High-quality Motion Deblurring from a Single Image

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Agenda

- Overview
- Problem
- Blur model
- Ringing artifacts
- Probabilistic model
- Noise model
- Blur kernel prior
- Latent image prior
- Optimization
- Algorithm
- Results

Overview

- New algorithm for removing motion blur
- Unified probabilistic model
- Analysis of the causes of common artifacts
- Several novel terms within the probabilistic model
- Efficient optimization
- Results and comparsions with other techniques

Problem

Blur model

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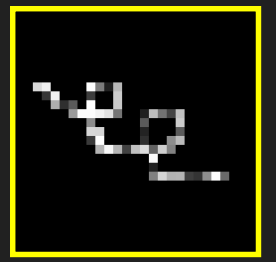

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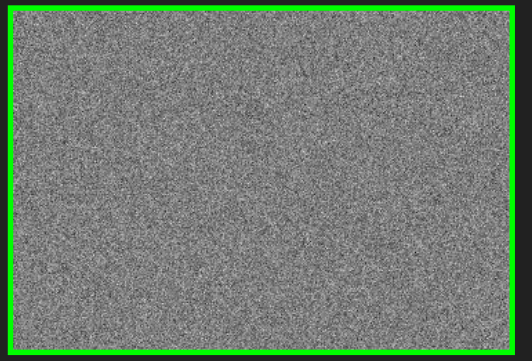
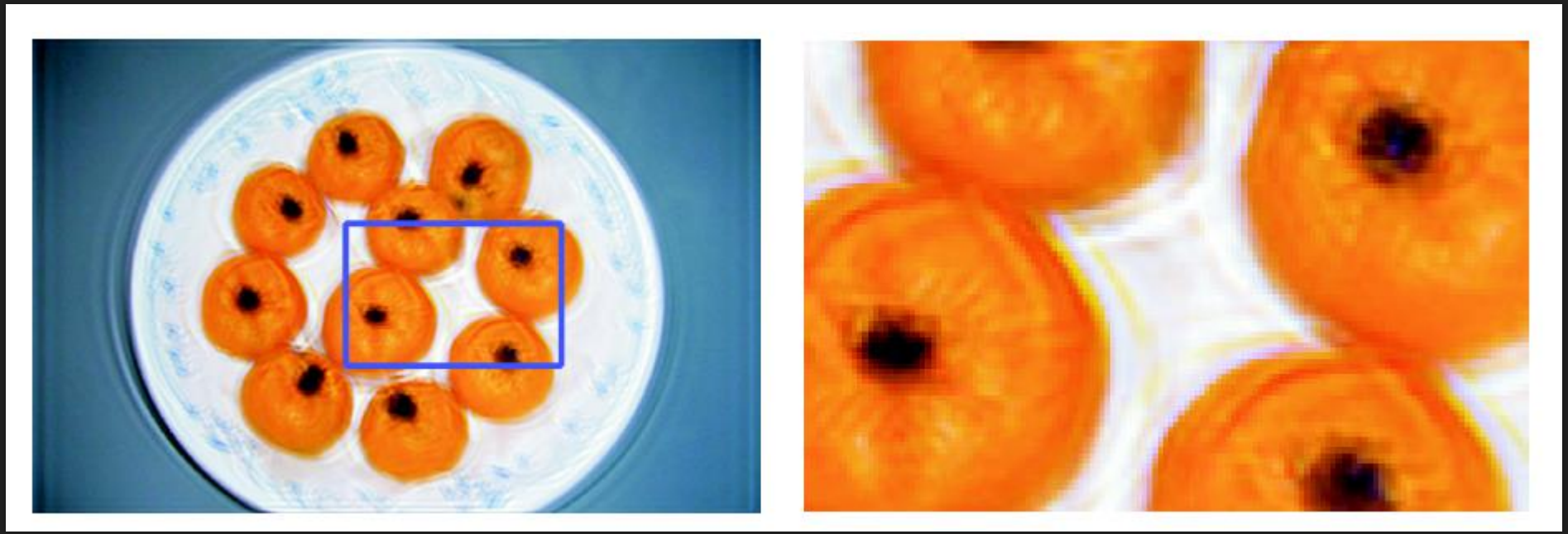


Ringing artifacts



Probabilistic model

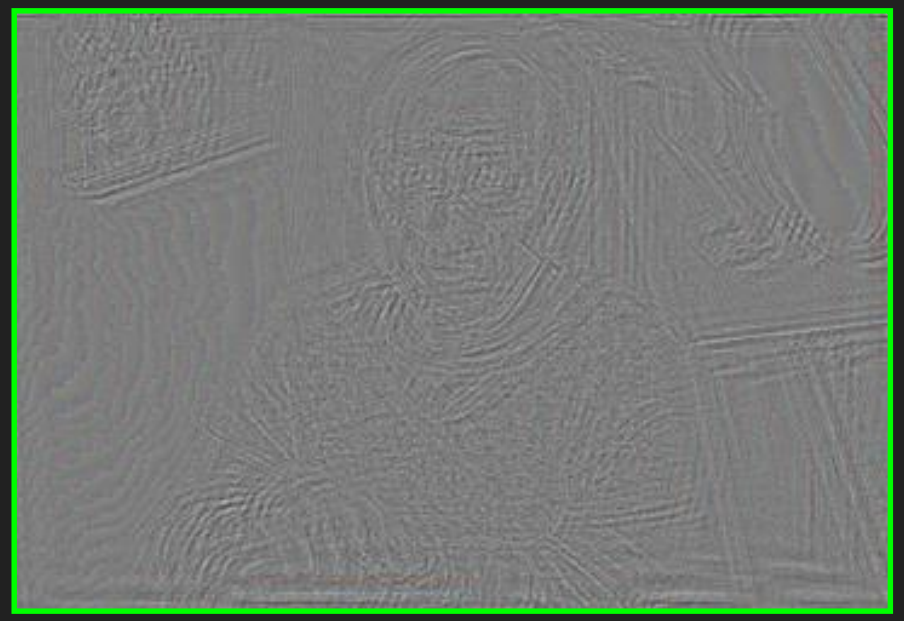
$$p(L, f|I) \propto p(I|L, f) \cdot p(L) \cdot p(f)$$

Noise model

$$\prod_i N(n_i|0,\zeta_0)$$

$$\prod_i N(\nabla n_i|0,\zeta_1)$$

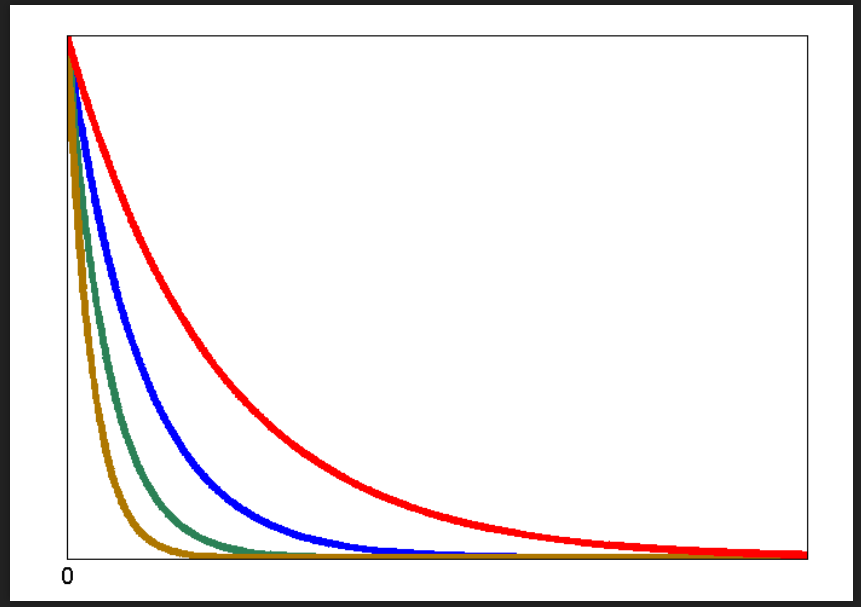
Noise model



$$\prod_i N(n_i \mid 0, \zeta_0) \prod_i N(\nabla n_i \mid 0, \zeta_1)$$
$$\prod_i N(\nabla\nabla n_i \mid 0, \zeta_2)$$

Blur kernel prior

$$p(f) = \prod_i e^{-\tau f_j}, \qquad f_j \geq 0$$

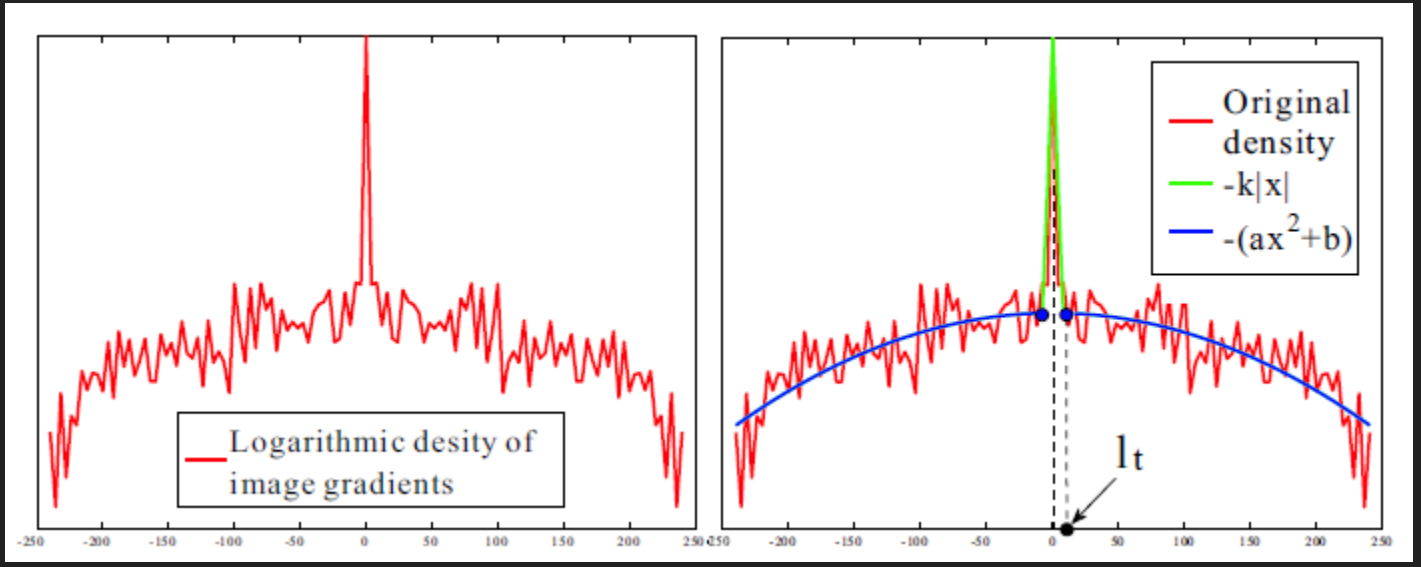


Latent image prior

$$p(L) = p_l(L) \cdot p_g(L)$$

Global prior

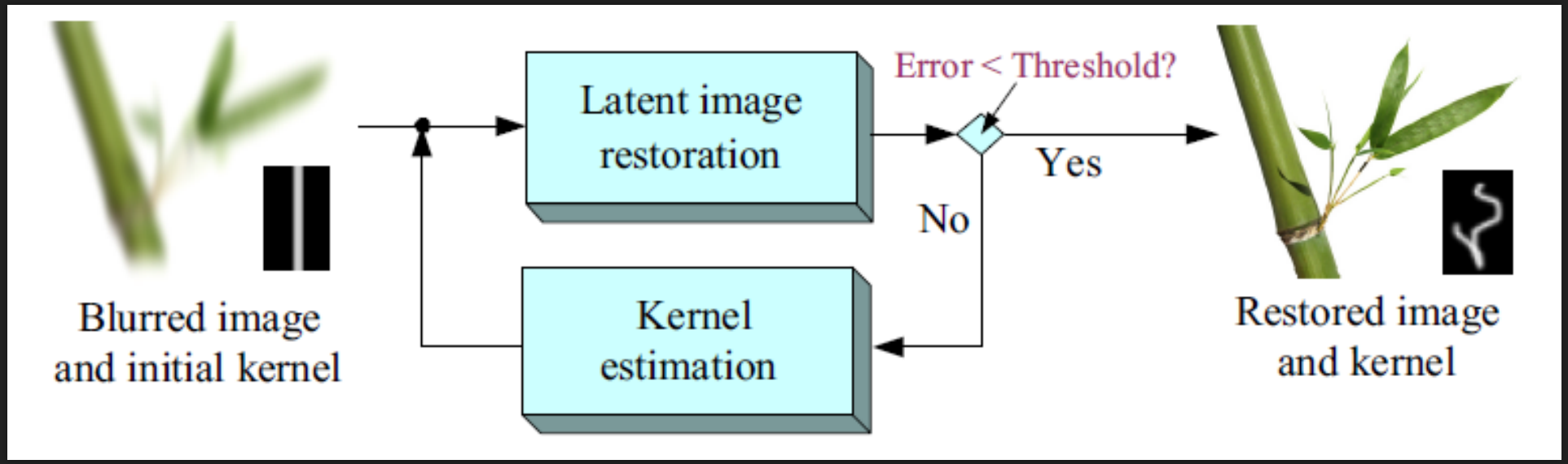
$$P_1(\nabla L) = \begin{cases} -k\,|\nabla L| & x \le c \\ -(a(\nabla L)^2 + b) & x > c \end{cases}$$



Local prior

$$p_2(L) = \prod_{i \in white} N(\nabla L - \nabla I \mid 0, \sigma_1)$$

Algorithm

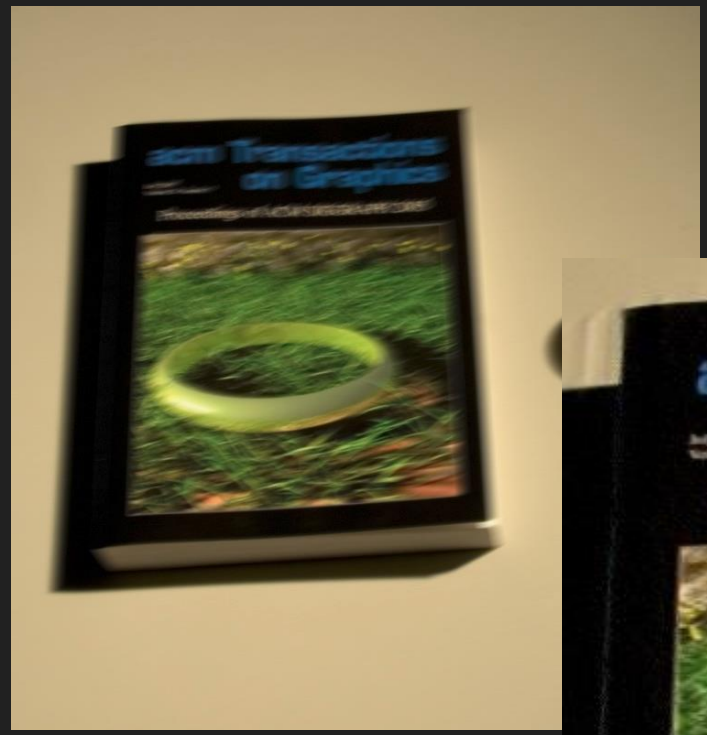

Blurred image
and initial kernel
Latent image
restoration
Error < Threshold?
Yes
No
Kernel
estimation
Restored image
and kernel

Optimization

MAP problem

$$\min E(L, f) = \min \log[\, p(n)\, p_1(\nabla L)\, p_2(L)\, p(f)]$$

Results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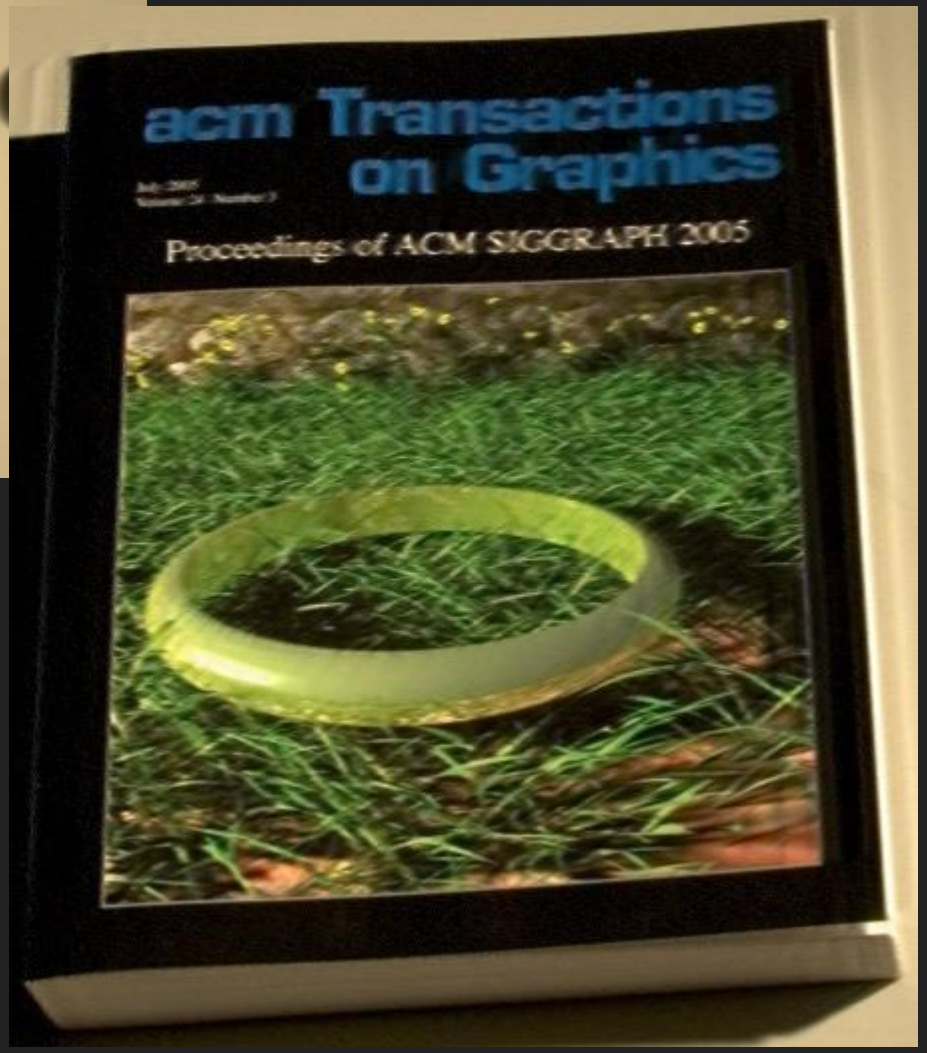
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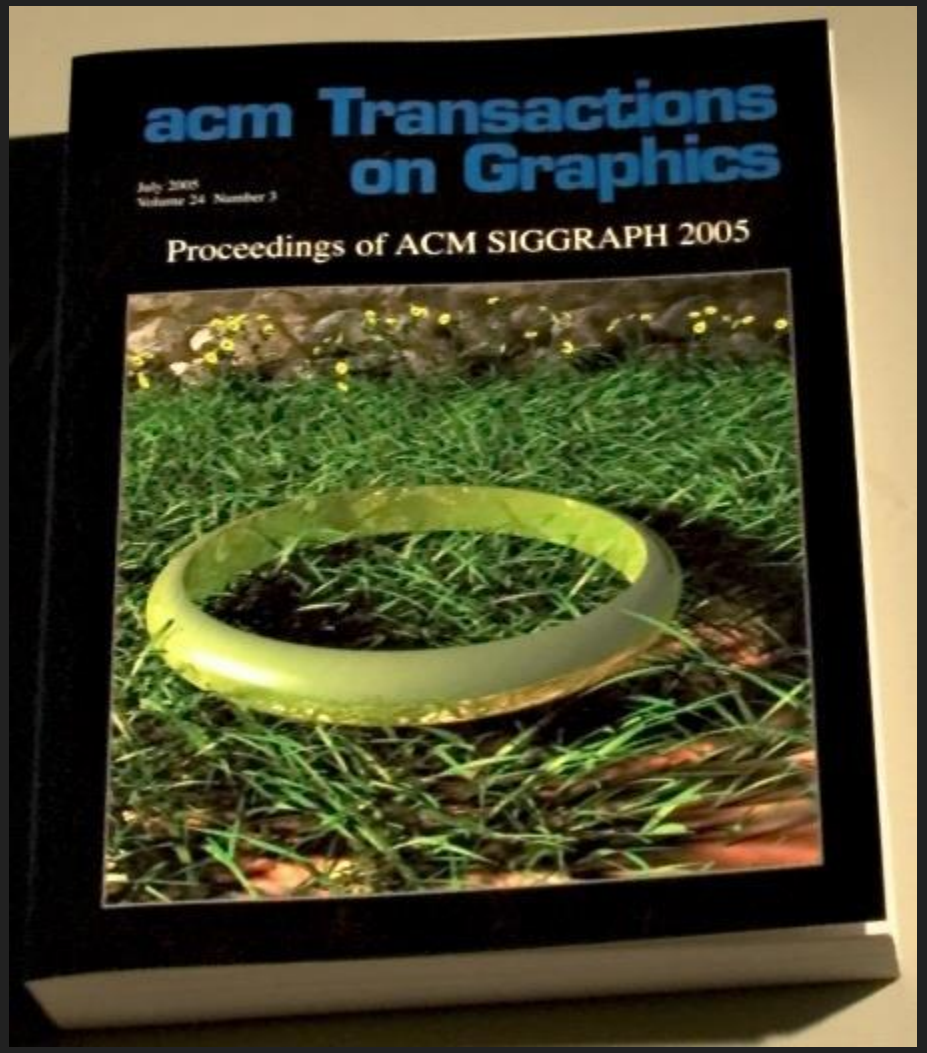
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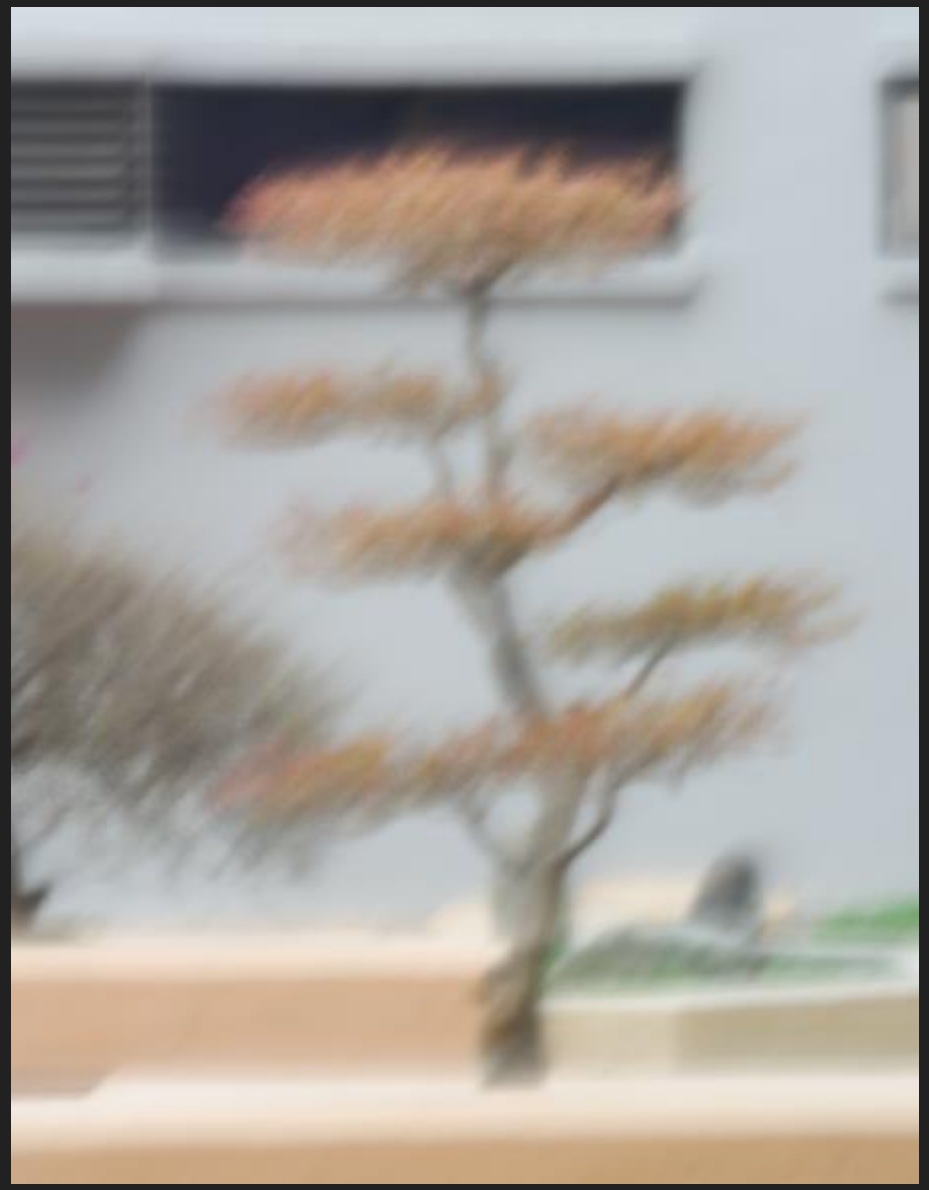
PHILIPS



Recap

http://www.cse.cuhk.edu.hk/~leojia/projects/motion_deblurring/index.html

Thank you!