Signal processing for SSVEP BCI

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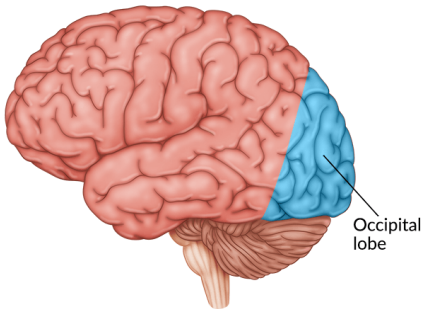
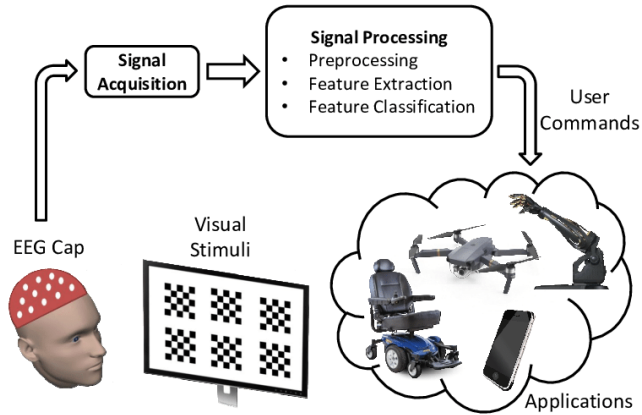
NEUROTECH LEUVEN KU LEUVEN

Steady State Visually Evoked Potentials

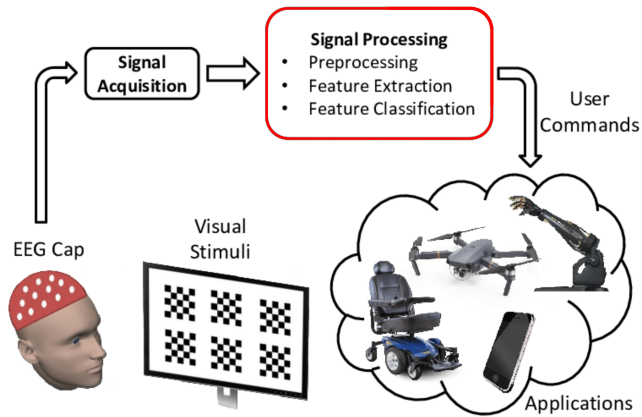
If a stimulus oscillates at a specific frequency, an oscillation at the same frequency will also appear in the brain activity of the occipital lobe.



SSVEP BCI

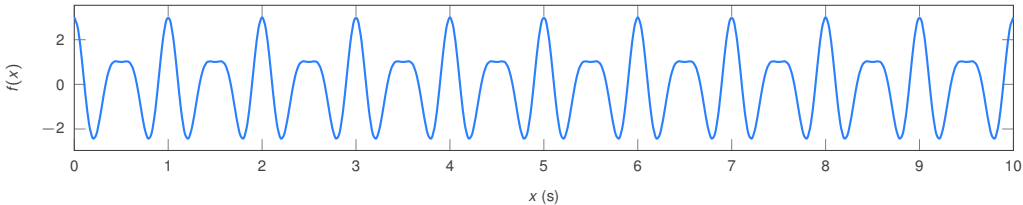

Signal Acquisition
Signal Processing
• Preprocessing
• Feature Extraction
• Feature Classification
User Commands
EEG Cap
Visual Stimuli
Applications

This workshop

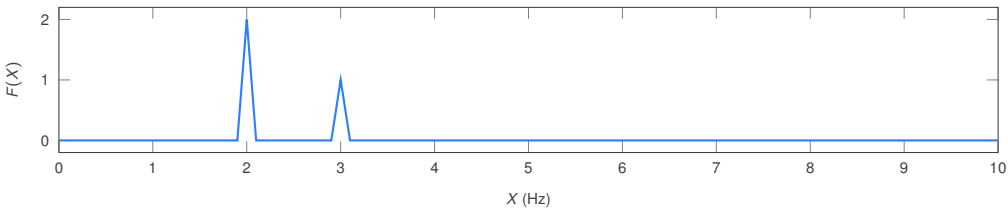


The Fourier transform

Time domain: $f(x) = 2\cos(2\pi x * 2) + \cos(2\pi x * 3)$

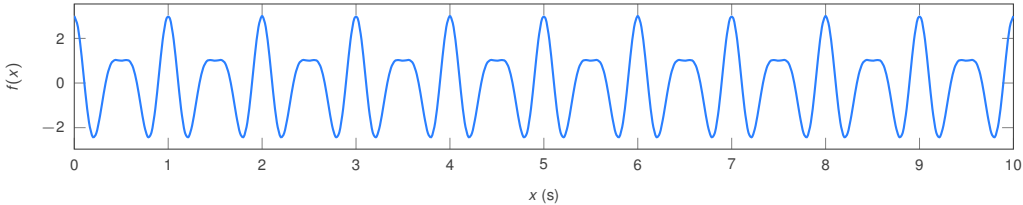


Frequency domain:

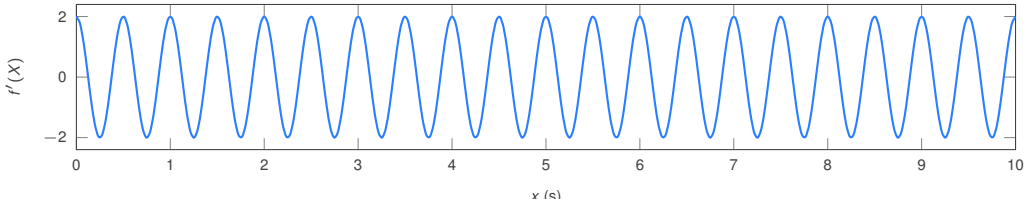


Filtering

Broadband signal: $f(x) = 2\cos(2\pi x * 2) + \cos(2\pi x * 3)$



Filtered signal at 2Hz:



Filtering

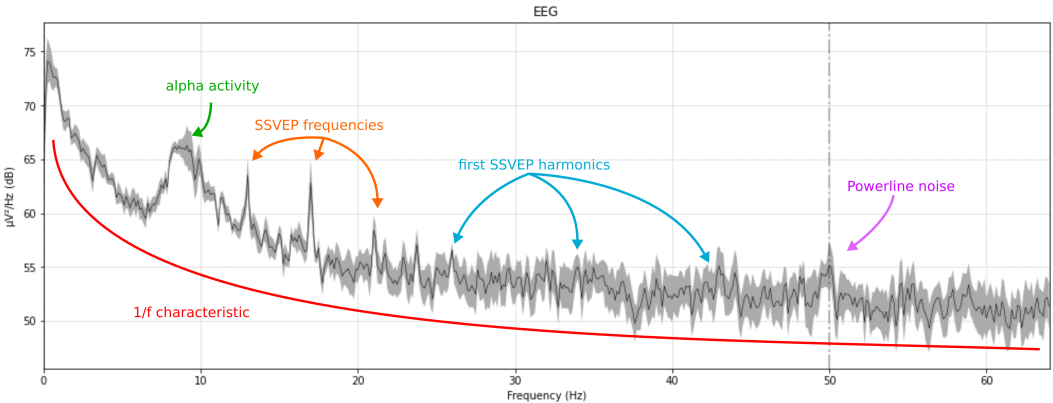
Apply a single filter:

- Single frequency filter
- Band-pass filter
- Band-stop filter
- Notch filter

Apply a time-frequency transform:

- Filterbank
- Wavelet transform,
- Multitaper filtering
- . . .

The EEG spectrum



Choosing stimulation frequencies

Consider

- SSVEP range (3.5-75Hz)
- Alpha activity (8-12Hz)
- Powerline frequency (EU: 50Hz, USA: 60Hz)
- Monitor refresh rate (60Hz, 144Hz, 240Hz, ...)
- Frequency spacing
- Comfort

Mind the harmonics!

Choosing stimulation frequencies

Which of these SSVEP designs are suited for the EU power grid and a 60Hz monitor?

- 2Hz, 5Hz, 8Hz, 12Hz
- 13Hz, 17Hz, 21Hz
- 20Hz, 30Hz, 40Hz, 50Hz
- 31Hz, 47Hz, 53Hz, 67Hz, 71Hz
- 12Hz, 14Hz, 18Hz, 23Hz
- 6.66Hz, 7.50Hz, 8.57Hz, 10.00Hz, 12.00Hz,
- 10.13Hz, 11.47Hz, 12.67Hz

Choosing stimulation frequencies

Primes are your friend!