Signal processing for SSVEP BCI

NeuroTech Leuven

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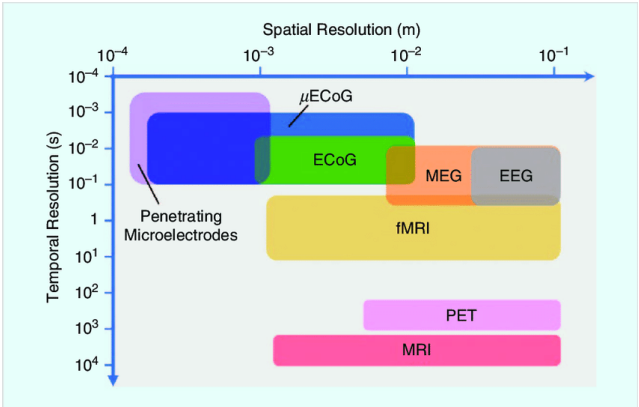
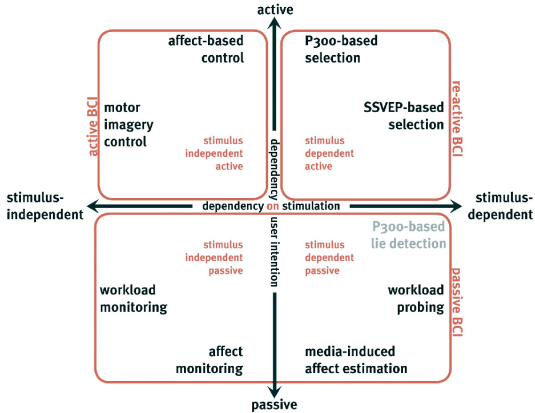
Neuroimaging modalities



Anish *et al.* (2018)

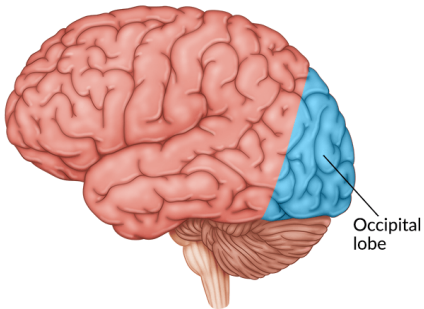
BCI paradigms



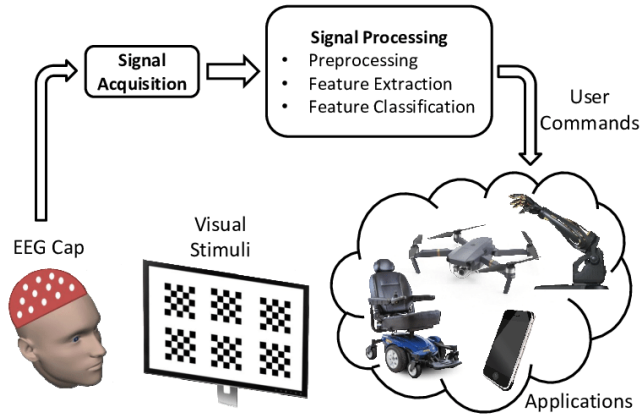
Mühl *et al.* (2014)

Steady State Visually Evoked Potentials

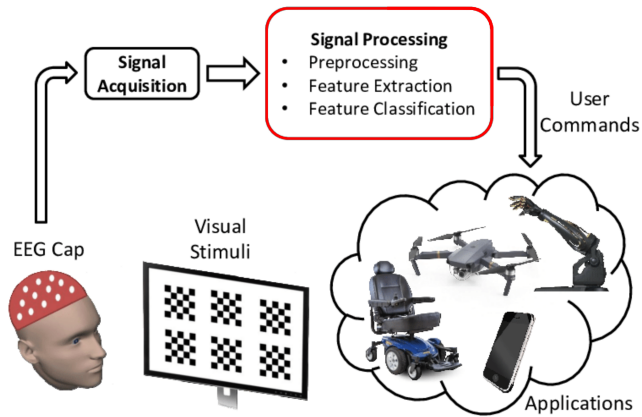
If a stimulus oscillates at a specific frequency, an oscillation at the same frequency will also appear in the brain activity of the occipital lobe.



SSVEP BCI

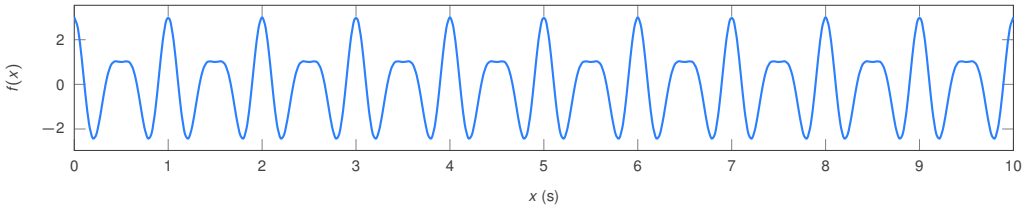

Signal Acquisition
Signal Processing
• Preprocessing
• Feature Extraction
• Feature Classification
User Commands
EEG Cap
Visual Stimuli
Applications

This workshop

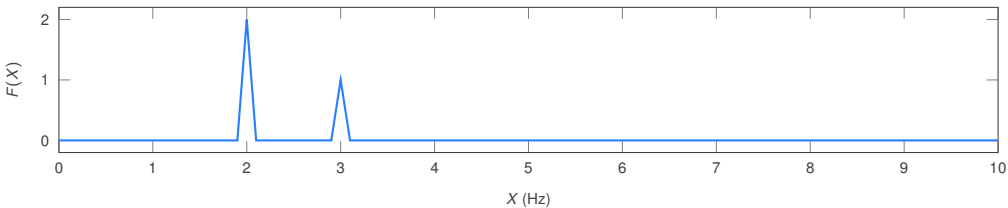


The Fourier transform

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

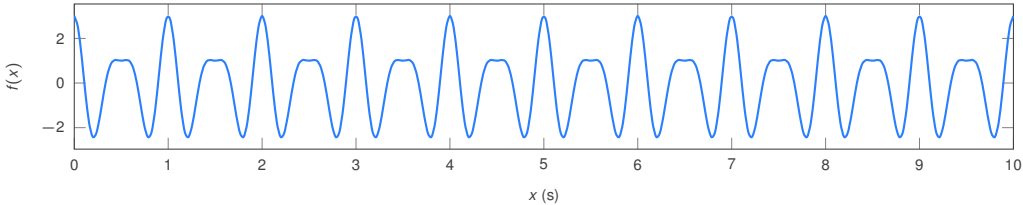


Frequency domain:

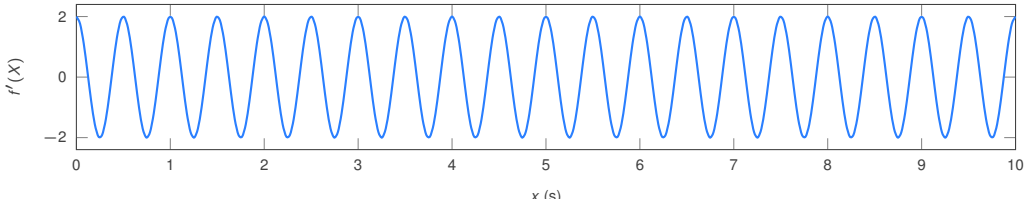


Filtering

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



Filtered signal at 2Hz:



Filtering

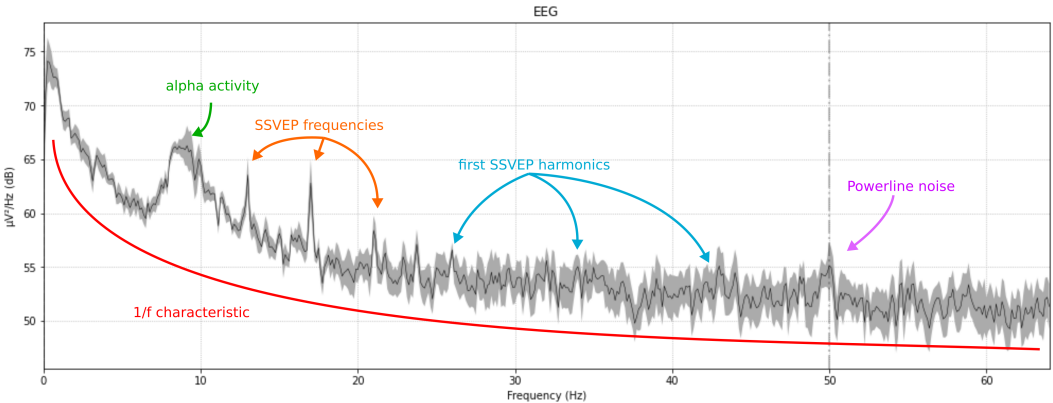
Apply a single filter:

- 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!