g.HIsys Block Library

g.HIsys comes with specialized blocks for biosignal analysis that are needed in many real-time experiments. The library contains blocks for plotting data, pre-processing (source derivation, Notch filter, bandpass filter), transformation (pre-post trigger, cut samples, select channels), feature extraction (on-line averaging, ERD online, online FFT, Pre/Post PSD, spectrogram, significance analysis), output signals through muscle activity (spasticity control, EOG selection, EMG selection) and a binary decoder.

FILTERS

The source derivation, notch filter, EEG/ECG BW filter and BP BW filter blocks allow you to remove artifacts from the data or to extract certain components.

FILE IO

The g.FROMfile and g.TOfile blocks are highly optimized blocks for quickly streaming data, which is especially important for a high number of channels or high sampling rates (up to 38.4 kHz per channel). The blocks also allow you to define a maximum file size to avoid unnecessarily large data-sets.

SIGNAL QUALITY

The g.SQcheck and g.SWdisplay allow you to perform real-time artifact detection and to identify whether the data are clean during the experiment.

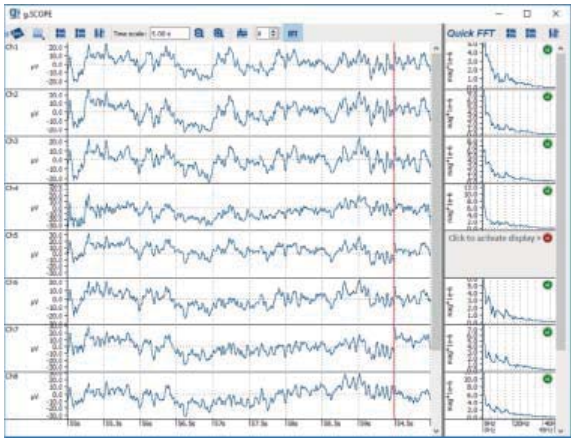
SIMULATION

The Real Time clock allows you to run the Simulink model without an amplifier connected and to simulate real-time behavior.

BATCH PROCESSING

The Batch Processing block allows to specify necessary off-line processing steps for a certain Simulink model. When the Simulink model is stopped, the processing is automatically performed.

VISUALIZATION



The g.VECTORscope allows you to visualize signal averages of multiple channels. The g.EPscope can show EPs from target and non-target signals and perform a statistical analysis. The g.SCOPE is used to visualize raw biosignal data, and the g.THRESHOLDscope allows you to visualize biosignal data and manually define a triggering threshold. The Online Plot and Online Spectrum Plot are used to visualize EPs and spectrum data.

SIGNAL MANIPULATION/TRANSFORMATION

The Select Channels blocks allow you to perform the signal processing steps on a sub-set of channels, the Cut Samples block is used for EPs to select a pre- and post-stimulus interval and the Trigger block allows you to select epochs for EPs. The Select Events block selects event codes from the incoming events. For each change of the incoming event code (from zero to a non-zero value), the event codes are compared to specified event codes for selection. The Binary Decoder converts data into binary format e.g. to generate trigger signals. The g.SENSORadaption block converts input data from a g.tec sensor (such as a temperature sensor, g.Sensor, GSR sensor and SpO2 sensor) into meaningful outputs corresponding to the sensor.

EMG/EOG

Spasticity Control allows you to check the EMG contraction level. EOG Selection allows you to control a device with eye-blinks and eye-movements. EMG selection threshold calculates the RMS and allows you to trigger on muscle movements. EMG selection calibration allows you to calibrate on certain muscle movements to generate triggers, if the threshold is crossed, and EMG 2D selection calibration allows 2D muscle control.

FEATURE EXTRACTION

Feature extraction blocks allows you to calculate the power spectrum, ERD, FFT, averages and to perform a significance analysis.

AUDIO/VIDEO PROCESSING

The AudioStimulation block presents a set of pre-recorded sound files via a low-latency sound driver to create different types of audio stimulation. The sound files can be enabled using a given sound ID. The g.AudioStream block sends stereo CD quality sound output to the standard speakers from Simulink. The g.CAMERAcapture block allows you to record videos together with biosignals.

INPUT / OUTPUT

The Marker block is for keyboard and mouse markers in Simulink. The block checks the system for keyboard and mouse events and generates markers accordingly. Multiple blocks can be used to look for different events. The g.Mouse block can generate cursor movements via Simulink, similar to mouse control.

EXPERIMENTS

The Paradigm block can be used for audio, picture, video and text paradigms. The Paradigm Presenter allows you to run multimodal paradigms with videos, audio, text, images and DIO with g.STIMbox.

EXAMPLES

Examples contains many ready-to-go Simulink models.

: ’ +QW K 3 H w6 vQ5’ 6 z QQ

eeea2 J6 5O :d2 fi K fQ M 2 b M 6 fiMf G8b2 J W f / dlea. fQ6 2 N 6

vQ6Hl.moG.ll lncl N 3 6QH l.ecoccbm ncl zD 6H Q q L QoD 5 D IQ3H /// QoD 5 D

Toolboxes

g.tec develops many toolboxes that run under g.HIsys. These toolboxes contain all real-time processing code and allow to interact with g.BSanalyze to calibrate BCI systems or to perform off-line analysis.

G.RTANALYZE REAL-TIME ANALYSIS

g.RTanalyze is a biosignal processing blockset for use with Simulink. The g.RTanalyze blocks can be used for on-line simulations under Simulink and for real-time applications with Highspeed Online Processing for Simulink. Drag and drop the pre-processing, parameter estimation and classification algorithms into your SIMULINK real-time application to accelerate your research, encourage creativity and reduce project costs. The blockset enables you to quickly compare multiple algorithms. Use the blocks as templates and make your own modifications.

The blockset is divided into general purpose blocks and biosignal processing blocks. General purpose blocks are derivations, filters and different algebraic blocks. Biosignal processing blocks are used for pre-processing, parameter estimation and classification of off-line or real-time EEG, ECG, EMG, respiration or galvanic skin response data.

Included parameter estimation blocks are: Hjorth parameters, Barlow parameters, Bandpower, Variance and Adaptive Autoregressive Models with RLS, Kalman and LMS algorithms, minimum energy, EMG co-activation index and EMG spasticity. All important methods for BCIs based on P300, motor imagery, SSVEP/SSSEP and slow cortical potentials are included. The ECG block allows you to calculate heart-rate and heart-rate variability parameters. Furthermore, respiration rate/deepness and the change rate of galvanic skin response can be calculated. The blockset contains also blocks to control a system with EOG and EMG activity for human computer interaction.

The apply classifier block allows you to use linear and non-linear classifiers for the on-line classification of parameters. Examples are linear discriminant analysis or support vector machine based classifiers calculated in g.BSanalyze. The classifier block also performs a statistical analysis to realize a zero class for BCI control. This means that the BCI system will not make a decision if the subject is not paying attention. Furthermore, blocks for majority voting and change rate calculation are included.

G.DISTRIBUTEDEEG

g.DISTRIBUTEDeeg allows you to record biosignal data using the g.tec amplifier g.USBamp from different distributed PCs (DataPCs) in the network and transmit the recorded data to a central evaluation / data storage PC (EvalPC). Data acquired from the DataPCs are synchronized using the OSC protocol for distributed systems, and the data are transmitted to the EvalPC using the UDP network interface.

MULTI-DEVICE ACQUISITION

g.HIsys also supports the acquisition from multiple g.tec amplifiers of similar or different types. This means a g.Nautilus can be used with a g.USBamp or g.HIamp, even with different sampling frequencies. You can also use multiple g.HIamps, g.USBamp or g.Nautilus in one single Simulink model. In Simulink, every amplifier is set up with a certain, individual sampling frequency. The amplifier block delivers the data samples in real-time to a Scope, to the signal analysis or to store the data. This allows you to work with more

than 256 channels e.g. for ECoG studies, and it also allows you to record from multiple users at the same time on one single computer. This makes the online data quality control much easier, requiring only one computer for data storage that can analyze data from multiple users.

CAMERA CAPTURE

The g.CAMERAcapture block allows you to record a video from a webcam in MATLAB/Simulink and to synchronize the video with the biosignal data. The synchronization is done using the video frame number, which is output from the g.CAMERAcapture block and saved with the biosignal data. The biosignals and video can be read with g.BSanalyze for offline analysis

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