Variational Bayesian sparse kernel-Based Blind Image Deconvolution with Student's-t Priors

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Introduction

- Blind Image Deconvolution
- Point Spread Function
- Student's t probability density function

- Student's-t pdf

  St(x— $\mu, \lambda, \nu) = \frac{\Gamma(\frac{\mathrm{v}+1}{2})}{\Gamma(\frac{\mathrm{v}}{2})}(\frac{\lambda}{\nu\Pi})^{\frac{1}{2}}(1 + \frac{\lambda}{\nu}(x-\mu)^2)^-(\nu+1/2)$

- Multivariate Gaussian Distribution

  N(x— $\mu, \Sigma) = (2\Pi)^{\frac{-\mathrm{M}}{2}}|\Sigma|^-1/2exp[-\frac{1}{2}(t-\mu)^T\Sigma^-1(t-\mu)]$

BID Model

- $g(x) = f(x) * h(x) + n(x)$
- vector format $g = f * h+n$
- $Fh = Hf = f * h$
  - F and H are block-circulant matrices with h and f vectors
- $g = Fh+n = Hf + n$

PSF Kernel Model

  - h(x) $= \sum_{M}^{i=1} \omega_i \phi_i(x)$
- h $= \sum_{i=1}^{M} \omega_i \phi_i$
- R(x,x$_i$) $= R(x - x_i)$
- h$= \phi * \omega = \Phi\omega = W\phi$
- g $=$ F $\Phi\omega + n = \Phi W f + n$

Variational Bayesian Inference

- observed variables D=g
- hidden variables $\theta = \omega, f, \alpha, \beta, \gamma$

- p(D) = L($\theta) + KL(q(\theta)||p(\theta/D))$
  - L($\theta) = \int q(\theta) \in \frac{\mathrm{P(D,}\theta)}{\mathrm{q}(\theta)} d(\theta)$
- KUlback-Leibler divergence KL(q($\theta)||p(\theta|D)) = -\int q(\theta) In \frac{\mathrm{p}(\theta|\mathrm{D})}{\mathrm{q}(\theta) d\theta}$

Experiments on Artificially Blurred Images

- Generated Degraded image g- blurring the true image f
- added gaussian noise with variance $\sigma_2 = 10^-6$

- SNR $= 10\log_1 0||f - g||^2/||f - f||^2$
- PSF 7x7 uniform square shape

Thank you