Summary

• We present a blind deblurring method which only requires weak assumptions on the blurring filter.
• The method reaches satisfactory reconstruction of various images degraded by various blurs and noise levels.
• Filter estimates are close to true blurs.
• Improvements are achieved in real blurred photos and in synthetic blurs.

Blind image deconvolution

Degradation model: \( y = Hx + n \)
- original image, \( H \) - linear blurring operator
- noise, \( y \) - degraded image (blurred and noisy).

(y, x, n) are vectorized in lexicographic order.

Aim: recovering \( x \) from \( y \).

Ill-posed problem: infinite number of solutions, blur operator typically ill-conditioned.

Applications: Photography, medical imaging, astronomy.

Assumptions (weak)

• Original image edges: sparse, sharp
• Blur operator: limited support, low pass nature.

Cost function

Cost function: \( C(x, H) = \|y - Hx\|^2 + \lambda R(F(x)) \)

\( R(\cdot) \): Favors sparse distributions.

Guided optimization

\( \lambda \) is initially set to a large value and is slowly decreased over iterations:
- Initially, the main features/details are estimated. Smaller details are progressively considered as \( \lambda \) decreases.
- The filter estimate improves over iterations.

\( \gamma \) can be initialized with a large value, being progressively decreased over iterations.

Algorithm

 Initialization:
1. Set \( H \) to the identity operator.
2. Set \( x \) equal to \( y \).
3. Set \( \lambda \) and the prior’s sparsity to the initial values of the corresponding sequences.

Optimization loop:
4. Find new \( x \) estimate: \( x = \arg\min_x C(x, H) (H \) fixed).
5. Find new \( H \) estimate: \( H = \arg\min_H C(x, H) (x \) fixed).
6. Set \( \lambda \) and the prior’s sparsity to the next values in sequence.
7. If \( \lambda \geq \lambda_{\text{min}} \), go back to 4, otherwise stop.

Conclusions

• We present a blind deblurring method which only requires weak assumptions.
• Results: Satisfactory reconstruction of various images degraded by various blurs and noise levels. Filter estimates close to true blurs. Improvements achieved in real photos.
• The method is also able to estimate parameterized blurs.