

Signal processing for SSVEP BCI

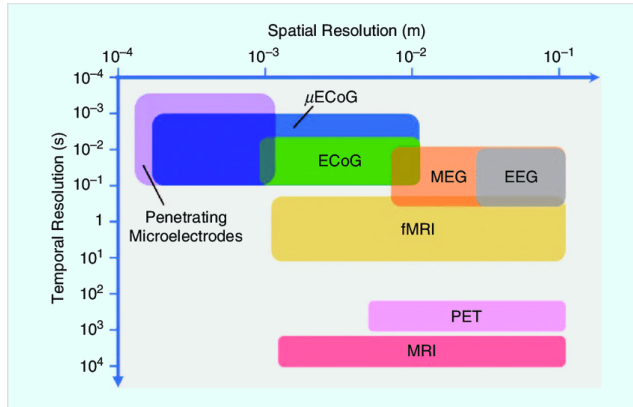
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Summer project 2022

NEUROTECH
LEUVEN

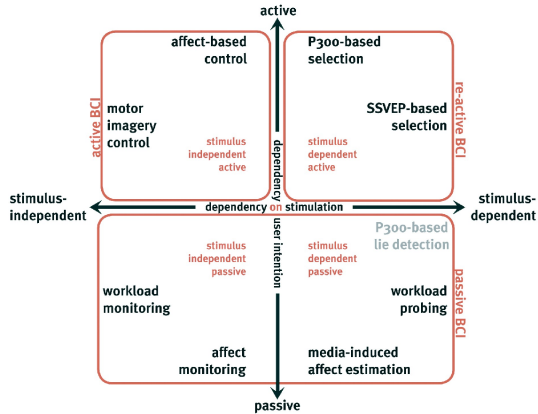
KU LEUVEN

Neuroimaging modalities



Anish *et al.* (2018)

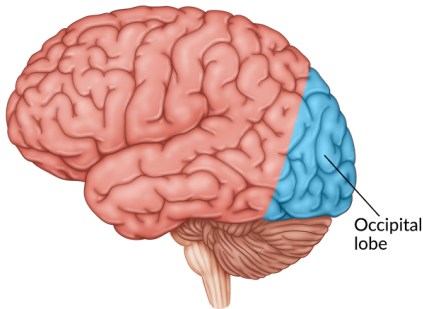
BCI paradigms



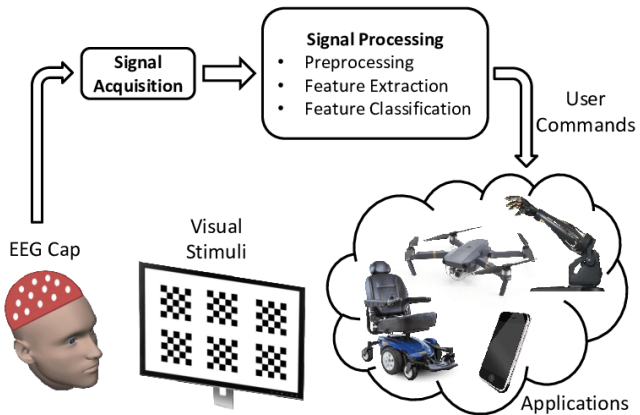
Mühl *et al.* (2014)

Steady State Visually Evoked Potentials

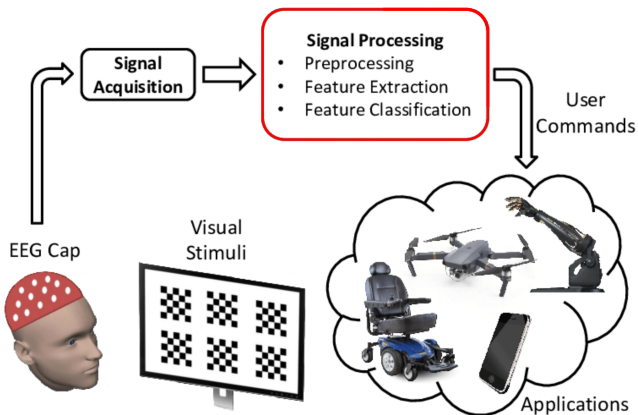
If a stimulus oscillates at a specific frequency, an oscillation at the same frequency will also appear in the brain activity of the occipital lobe.



SSVEP BCI

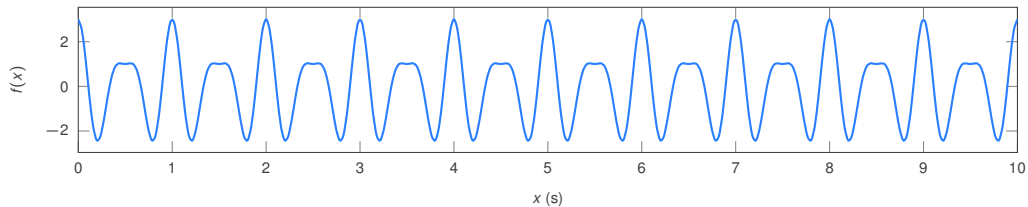


This workshop

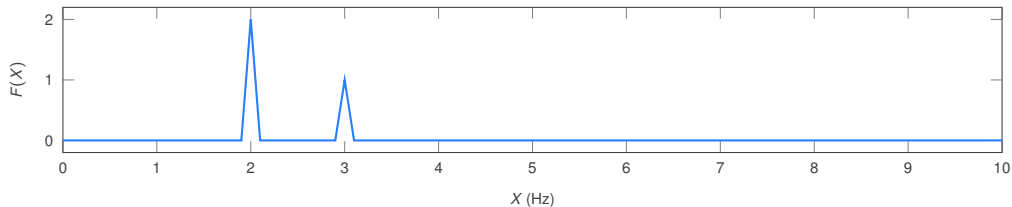


The Fourier transform

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

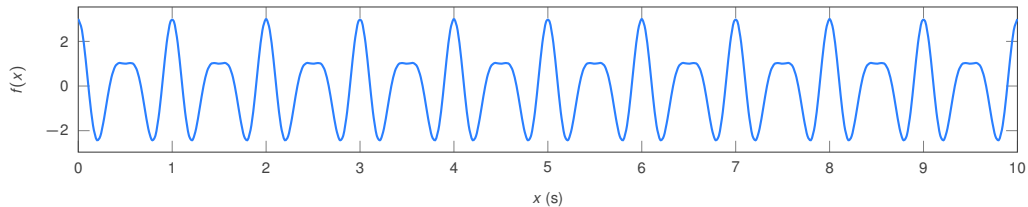


Frequency domain:

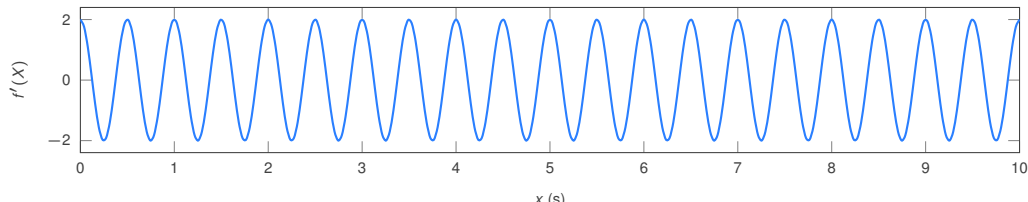


Filtering

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



Filtered signal at 2Hz:



Filtering

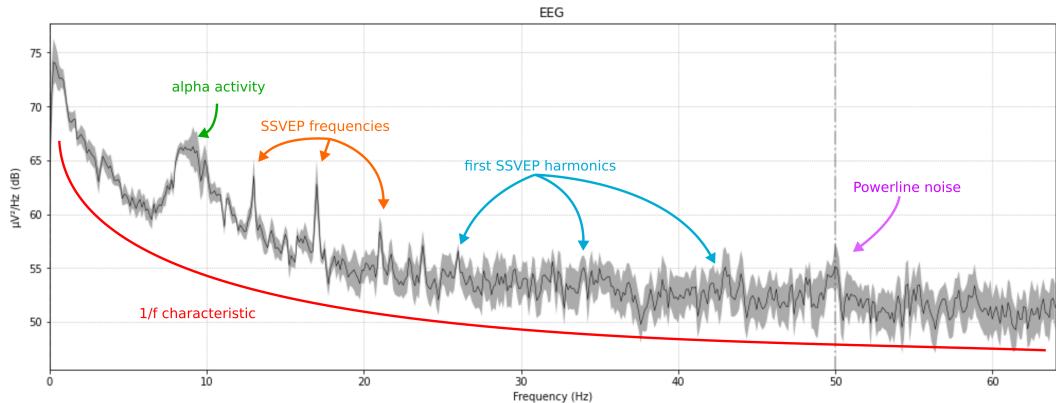
Apply a single filter:

- ▶ 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!