Infimal-Convolution of TV-Type Functionals as Regularization for Image Sequence Reconstruction

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We propose the infimal convolution of total (generalized) variation type functionals (ICTV) as regularization for the reconstruction of corrupted or incomplete image sequences.

Assuming that an image sequence is represented by a function u defined on a three dimensional domain, a simple form of the proposed regularization term can be given formally as

$$\mathrm{ICTV}(u) = \min_v \| |\nabla(u-v)|_{\beta_1} \|_1 + \| |\nabla v|_{\beta_2} \|_1.$$

Here, ∇ denotes the spatio-temporal derivative and $|\cdot|_{\beta_1}, |\cdot|_{\beta_2}$ denote two norms on $\mathbb{R}^3$ applying a different weighting of the temporal derivative. The choice of this particular type of functional is motivated by the need of suitably combining spatial and temporal regularity requirements.

The functional is defined in an infinite dimensional setting and important analytical properties are established. As application we consider the reconstruction of compressed video data, where experiments confirm a significant improvement compared to standard total variation type methods, which originates from the introduction of spatio-temporal anisotropies.

In the medical imaging context, the proposed functional has also been applied successfully for the regularized reconstruction of highly under-sampled dynamic MRI data.