Removing Shadows from Images of Documents

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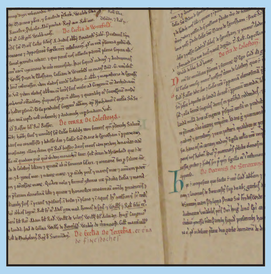
Motivation

- Images of documents, receipts, menus, books, newspapers, flyers, signs, and other text are frequently captured with distracting shadows.

Problem: Distracting shadows



Goal: Remove shadows, keep original color and tone

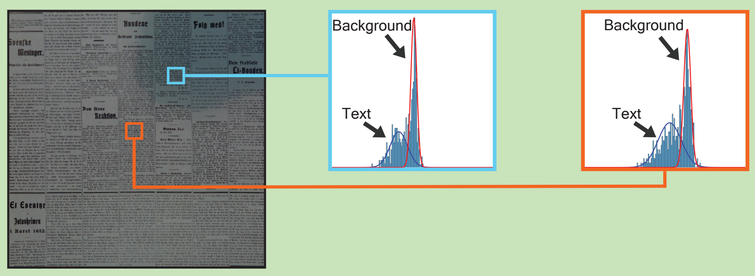
Previous Work

- Observation: Most documents have a constant colored background
- State-of-the-art method from Oliveira et al. [2013] generates gain map in background-only (i.e., no text) regions, but has interpolation inaccuracies.
- We also compare with Gong et al. [2014], which performs general shadow removal of natural images based on heuristics using user-defined brush strokes in bright and shadow regions.

Our Approach

- Our technique estimates text and background colors in local blocks to generate a shadow map, or per-pixel gain, to match local estimates to a global reference.
- Steps of our algorithm:

(1) Cluster intensities in small blocks as text and background. Select text cluster mean as local reference.

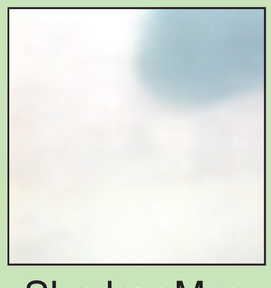


Input

(2) Repeat Step 1 using the entire image to get global reference background intensity.

Input

(3) Generate shadow map, $\boldsymbol{\alpha}_i$, by dividing local background, $\boldsymbol{\ell}_i$, by global reference, $\mathbf{g}$.



Shadow Map

$$\boldsymbol{\alpha}_i = \frac{\boldsymbol{\ell}_i}{\mathbf{g}}$$

(4) Apply shadow map to original input, $\mathbf{c}_i$, to get deshadowed output, $\tilde{\mathbf{c}}_i$.

Output

$$\tilde{\mathbf{c}}_i = \frac{\mathbf{c}_i}{\boldsymbol{\alpha}_i}$$

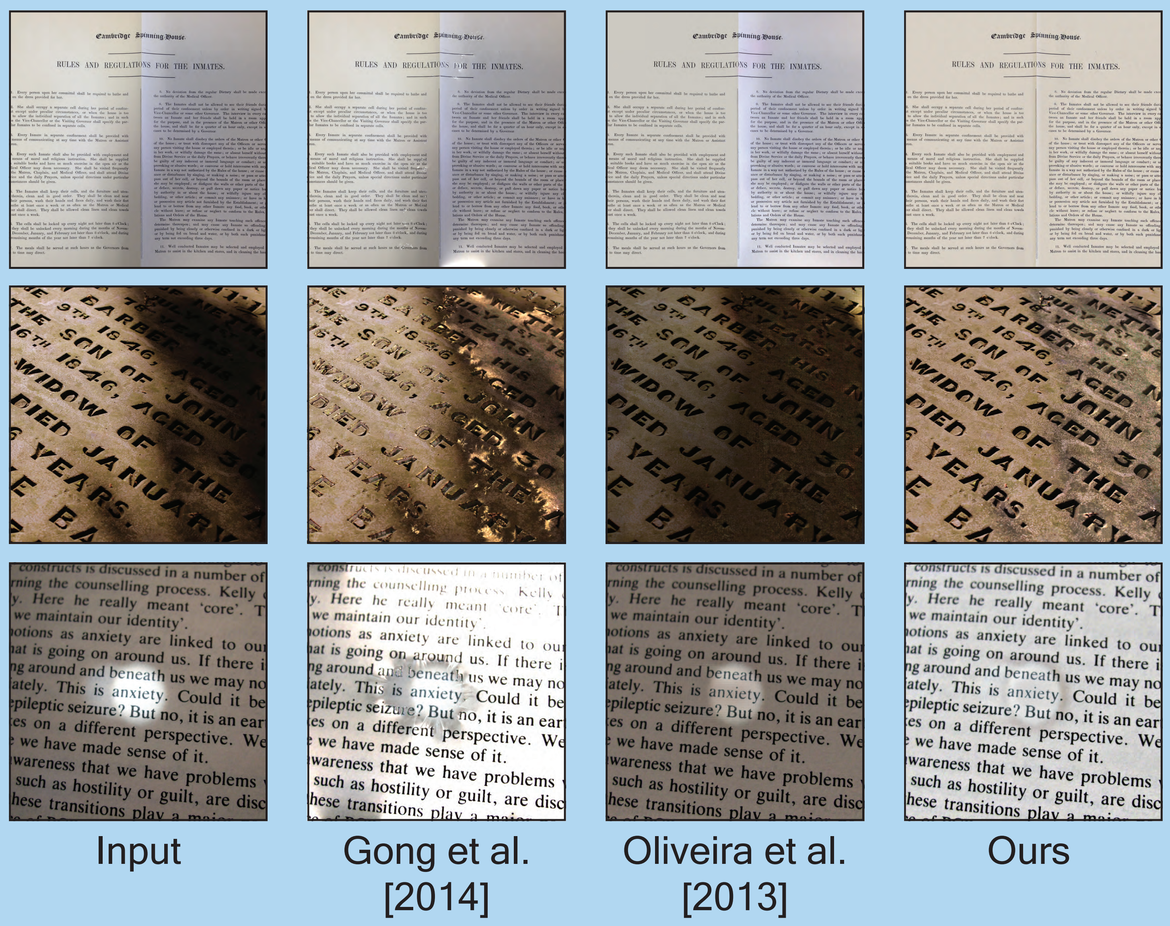
Results - Controlled

Input | Gong et al. [2014] | Oliveira et al. [2013] | Ours

- We provide a comparison with previous approaches evaluating average and median MSE on our controlled dataset consisting of 81 images.

Method	Avg. MSE	Median MSE
Bell et al. [2014]	125.44	119.94
Gong et al. [2014]	390.98	172.57
Pilu et al. [2002]	67.38	53.54
Wagdy et al. [2013]	74.06	43.73
Oliveira et al. [2013]	23.08	19.01
Ours	22.26	18.45

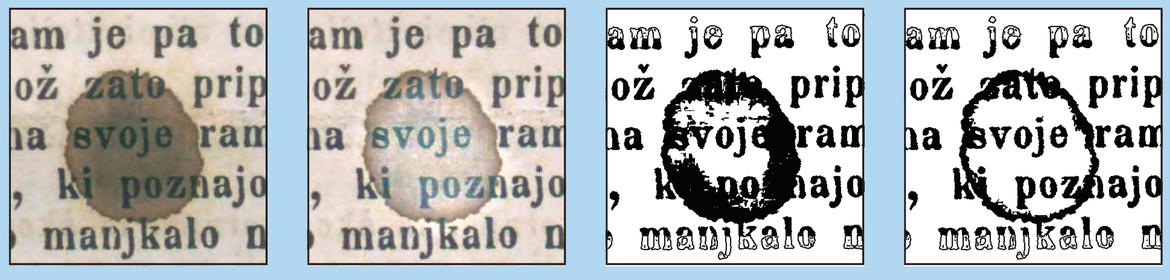
Results - Flickr



Input | Gong et al. [2014] | Oliveira et al. [2013] | Ours

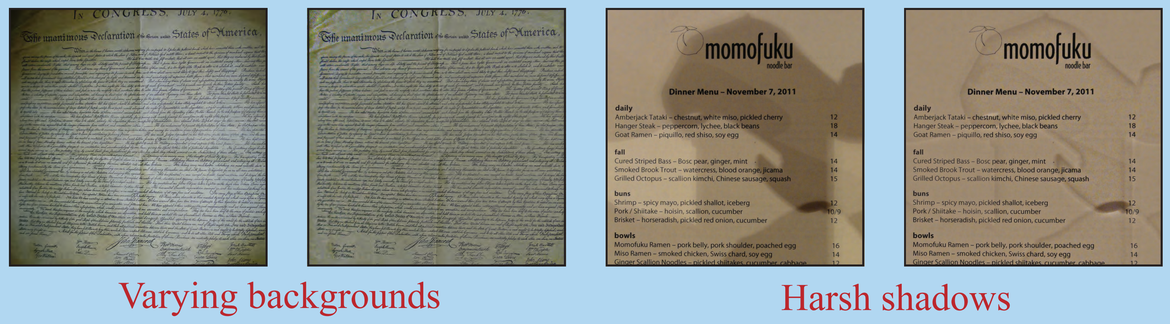
Image Binarization

- Use our method as a pre-process for inputs to image binarization used in Optical Character Recognition (OCR) tasks



Input w/o Ours | Input w/ Ours | Output w/o Ours | Output w/ Ours

Limitations



Varying backgrounds
Incorrect global statistics

Harsh shadows
Incorrect local statistics