Fast model of space-variant blurring and its application to deconvolution in astronomy

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Rationale
In many applications, the point spread function (PSF) varies spatially. This is the case in wide-field imaging in astronomy, due to optical aberrations of the instrument, or imperfect correction of adaptive optics systems away from the reference stars. PSF are also often shift-variant in microscopy (e.g., in confocal microscopy, the PSF widens with depth).

Fast models of space-variant blurring are essential for iterative deblurring.

Prior works
Bloc processing: convolve, then interpolate [Nagy & O'Leary 1998]

Proposed fast approximations
PSF interpolation: weight with interpolation kernel, then convolve [Hirsch 2010]

Optimal localized approximation: refine weights and PSF to minimize approximation error

Results
Simulated blur: optical aberrations
defocus, spherical aberrations, tilt, vignetting restoration: MAP with smoothed total variation

Tradeoff between approximation quality and computational cost


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