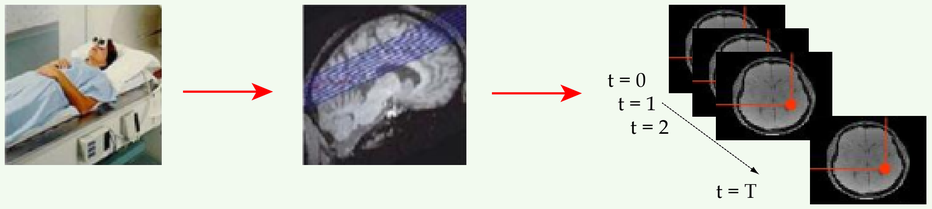
Image reconstruction in parallel MRI using wavelets

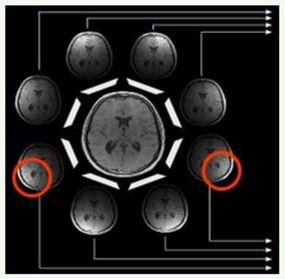
ANR project OPTIMED

Context



- Goal: dynamical study of brain activity trough functional MRI
  (collaboration with NeuroSpin-CEA)
- Problem: reduce acquisition time
- Solution: parallel MRI

Parallel MRI



- Antennas operating in parallel
- Complementary sensitivity profiles of antennas
- Subsampling in the Fourier domain

Model: $d = \mathbf{S}\,\rho + B$

– d: observed data
– $\mathbf{S}$: sensitivty matrix
– ρ: image to be reconstructed
– B: circular Gaussian acquisition noise with zero-mean and covariance matrix Ψ

Reconstruction

- Classical solution: SENSE (weighted least squares)

$$\hat{\rho}_{WLS} = [\mathbf{S}^H \Psi^{-1} \mathbf{S}]^{-1} \mathbf{S}^H \Psi^{-1} d$$

- Proposed method: regularization in the wavelet domain
  - coefficients of the image to be reconstructed: $\mathbf{O}_\rho$
  - coefficients of the observed image: $\mathbf{O}_d$
  - coefficients estimated by maximum *a posteriori*:

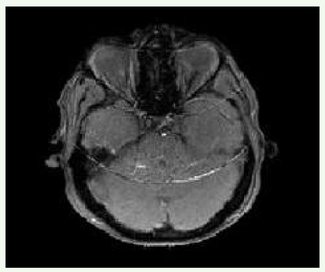
$$\mathbf{O}_\rho = \arg\max_{\mathbf{o}_\rho} f(\mathbf{O}_\rho | \mathbf{O}_d) = \arg\max_{\mathbf{o}_\rho} [\ln f(\mathbf{O}_d | \mathbf{O}_\rho) + \ln f(\mathbf{O}_\rho)]$$

$\Downarrow$

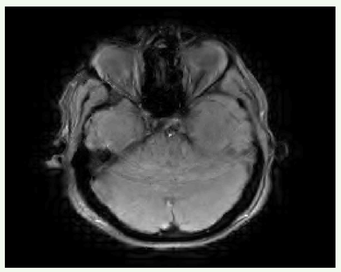
Non necessarily convex criterion promoting the sparsity of the solution

$\Longrightarrow$ Use of iterative proximal algorithms

Results



Classical solution SENSE



Proposed method

Contact: Lotfi Chaari, Jean-Christophe Pesquet

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