Blur-Invariant Deep Learning for Blind-Deblurring

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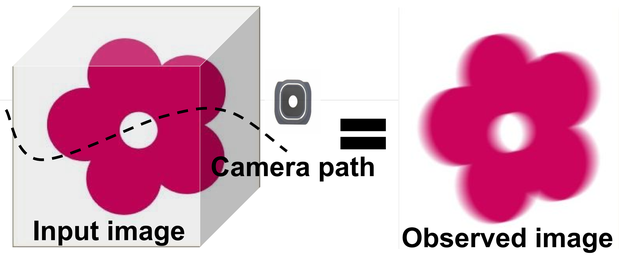
International Conference on Computer Vision (ICCV 2017)

Problem Definition

- Long exposure photography leads to blurry frames.
- Induced blur can be space-variant/invariant depending on the motion undergone and the scene structure.



Challenges and Goal

- Revert back the blurring process to estimate the clear input frame from the blurred observation.
- Given a single observation.
- Camera motion is unknown (Blind deblurring).

Approach

A feature based method to undo deblurring using deep networks.

Prior Works

1) Conventional Methods

Least square solution

$$\|B - KI\|_2^2$$

Too many unknowns.
Highly ill-posed

Add priors

$$\|B - KI\|_2^2 + \underbrace{\lambda_1 |\rho(I)| + \lambda_2 |\rho(K)|}_{\text{Priors}}$$

- Priors used: Gradient sparsity of latent image, kernel sparsity etc.
- To balance between over-smoothing and ringing, proper selection of prior and prior weightage required.
- Time consuming optimization frameworks.

2) Deep-learning based

- Estimate kernels using deep networks.
- Final deblurring is outside the network using non-blind deblurring techniques.
- Drawbacks: Error in kernel estimation propagates to the final result.

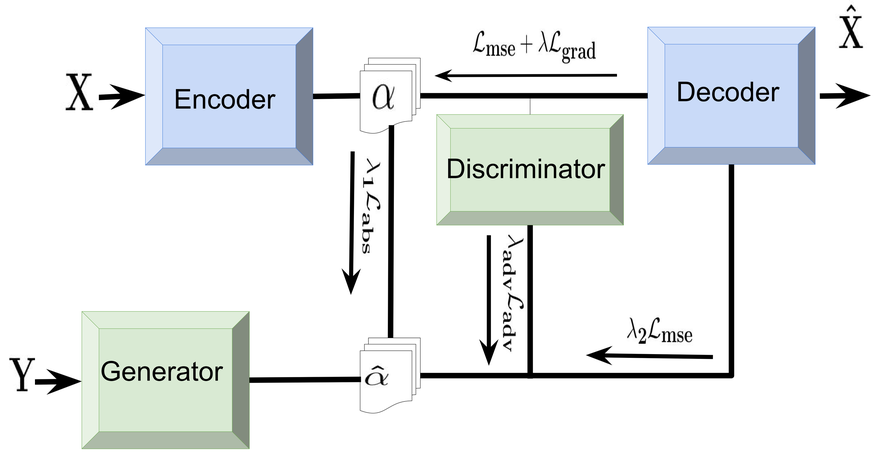
➢ Non-blind deblurring again faces the prior choosing and weighing problem.

Blur-Invariant Representation Learning

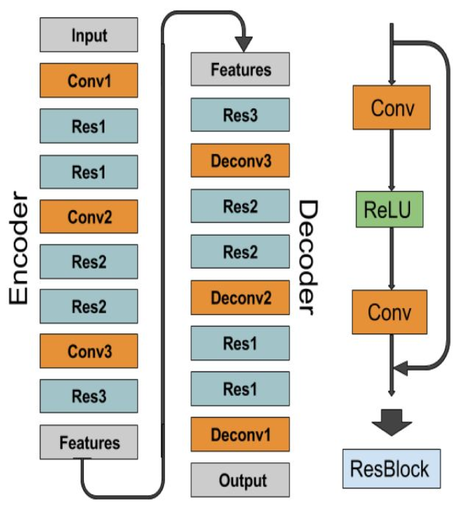
$$\alpha \;\; \underset{D_b}{\overset{D}{\rightleftharpoons}} \;\; \begin{matrix} I \\ B \end{matrix} \;\; B = I * K$$

- Dictionary methods constrained due to linear operations.

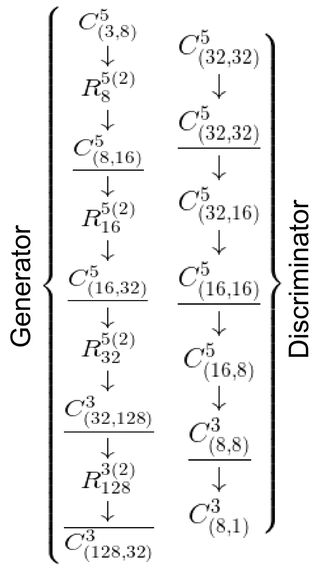
Network Structure



Encoder-Decoder module



GAN module



Training Phase

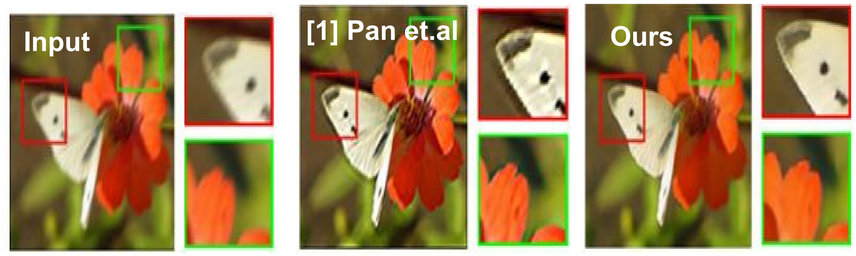
Two stage training -- ADAM optimizer -- 128X 128 Patches -- PASCAL VOC Dataset

Encoder-Decoder 1) Noisy data 2) L2 loss on data

Generative Adversarial Network

Results and Comparisons

Space-Invariant



Space-variant

Comparison with deep-networks

References

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2) L. Xu, S. Zheng, and J. Jia. Unnatural l0 sparse representation for natural image deblurring. In CVPR, 2013.
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We thank Microsoft India and ACM India for the Travel grant