CI Vocoder – General settings for usage

The CI Vocoder simulates Cochlea Implant signal processing using pulsatile sampling of the signal envelope in N "electrode channels". It is also possible to simulate electroacoustic hearing or acoustic hearing only (via low frequency band pass). After simulation of cochlea implant signal processing the generated sequential pulse patterns across channels are auralized.

In the auralisation stage each pulse gets filtered with a narrow band filter. This narrow band filter can be placed at the approximated positions of real cochlear implant electrode arrays. For a detailed description of the signal flow please read the included master thesis of Timo Bräcker about the developed CI Vocoder.

Input parameters:

Signal = vector with time signal. Only one channel at a time can be vocoded.

fs = sampling frequency of input signal

vocoder_type = Type of Vocoder: Possible choices: 'CI' for pure electric simulation,
'Acoustic' for simulation of low-frequency hearing or
'EAS' for electroacoustic simulation.

Optional input parameters

All optional input parameters can be evoked with 'key'-'value' pairs. See below for the details.

Output parameters:

vocoded_signal = vector with the vocoded signal

mElectroderand = (optional) outputs the used electrode randomization across pulsatile sampling. This can be used to create a "synchronized" electrode pattern across ears. Example usage:

[vocoded_signal_left, mElectroderand] = CI_Vocoder(my_signal, 44100, 'CI'); - logs electrode pattern

vocoded_signal_right = CI_Vocoder(my_signal, 44100, 'CI', use_electrode_pattern', mElectroderand);

PPS-Rate over all channels. To obtain PPS per Channel divide this number by number of center_frequencies_hz_stimulation

p.addParamValue('voc_sampling_frequency_hz', 22000, @isnumeric); % 55000

Bandwidth of Filters

p.addParamValue('filters_per_ERBaud', 1, @isnumeric);

Order of Gammatonefilterbank (stimulation and auralisation analysis filterbank)

p.addParamValue('gamma_order_stimulation', 3, @isnumeric);

p.addParamValue('gamma_order_auralisation', 3, @isnumeric);

Lowest cutoff frequency of gamma tone filter bank

p.addParamValue('lower_cutoff_frequency_hz', 150, @isnumeric); % 70

One specified center frequency

p.addParamValue('specified_center_frequency_hz', 1938, @isnumeric); % 1175

Upper cutoff frequency of gamma tone filter bank

p.addParamValue('upper_cutoff_frequency_hz', 8000, @isnumeric); % 8500

Middle frequency of analysis-filter bank for MED-EL model

p.addParamValue('center_frequencies_hz_stimulation', …
[120 235 384 579 836 1175 1624 2222 3019 4084 5507 7410], @isnumeric);

Middle frequency of analysis-filter bank for Cochlear Nucleus model

p.addParamValue('center_frequencies_hz_stimulation', …
[250 375 500 625 750 875 1000 1125 1250 1438 1688 1938 2188 2500 2875 3313 3813 4375 5000 5688 6500 7438], @isnumeric);

Default pulse-length is 2 Samples, which equals 36 ms at f_sampling = 55100 Hz.

p.addParamValue('len_pulse', 1, @isnumeric);

Electrode mapping auralisation filter bank for MED-EL model

p.addParamValue('center_frequencies_hz_auralisation', …
[390 550 759 1031 1384 1843 2440 3216 4225 5537 7243 9460], @isnumeric);

Electrode mapping auralisation filter bank for Cochlear Nucleus model

p.addParamValue('center_frequencies_hz_auralisation', …
[664 775 902 1046 1210 1396 1608 1849 2123 2435 2789 3192 3651 4173 4766 5441 6208 7081 8074 9204 10488 11950], @isnumeric);

Existing electrode pattern

p.addParamValue('use_electrode_pattern', 0, @isnumeric);

Spatial spread in mm

p.addParamValue('spatial_spread', 3, @isnumeric);

Compression (0 = off, 1 = on)

p.addParamValue('bcompress', 0, @isnumeric);

Exponential decay constant for spatial spread (0.0036 for MED-EL, 0.009 for Cochlear model)

p.addParamValue('lambda', 0.009, @isnumeric);

Distance between adjunct electrodes [m] for calculation of spatial spread (0.0028 for MED-EL, 0.0007 for Cochlear model)

p.addParamValue('distance_electrodes', 0.0007, @isnumeric);