Learning better image regularizers using bi-level optimization

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Variational methods are a class of effective approaches, which have been successfully applied to solve various inverse problems in image processing. A typical variational image processing model consists of an image prior term (also known as regularizer) and a data fidelity term, and its performance heavily depends on the regularization term. The development of better image regularization techniques has received intensive attention in the past two decades. We focus on a so-called Fields of Experts (FoE) image prior model (a filter-based higher order MRFs model), and introduce a bi-level optimization framework to train the FoE prior model. The resulting variational models with the learned image priors lead to generally demanding non-convex minimization problems, which can be efficiently solved using a recently proposed non-convex optimization algorithm - iPiano.

With the learned image prior models, we can significantly boost the performance of traditional variational models for classic image restoration problems, which employ hand-crafted image prior models, such as image denoising, super-resolution, de-convolution and in-paiting. The performance of our trained models is on par with the state-of-the-art algorithms for image restoration. Furthermore, our trained model comes along with the additional advantage, that inference is extremely efficient, since our models are well-suited to GPU parallel computation due to its simplicity.