Where is Physiological Noise Lurking in k-Space?

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Objectives

- Investigation of *k-space structure* of physiological noise in fMRI
  
  This is useful for:
  - *Knowledge of the k-space distribution is important in itself*
  - *Reduction in computational burden*
  
  **Example.** Little degradation if only spatial frequencies containing 90% of the total energy are used in reconstruction:
Data

- A **27-run** set of **resting state fMRI** data and associated anatomical images of one volunteer.
- 3 T Siemens Skyra scanner
- 32-channel head coil array
- EPI sequence parameters:
  - **TR:** 77 ms, **TE:** 21 ms, **FA:** 60°,
  - **FOV:** 224 mm, **matrix size:** 64 x 64,
  - **voxel size:** 3.5 x 3.5 x 6 mm

- **Two slices** per run:
  - About **30 seconds** in length
  - A fixed reference slice
  - Second slice, with the gap to the reference slice **advancing**

- **Reference cardiac and respiratory signals** were obtained **time-locked** to the fMRI data
DRIFTER

- DRIFTER is a model-based method for retrospective identification and removal of physiological noise in fMRI data
- Based on a stochastic resonator model and estimation with Kalman filters and smoothers
- Each voxel is handled independently
DRIFTER: Illustration
**k-space amplitude maps**

- Distribution of logarithmic *k*-space amplitude for slices 7 and 19
- Contour in the 3rd column: enclosure of frequencies containing 90% of total energy
Cardiac noise amplitude

Effect of using only a subset of spatial frequencies on cardiac noise map reconstruction
Respiratory noise amplitude

Effect of using only a subset of spatial frequencies on respiratory noise map reconstruction
Animated example: cardiac noise
Animated example: respiratory noise

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Respiratory noise amplitude
Conclusions

• We have presented how physiological noise is structured in $k$-space

• Noise is heavily concentrated to low spatial frequencies

• It is possible to use only a subset of spatial frequencies in the reconstruction and have little degradation in quality
Conclusions

The **DRIFTER toolbox** for **MATLAB** and **SPM** is available for download

http://becs.aalto.fi/en/research/bayes/drifter/