Anthropomorphic image reconstruction via sub-Riemannian geometry and hypoelliptic diffusion

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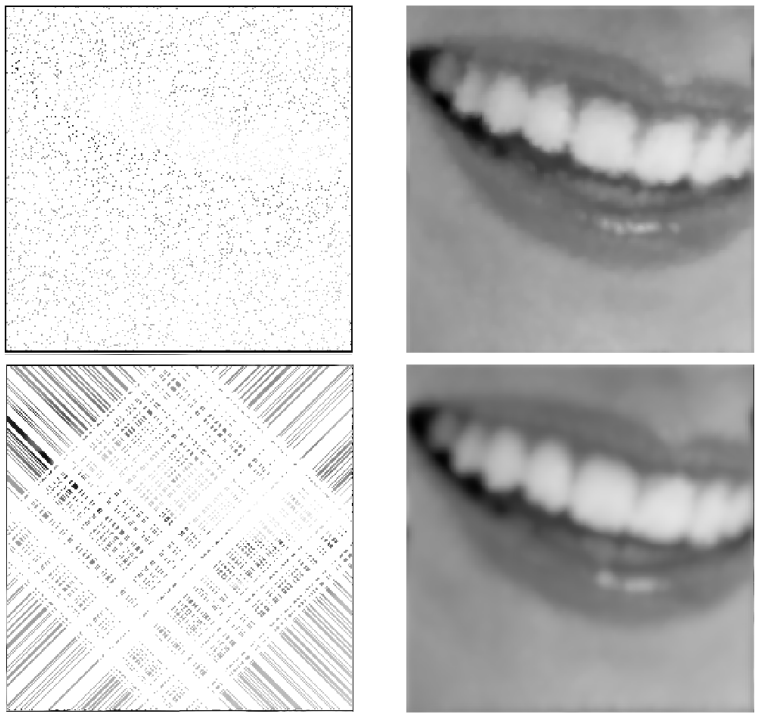
In this talk I will present an algorithm of image reconstruction based on a model of geometry of vision started with the works of Hubel and Wiesel at the end of the 50s, up to the works by Petitot, Citti and Sarti and our research group.
One of the main features of this model is that the primary visual cortex V1 lifts an image from $\mathbf{R}^2$ to the bundle of directions of the plane. Neurons are grouped into orientation columns, each of them corresponding to a point of this bundle. In this model a corrupted level set of an image is reconstructed by minimizing the energy necessary for the activation of the orientation columns corresponding to regions in which the image is corrupted gives rise to a sub-Riemannian problem. To this sub-Riemannian problem is naturally associated an hypoelliptic heat equation on the bundle of directions of the plane that can be used to reconstruct a "natural" image.
One of the main difficulties is the numerical integration of such a diffusion equation that being highly non-isotropic contains two different diffusion scales. We solve this problem by using techniques of non-commutative Fourier analysis on a suitable semi-discretization the group of rototranslations of the plane. The use of the knowledge of "where" the image is corrupted permits to reconstruct images with 97% of corruption obtaining result at the state of the art in image processing.



Références

[1] U. Boscain, R. Chertovskih, J.P. Gauthier, A. Remizov. *Hypoelliptic diffusion and human vision: a semi-discrete new twist.* SIAM Journal on Imaging Sciences 2014, Vol. 7, No. 2, pp. 669-695

[2] U. Boscain, R. Chertovskih, J-P Gauthier, D. Prandi, A. Remizov, *Highly corrupted image inpainting through hypoelliptic diffusion*, arXiv:1502.07331.

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