Blind image deconvolution for a shaken photograph

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Despite all the advances in digital photography, motion blurring is still one of the most common causes of blurred pictures caused by camera movement during exposure time. A motion-blurred picture is usually modeled by

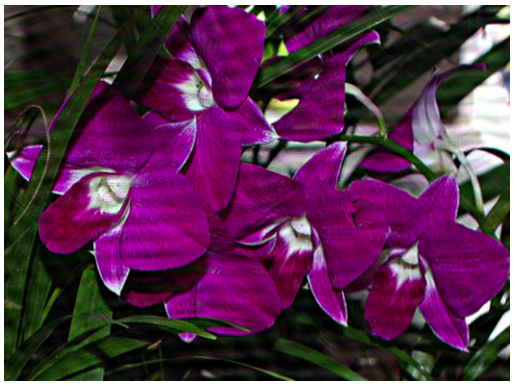
$$f = p * g + n,$$

where f denotes the blurry picture, g denotes the sharp one, n denotes image noise, and p denotes the blur kernel determined by camera movement. Then blind image deconvolution is about how to recover both the sharp image g from its blurred observation f without knowing the operator A; a challenging ill-posed non-linear inverse problem.

Our main objective is to develop powerful mathematical concepts and techniques for solving the blind image deconvolution problem, particularly for motion blurring caused by camera shake. Based on wavelet tight frame theory and ℓ_1 norm related minimization models for sparse approximation, we developed several important results and techniques for blind image deconvolution, including (i) a wavelet frame based mathematical functional that accurately measures the sharpness of an image [Ji et al. (2012), ACHA]; (ii) a new non-blind image deconvolution that is robust to the kernel error often seen in blind deconvolution [Ji & Wang (2012), IEEE TIP]; and (iii) a framelet-based algorithm for removing motion blurring caused by camera shake [Cai et al. (2012), IEEE TIP].

The experiments showed that the blind deconvolution algorithms we developed can be used to effectively remove motion blurring from images. Moreover, these results and techniques are quite general such that they are applicable to many other inverse problems arising from imaging science with small modifications.

(a) a motion-blurred photo



(b) the recovered one by our method