Image Priors for Image Deblurring with Uncertain Blur

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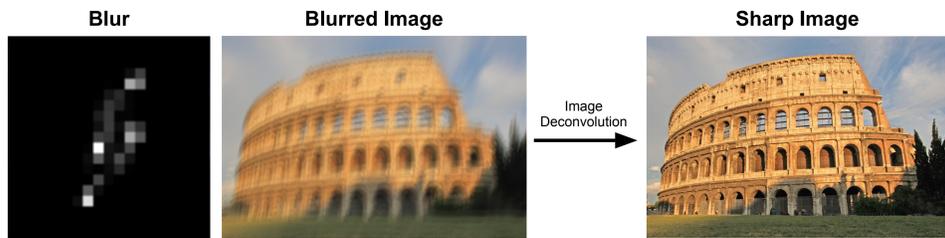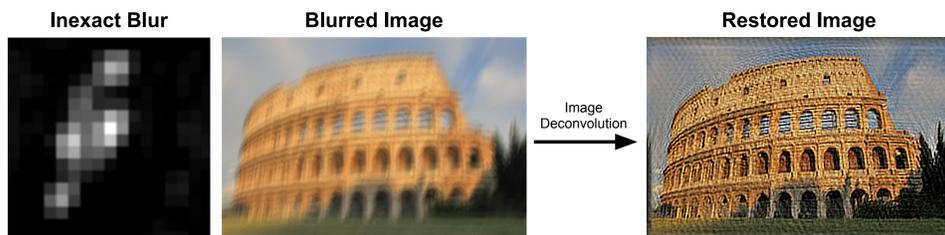
UCLA

Problem

The problem we consider is non-blind deconvolution

when the PSF (blur) is not fully known or exactly estimated by a blind deconvolution method, artifacts appear in the sharp reconstruction.
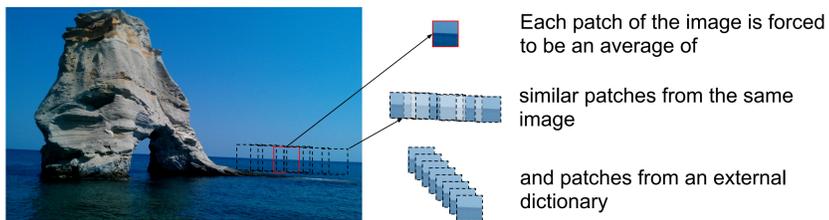

- We address deblurring when blur is uncertain by introducing a prior on the sharp image.
- The prior is built by exploiting the partial knowledge of the blur.

Contributions

- A novel non-local image prior built directly from the blurry input.
- A unified framework that combines dictionary-based and non-local approaches.
- A consensus strategy that exploits partial knowledge about the blur to discard correspondences due to the blur.

Patch-based Framework

Each patch of the image is forced to be an average of

similar patches from the same image

and patches from an external dictionary

Averaging of non-local corresponding patches is effective to remove artifacts such as noise.

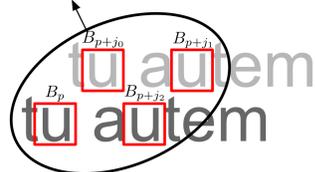## Self-similarities in blurred images

When we apply the above procedure to a blurred image incorrect correspondences may be generated.
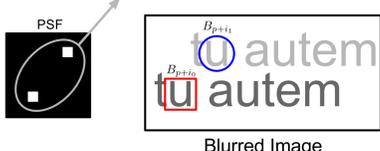

Set of non-local corresponding (self-similar) patches
$$\mathcal{C}_p = \{j \in \mathbb{Z} : ||B_p - B_{p+j}||^2 \leq \epsilon^2\}$$

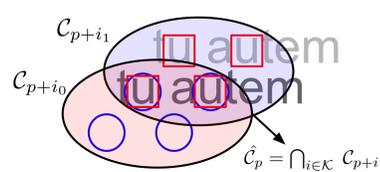**a)** Sharp image of text, and two similar patches (red squares).

c) Set of similar patches from the blurred image. Which of these are correspondences also in the sharp image?

set of dominant blur peaks
$$\mathcal{K} = \{i \in \mathbb{Z} : |max(k) - k_i| \leq \tau\}$$

$$\hat{\mathcal{C}}_p = \bigcap_{i \in \mathcal{K}} \mathcal{C}_{p+i}$$

b) Blurred version of the previous image.

d) The correlated patches shown in **(a)** are obtained by overlapping the correspondence sets of the two patches.

References

[1] S. Cho, J. Wang and S. Lee. Handling Outliers in Non-blind Image Deconvolution In *ICCV '11*

Algorithm

The image prior is connected to the patch-based framework as

Dictionary formed of	Image Prior

only patches from the same image
$$A = I - C^T$$
$$b = 0$$

where C is a matrix that defines correspondences between patches. For any pair of patches i, j we define $C_{i,j} = c$ if $j \in \hat{\mathcal{C}}_i$ and 0 otherwise. c is defined such that $\sum_j C_{i,j} = 1$.

patches from the same image

and patches from an external dictionary
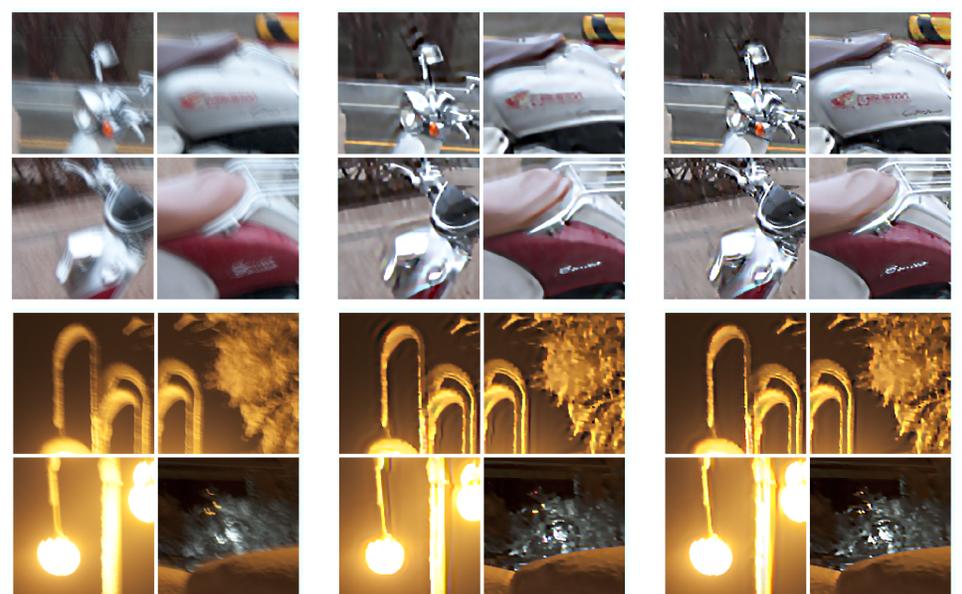$$A = I - C_{self}^T$$
$$b = (D_{ext} C_{ext})(k)$$

where k identifies the central row of the matrix

where C_{self} defines similar patches within the blurred image, and C_{ext} defines for each patch of the blurred image similar patches in the dictionary D_{ext}.

The sharp image is then estimated by minimising the following energy

Sharp Image written as vector

Results

Selected areas from real blurred images.

Deblurring results with the algorithm of Cho et al. [1].

Deblurring results with our algorithm.

Web

Project webpage
http://www.iam.unibe.ch/~cvg/dperrone/uncertainblur/

Acknowledgments