We propose a method to model the blur kernel space of a given dataset. Using this blur kernel space, we can perform image deblurring and blur synthesis.

1. Introduction

2. Limitation of existing methods

Blurr model:
\[ y = \hat{F}(x, k) + \eta = \hat{F}(x, k) \]

3. Blur kernel encoding

- Find two functions F and G such that:
  \[ y = F(x, k) \quad \text{and} \quad k = G(x, y) \]
- Learn F and G by optimizing the objective function, given training data \((x_i, y_i)\):
  \[
  \sum_{i=1}^{n} \rho(y_i, F(x_i, G(x_i, y_i))) + \frac{\mu}{2} \|k\|_1 + \gamma (\frac{\partial^2 g_1(x)}{\partial x_1^2} + \frac{\partial^2 g_2(x)}{\partial x_2^2})^{1/2}.
  \]
- F and G are implemented by two neural networks.

4. Image Deblurring

- General Image Deblurring
  Given F, a blurry image y, we can alternatively search for x and k via an objective function:
  \[
  \rho(y, F(x, k)) + \lambda \|k\|_1 + \gamma \left(\frac{\partial^2 g_1(x)}{\partial x_1^2} + \frac{\partial^2 g_2(x)}{\partial x_2^2}\right)^{1/2}.
  \]
  - To stabilize the optimization, we reparameterize x and k by Deep Image Prior (DIP)\(^{(1)}\)
- Domain-specific Deblurring
  - Replace DIP of x with G\(_{\text{Gan}}\)(z) in which G\(_{\text{Gan}}\) is the pretrained StyleGAN.

5. Experiments

Image Deblurring

- Apply blurs learned from a reference sharp-blur dataset
- Improve SRN-Deblur performance

Face Deblurring

- Blur Swapping

Loss Convergence

6. Data augmentation

- Propose a method to encode the blur kernel space of a deblurring dataset.
- Propose some applications of the blur kernel space.

7. Conclusion