A SPATIALLY VARYING PSF-BASED PRIOR FOR ALPHA MATTING

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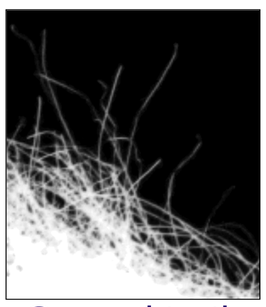
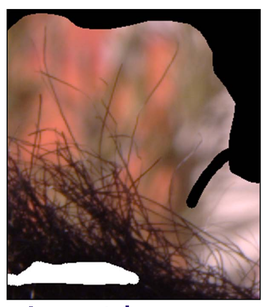
Abstract

We propose a new “image formation” based prior for alpha matting. The prior matte is obtained by convolving the high-resolution binary object segmentation with the spatially varying point spread function (PSF) of the camera. By assuming that the PSF is a single peaked kernel, we recover the binary segmentation with an MRF-based approach, which exploits flux and a new way of enforcing connectivity. Our new prior enables us to generate results that outperform all competitors on a public benchmark.

Motivation



Ground truth



Input image + trimap

Result of [Wang et al.07]

State-of-the-art matting models are **ambiguous!**

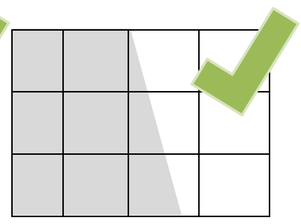
Our contribution: **Stronger prior** from the **image formation process**

Our prior model

Why do fractional alpha values occur?

Defocus blur

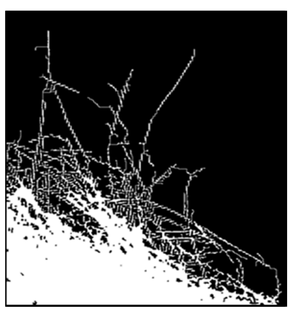
Motion blur



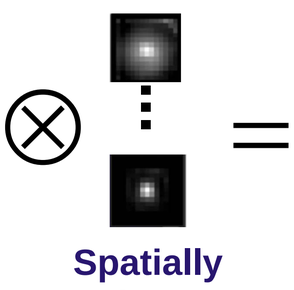
Discretization

Light-transmitting objects

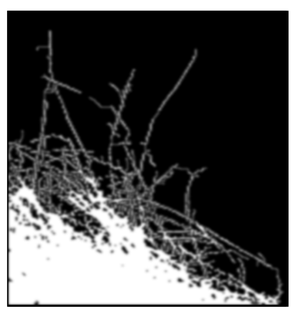
Our model:



Binary segmentation



Spatially varying PSF (~ depth)



Matting Prior

Approach taken

Key challenge: Blind deconvolution from approximate alpha matte.
(Reconstruct binary segmentation and spatially varying PSF)

Estimating and upsampling an initial matte

- **Initialize alpha** with conventional matting method [Rhemann et al., BMVC08]
- **Upsampling alpha** ensures that underlying binary segmentation is at least pixel sized

Estimating the binary segmentation

Data:	**Flux**:	**Smoothness:**	**Connectivity**:
Binary segmentation close to input alpha	Detects edges / preserves thin structures (e.g. hair)	Ising prior	Enforces segmentation to be 4-connected

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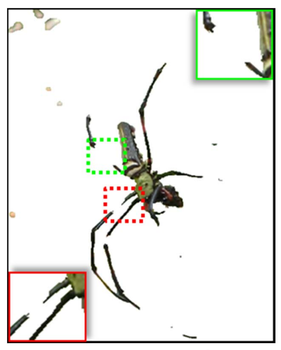
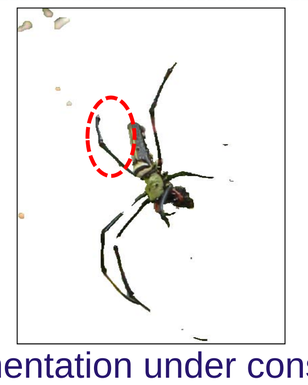
Enforcing connectivity

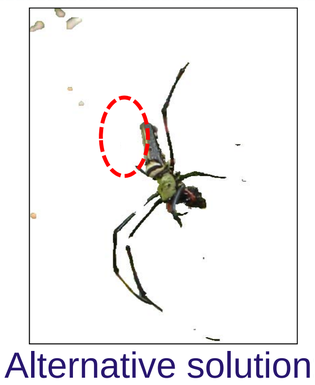


Segmentation without connectivity

For each disconnected island:



Segmentation under constraint that island is connected

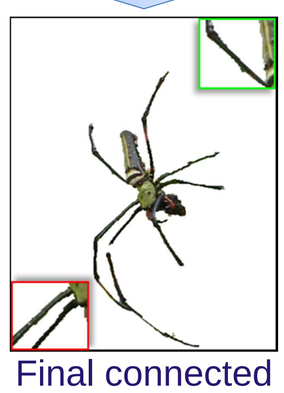


Alternative solution: remove island

Keep solution with lower energy

How to find segmentation under constraint that two regions are connected?

- **DijkstraGC** [Vicente et al., CVPR09]**:** Computationally expensive.
- **Our approach:** Shortest path computation in **min-marginal map** [Kohli, Torr; ECCV06]



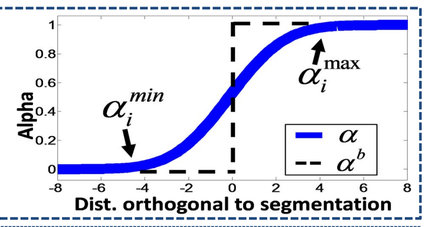
Final connected segmentation

Estimating a spatially varying PSF

Basic idea:
Segment image into regions with similar defocus and estimate a PSF in each region.

Energy for blur kernel estimation:

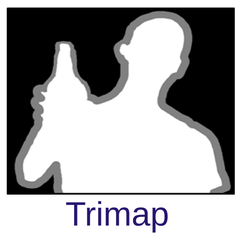
Data:
Estimate blur radius along segmentation boundary



Smoothness: Constrast-sensitive truncated linear

Loose comparison of defocus estimation:

Input image



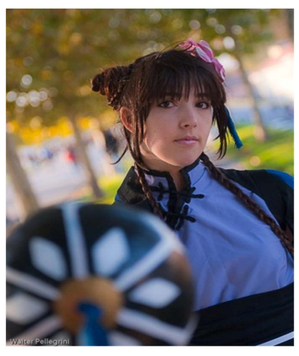
Trimap

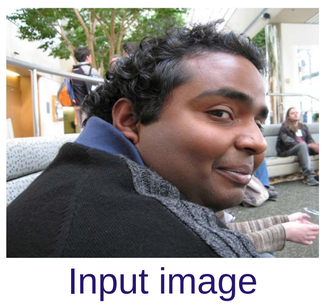
Our defocus map using trimap

Defocus map [Bae et al., Eurographics07]

Depth map of [Levin et al., SIGGRAPH07]

Results





Input image

Composite with [Levin et al.,CVPR06]

Our composite

Performance on alphamatting.com benchmark:

- Top performing on 3 out of 4 error measures
- Our prior: better than prior of [Rhemann et al.,CVPR08]