Finite Rate of Innovation model for Image Coding

Supervisors : Sylvain Meignen(LJK),
Location : LJK Laboratory (campus)
PhD Thesis : yes (co-supervised with Edinburgh, Scotland)
email : sylvain.meignen@imag.fr, phone:(+33).4.76.51.43.95

1 Finite Rate of Innovation

In image processing, a lot of signals are not bandlimited and thus cannot be represented using decomposition on bandlimited filters. Typical illustrations of this are streams of Dirac or piecewise polynomials. Thus, to encode such signals using linear techniques like wavelet decompositions results in many detail coefficients and are therefore not optimal. To circumvent this problem, some authors [1] remarked that streams of Dirac and piecewise polynomials are associated with a finite degree of freedom. For instance, the former are defined by the location of the Diracs and their amplitude, and are said to be with *finite rate of innovation* (FRI).

The key issue to determine the FRI is to use an annihilatory filter (also called locator) filter [1]. Then a filter is applied onto the signal depending on the computed FRI bearing in mind that signal reconstruction has to be still possible from the filtered signal. However, the approach proposed in [1], is limited in that it is very sensitive to noise or other perturbation, and also because most signals are usually not characterized by a finite degree of freedom. For that reason, many developments have been carried out to estimate FRI in a noisy context [2][3] which can be viewed as attempts to stabilize the seminal algorithm.

2 Objectives of the internship

The goal of the internship will be first to understand the literature on FRI and to implement the algorithm proposed in [1] and show its sensitivity to noise. Then, it will be interesting to study how noisy signals have been dealt with in that context in the above mentionned papers. Finally, we will try to switch to image coding by remarking that a row of an image can be modelled by a FRI signal plus some oscillations that we will try to characterize. This should naturally lead to a new image encoder. In this regard, the student will have to study alternative approaches proposed in [4] to encode and image using FRI-like approaches.

3 Prerequisite

The student should be skilled in mathematical image processing and be familiar with Matlab. He should have some personnal interest for image compression and super-resolution.

References

[1] M. Vetterli, P. Marzialano, T. Blu, *Sampling Signals with Finite Rate of Innovation,* IEEE Transactions on signal processing, vol. 50, n. 6, pp. 1417-1428, 2002.

[2] V.Y.F. Tan and V. Goyal, *Estimating Signals with Finite Rate of Innovation from Noisy Samples: a stochastic algorithm,* IEEE Transactions on signal processing, vol. 56, n. 10, pp. 5135-5146, 2008.

[3] I. Maravic and M. Vetterli, *Sampling and Reconstruction of Signals with Finite Rate of Innovation in the Presence of Noise,* IEEE Transactions on signal processing,vol. 53, n. 8, pp. 2788-2805, 2005.

[4] I. Maravic and M. Vetterli, *Exact Sampling Results for some Classes of Parametric Non-Bandlimited 2D Signals,* IEEE Transactions on signal processing,vol. 52, n. 1, pp. 175-189, 2004.