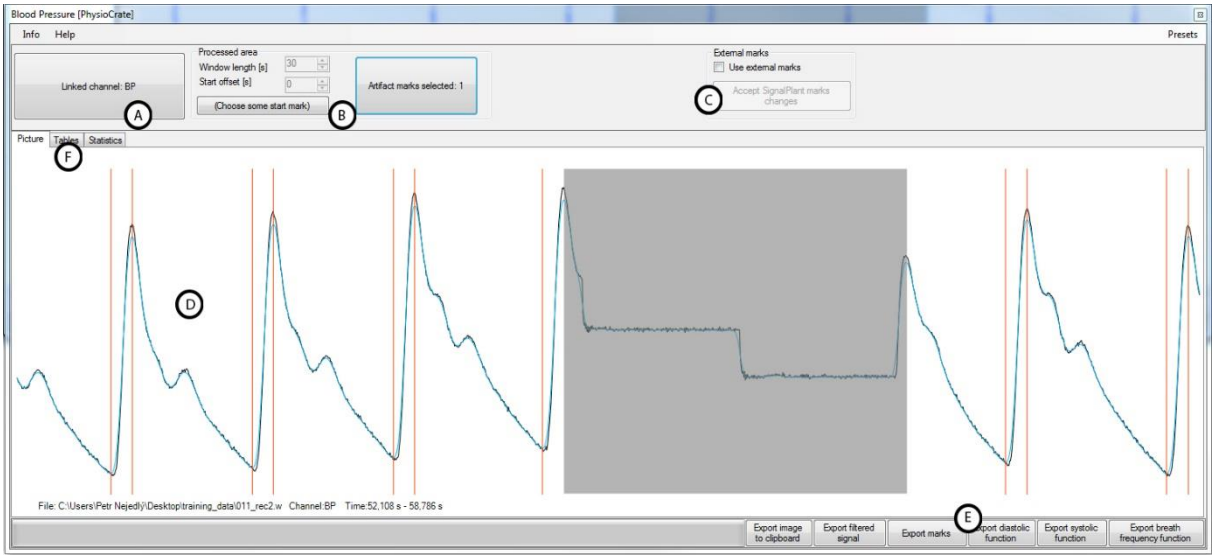

Figure 1 –Blood pressure analysis plugin window. Black line is original signal, blue line is filtered signal (FIR low-pass at 10 Hz, 50th order) and light grey rectangle is artificial area. Orange vertical lines shows systoles and diastoles.

Respiration signal analysis plugin

The plugin allows computing of specific features from respiration signal. It detects inspiration and expiration in predefined window or in the whole signal length, excluding locations marked as artificial. Then, statistical results of breath frequency, amplitude and ventilation values are found and printed in a table. Furthermore, detected respiration frequency curve and inspiration positions marks may be exported back to the SignalPlant.

Usage

Attach channel to the plugin using button (Fig-A). Cut-off frequency and order of low pass FIR filter may be changed (Fig-C). The source signal and preview of result signal are shown in panel (Fig-D) Breath-to-Breath results are shown in the "Tables" page and overall results are available in the table on "Statistics" page (Fig-F). If the source signal contains any artificial areas that distort your results, they may be excluded from analysis by selecting artificial marks (Fig-B). It is also possible to analyse specific time interval only. To do so, it's needed to select start mark (Fig-B) and set the length of the time window. Plugin may be called from SignalPlant command line by "RESPIRATION" command with required parameter CHANNEL(name); other parameters are optional. If detected inspirations or expirations are not identified correctly, user is allowed to export marks (Fig -E) and correct them in SignalPlant. After correction new valid positions must be accepted (Fig -G).

Batch processing parameters

CHANNEL(channel_name)	channel to be executed
PARAM(FIR_ORDER;FREQ_CUT;)	filter setting
AREA(START_MARK_NAME;WINDOW_LENGTH;ART_MARK)	start mark, window length and artificial marks names
EXPORT(FiltSig;Marks;FreqFnc)	export settings

Batch processing reserved words for EXPORT

FiltSig	exports filtered signal to SignalPlant
Marks	exports inspiration-to-inspiration marks
FreqFnc	exports exhalation to exhalation respiration variability function

Example command for batch processing

```
RESPIRATION CHANNEL(RESP) PARAM(500;0.5) AREA(start;30;artifact) EXPORT(FiltSig)
```

Executes breath signal analysis with in channel RESP. Filter is set to 500th order and 0.5Hz cut-off frequency. Analysis is executed in 30s window starting with mark labeled "start" (i.e. its info-field is set to "start"). Areas containing "artifact" in info field will be excluded. Filtered signal will be exported back to SignalPlant. Statistical results of breath frequency, amplitude and ventilation and are found in SignalPlant variables.

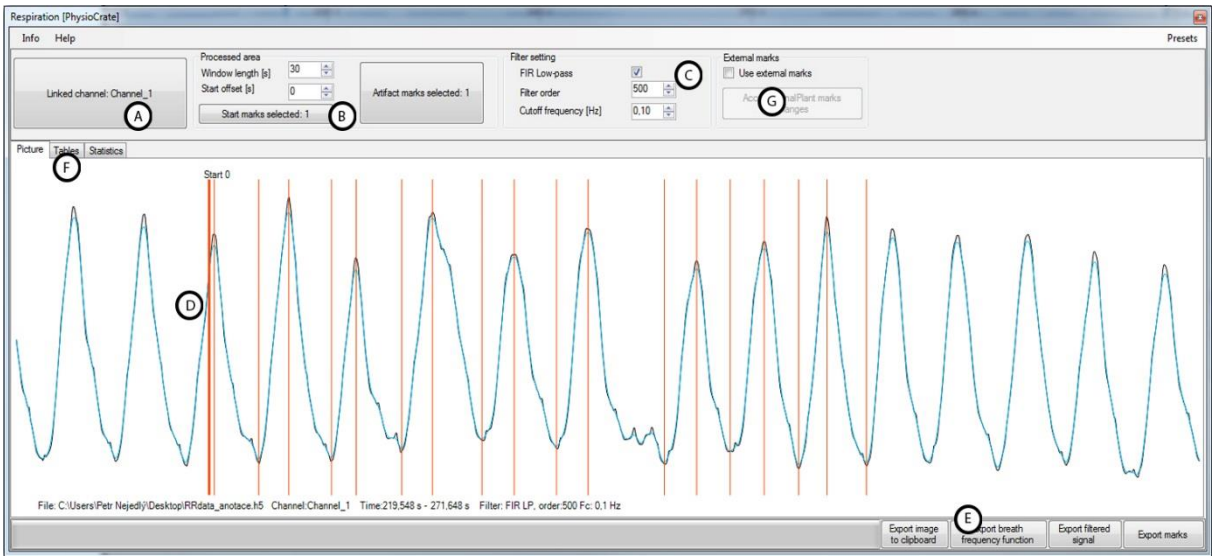

Figure 2 –Respiration analysis plugin window. Blue line is filtered signal(FIR low-pass at 0.1 Hz, 500th order) and black line is original signal. Orange vertical lines shows inspiriums and exspiriums.

EMG ANALYSIS

The plugin allows labeling of areas based on EMG activity in specified frequency range. User can select from several detection options. Detected areas can be exported back to SignalPlant for further usage. Statistical results from detected segments are also printed in a table.

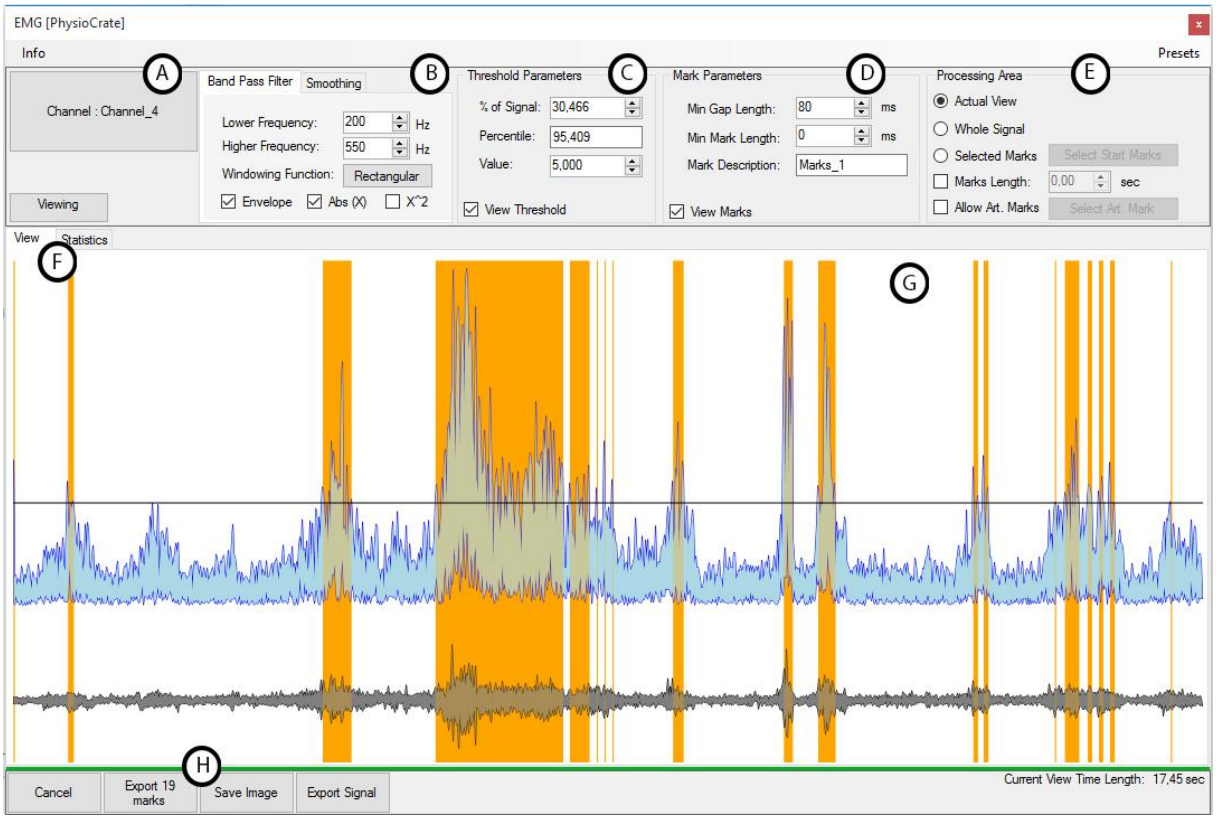

Figure 3, Emg analaysis plugin window. Original is grey curve in the bottom of the window. Envelope of the signal filtered in specified frequency range is blue curve. Orange verticals shows higher activity areas.

USAGE

Attach channel to the plugin using button (Fig-A). Cut-off frequency of band pass FFT filter may be changed (Fig-B) as well as segment detection mode. First mode obtain signal envelope from Hilbert transform. Second mode computed absolute value from signal. Last mode uses squaring of signal to obtain signal power (Fig-B). User may specify threshold for filtered and processed EMG signal. Threshold value can be set by specific value or percentile (Fig-C). Short duration peaks may be excluded from analysis by selecting minimum gap between two segments (Fig-D). It is also possible to analyse specific time interval only. To do so, it's needed to select start mark (Fig-E) and set the duration. Artificial areas may be excluded from analysis by selecting artificial marks (Fig-E). The grey signal in bottom of preview window is original EMG signal and blue signal is preview of filtered and processed EMG signal (Fig-G). Preview of detected areas is shown in panel (Fig-F) as orange blocks. Plugins allows export detected segments back to the SignalPlant as marks. Moreover, filtered signal may be exported as well (Fig-H).