Master's degree research project

Image restoration: a new discretization for the total generalized variation

Keywords: image restoration, variational regularization, total variation, total generalized variation, large-scale convex nonsmooth optimization

Location: GIPSA-Lab research center, team AGPIG, campus of St Martin d'Hères

Supervisor: Laurent Condat, CNRS research fellow. Contact: see my email on my webpage
http://www.gipsa-lab.grenoble-inp.fr/~laurent.condat/

Required competences: skills in image processing, convex optimization, and Matlab or Python programming. This project is rather targeted to the MSIAM track MSCI

PhD foreseen: yes, the candidate should be motivated to continue with a PhD after this internship

The total variation (TV) is a popular convex regularization functional in image processing, introduced in the nineties. The TV of a continuously-defined image x with domain Ω is defined as

$$\mathrm{TV}(x) = \int_\Omega |\nabla x|, \tag{1}$$

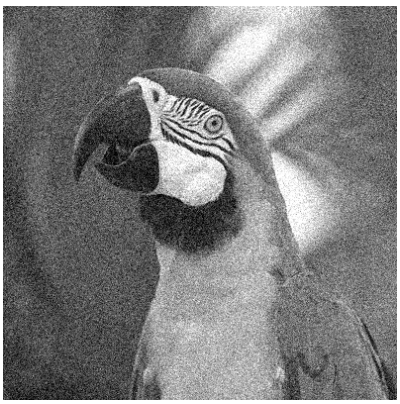
where $|\cdot|$ denotes the 2-norm. The TV is efficient, since it maintains sharp edges in the image, but it yields a piecewise constant effect, which is unpleasant. Recently, the total generalized variation (TGV) has been proposed [1]. It is defined as

$$\mathrm{TGV}(x) = \min_v \int_\Omega (|\nabla x - v| + \mu |Jv|), \tag{2}$$

where J denotes the Jacobian of a vector field and μ is a parameter. When $\mu \to +\infty$, the TGV behaves like the TV. The TGV gives nice images with sharp edges and smooth regions.

In practice, the images are discrete: the pixel values are defined on a grid. The classical discretizations of the TV replace the derivatives by finite differences. This has some drawbacks [2]. To correct them, L. Condat proposed a new discretization of the TV, which has much better properties [2]. The goal of this project is to apply similar ideas to define a new discretization of the TGV. The extension of the new TV and TGV to color images will be investigated, as well. Algorithms for TGV minimization will be written, and tests on some imaging problems, like denoising, deblurring, enlargement, will be performed.

[1] K. Bredies, K. Kunisch, and T. Pock, "Total generalized variation," SIAM J. Imaging Sci., 3(3), 492-526, 2010.
[2] L. Condat, "Discrete total variation: New definition and minimization," preprint hal-01309685, 2016.



noisy image

denoised with the TV

denoised with the TGV ($\mu = 2$)