Deblurring Low-light Images with Light Streaks

Zhe Hu[1,2], Sunghyun Cho[2], Jue Wang[2], Ming-Hsuan Yang[1]
[1]University of California, Merced, [2]Adobe

Code Available at https://eng.ucmerced.edu/people/zhu/CVPR14_lightstreak.html

Introduction

Goal: recover blurry images under low-light conditions

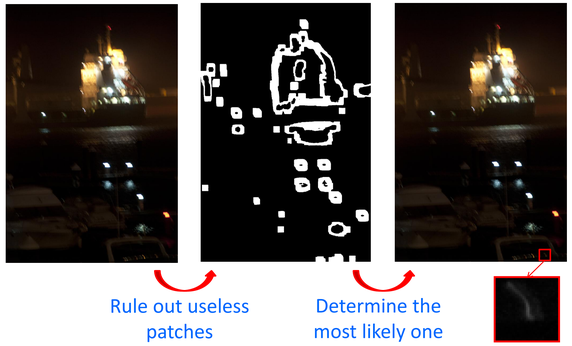
• Low light conditions: blur often occurs / few salient edges (recent deblurring methods easily fail)
• Light streaks: blurred light sources (commonly existing) / indicating blur trajectories

Light-streak patch   Blur kernel

• Guide our deblurring system

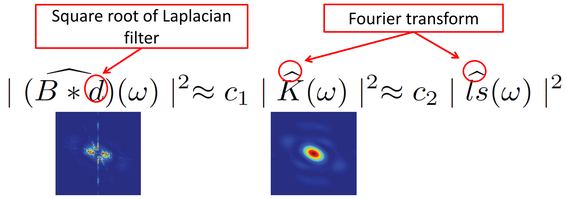
Light Streak Detection

Pipeline



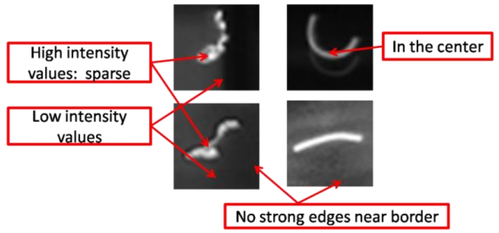
Light Streak Detection

1. The measure to determine how likely a patch contains a light streak
• Power-spectrum property of blur kernels by Goldstein and Fattal [4]



• Power spectrum of blurry input ≈ power spectrum of light-streak patch
• Difference of power spectrum as the measure

2. Reduce computation
• Property of light-streak patches (heuristic)



• Filter-based approach for each property

Proposed Algorithm

General formulation

$$(\hat{I},\hat{K}) = \arg\min_{(I,K)} \sum_{\partial^\star} |\partial^\star B - \partial^\star I * K|_2^2 + \phi_I(I) + \phi_K(K)$$

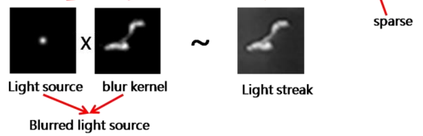
$\partial^\star \in \{\partial_x, \partial_y\}$ — constraints

Proposed Algorithm

• Update blur kernel K

$$K^{(n+1)} = \arg\min_K \sum_{\partial^\star} |\partial^\star B - \partial^\star I^{(n)} * K|_2^2 + \phi_K(K, ls)$$

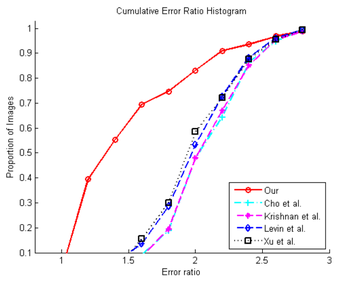
$$\phi_K(K, ls) = \lambda \sum_{\partial^\star} |\partial^\star D * K - \partial^\star ls|_2^2 + \mu |K|_1$$

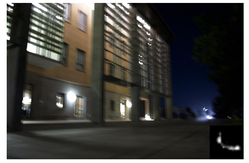


• Update dot pattern D (Gaussian-like pattern)
• Update latent image I

Quantitative Comparisons

• Synthetic images





Reference

[1] S. Cho and S. Lee. Fast motion deblurring. In SIGGRAPH Asia, 2009.
[2] D. Krishnan, T. Tay, and R. Fergus. Blind deconvolution using a normalized sparsity measure. In CVPR, 2011.
[3] B.-S. Hua and K.-L. Low. Interactive motion deblurring using light streaks. In ICIP, 2011.
[4] A. Goldstein and R. Fattal. Blur-kernel estimation from spectral irregularities. In ECCV, 2012.

Qualitative Comparisons