GAN-Based Image Deblurring Using DCT Discriminator

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Background

- Image Deblurring
  - Produce clear images by image deconvolution.
  - Promote camera minimization.
  - Can restore images after filming.
Basic Theory

Ex: ) Lena, Blur strength size=21

\[ I_B = k \otimes I_S + n \]

It is difficult to Estimate Original Image...
Conventional Method

- Non-Blind Image deblurring.
  - Kernel Estimation
- Blind Image deblurring.
  - CNN Based Methods

CNN-Based Methods

- CNN Using GAN
- Single Encoder Decoder Architecture
- Multi-Scale Architecture

Problem

- Multi-Scale and Multi-Patch Architecture takes much time.
- Lacks detail of image.
- Leaving block noise or ringing artifacts
Overview of our proposed method

- Single Scale Architecture
- Include Adversarial loss by using discriminator
- Using Discrete cosine transform for loss

\[
\mathcal{L}_{L1} = |x - G(y)| \\
\mathcal{L}_DCT = \left| \left| DCT(x) \right| - \left| DCT(G(y)) \right| \right| \\
\mathcal{L}_{adv}: Adversarial loss \\
\mathcal{L}_{cont}: Perceptual Loss
Overview of our proposed method

• Architecture

  - Simple Encoder Decoder
  - 7 Residual Block (ResBlock)
  - Parametric ReLU (PReLU) is adopted in order to prevent overfitting

• Train Dataset

  A part of GOPRO, DVD, NFS, HIDE Dataset are used for training.
Influence of DCT loss

Sharp

Non-linear Kernel

Trained without DCT loss

Trained with DCT loss
Subjective Result  
Testing Dataset

DeblurGAN  
DeblurGANv2  
SRN  
DeblurDCTGAN
Subjective Result

Real Image

DeblurGAN
DeblurGANv2
SRN
DeblurDCTGAN
## Result of PSNR and SSIM

<table>
<thead>
<tr>
<th>Method</th>
<th>Processing Time</th>
<th>GOPRO</th>
<th>DVD</th>
<th>NFS</th>
<th>HIDE</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>PSNR</td>
<td>SSIM</td>
<td>PSNR</td>
<td>SSIM</td>
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<tr>
<td>Blurred</td>
<td></td>
<td>25.64</td>
<td>0.8580</td>
<td>26.97</td>
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<tr>
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<td>25.31</td>
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<td>0.9051</td>
<td>28.68</td>
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<tr>
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<td>30.46</td>
<td>0.9428</td>
<td>30.15</td>
<td>0.9205</td>
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</table>
Conclusion

• DeblurDCTGAN can precisely remove blur.
  • By using GAN, details of the restored image can be retained.
  • DCT loss can reduce block noise or ringing artifacts.

• Relative to conventional methods, processing time of DeblurDCTGAN is reduced.