Imaging with Kantorovich-Rubinstein discrepancy

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In variational imaging one often minimizes the weighted sum of a discrepancy term (as a data fit) and a regularizing functional. Two successful models for denoising are the Rudin-Osher-Fatemi (ROF) model and the L^1-TV model. While the L^1-TV model overcomes the contrast loss of the ROF-model it still has some drawbacks, e.g. the staircasing effect and the effect of "suddenly disappearing structures". With respect to staircasing, several adaptions of the TV seminorm has been proposed, most notably the total generalized variation TGV by Bredies, Kunisch and Pock.

In this talk we model images in the space of Radon measures. Since L^1 is isometrically embedded in this space, we obtain a generalization of the L^1-TV model by going from the Radon norm to more general norms on the space of Radon measures. We propose to use the Kantorovich-Rubinstein norm (which is also known as the bounded-Lipschitz-norm and is motivated by ideas from optimal transport) for the discrepancy term. This leads to the KR-TV model as a generalization of the L^1-TV model. The kind of generalization is similar to the generalization from the ROF model to L^2-TGV denoising. We also point out relations to Meyer's G-norm approach to structure-texture decomposition. We also show that the method does not exhibit the problem of "suddenly disappearing structures" as it preserves to total mass of the image in a certain parameter regime.

We also present an accelerated primal dual method to solve the respective minimization problem and it turns out that the resulting algorithm is only slightly more involved than for the L^1-TV model. Numerical examples indicate that the proposed model does not suffer from contrast loss, does produce less staircasing that the ROF and the L^1-TV model and is particularly suited for structure-texture decomposition.