Presentation of the activities of the signals group of L2S

Signals group in 2012
- Permanent researchers 14 (5 CNRS, 9 University)
- PhD students : 12
- Postdoctoral fellows : 2
- Publications in peer-reviewed journals : 24
- Chapters in books : 2
- Publications in conferences with proceedings : 28
- Invited conferences : 3

Research at Signals group is classified along two axes

Statistical modeling (7 permanent researchers)

- Time series analysis
  - Long-memory processes : piecewise FARIMA models, prediction of strongly-dependent processes
  - Non-gaussian processes : ARIMA models with non-gaussian innovations, ARMA signals with specified symmetric marginal probability distribution
  - Robust estimation of SARIMA models : application to short-term load forecasting
  - Missing data : financial models with missing observations

Multi-sensor signal processing
- Performance in array processing in terms of estimation and resolution limits : near-field estimation, analysis of polarized antennas, MIMO radar
- Multilinear SVD : tensor decomposition at low cost, multidimensional harmonic retrieval
- Space-time adaptive processing (STAP) for airborne radar : range recursive STAP algorithm, bistatic STAP, MIMO-STAP, heterogeneous clutter
- Difficulties : Due to the change of the temperature on the spacecraft; Small detector, lead field matrix is known; Very noisy signals.
- Our approach : Use of mixed-norms to take into account the time persistence of signals.
  - Our approach ⇒ problems with a scan procedure.
- Objectives : To localize the neuronal sources.

Inverse problems (7 permanent researchers)

Bayesian approaches
- Bayesian variational methodology : algorithms for solving large dimensional inverse problems, convex optimization in functional spaces
- Non parametric methods : infinite mixture of gaussian models, estimation without sampling grid, fine modeling of dynamics evolution of images
- Stochastic markovian models : hidden gaussian Markov models, prior for piecewise homogeneous images

General approach for sparse approximation
- Non differentiable convex optimization : sparse method such as Lasso/Basis pursuit, mixed norms for structured sparsity, accelerated first order optimization methods, study of algorithmic complexity and convergence rate
- Random models : Bernoulli-gaussian models, EM-like iterative algorithms

Applications
- medical imaging
- Position Emission Tomography (PET)
- far infrared imaging
- super resolution estimation
- Synthetic Aperture Radar (SAR) imaging
- microwave diffraction tomography
- analysis of biological data
- parallel computing (cluster, Graphics Processing Unit) for 3D or 3D + T tomographic problems
- aeroacoustic imaging :

- Wind tunnel test by Renault S2A

- Objectives : Sparse prior for the source spatial distribution; Background noise estimation; Hyperparameter estimation by Bayesian inference; Fast implementation using Graphics Processing Unit (GPU);
- inverse problem M/EEG :

From EEG recording on the scalp, how to localize the neuronal sources ? ≈ 150 sensors on the scalp; ≈ 20000 neuronal sources (depending of the model); Lead field matrix is known; Very noisy signals.
- Problem very under-determined ⇒ need of strong prior.
- Our approach : Use of mixed-norms to take into account the time persistence of signals; Use of Gabor dictionary; Development of new convex optimization algorithms to process real data in reasonable time.
- Difficulties : Data are collected from a spacecraft telescope; Residual drift on the measurements due to the change of the temperature on the spacecraft; Small detector ⇒ large map are acquired with a scan procedure.
- Objectives : Reduce artifacts, estimated offset and glitch; Design a super resolution approach; Solve the ill posed inverse problem; Separate the cosmic background and the stars; Design an unsupervised approach.

(a) true, (b) official approach, (c) our approach without drift estimation, (d) our approach with drift estimation.