#### GAN-Based Image Deblurring Using DCT Discriminator

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





#### Ex: ) Lena, Blur strength size=21



Blur Image  $I_B$ 

Original Image  $I_S$ 

PSF k

 $I_B = k \otimes I_S + n$ 

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



Generative Adversarial Network (GAN)

#### Problem

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







Multi-Scale Architecture

#### **Overview** of our proposed method

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



### Overview of our proposed method

• Architecture



- $\cdot$  Simple Encoder Decoder
- $\cdot$  7 Residual Block (ResBlock)
- $\cdot$  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





Linear Kernel







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Trained without DCT loss  $% \left( {{\left( {{{{\rm{DCT}}}} \right)}_{\rm{T}}}} \right)$ 



Trained with DCT loss

#### Subjective Result Testing Dataset































DeblurGAN



Jv2

SRN

DeblurDCTGAN

### Subjective Result Real Image



DeblurGAN

DeblurGANv2

SRN

DeblurDCTGAN

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# Result of PSNR and SSIM

Method	Processing Time	GOPRO		DVD		NFS		HIDE	
		PSNR	SSIM	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
Blurred		25.64	0.8580	26.97	0.8462	32.09	0.9426	23.95	0.8299
DeblurGAN	$0.85 \mathrm{s}$	25.02	0.8493	25.31	0.8368	28.20	0.9254	23.56	0.8181
DeblurGANv2	$0.35~\mathrm{s}$	28.00	0.9051	28.68	0.8871	32.55	0.9484	26.61	0.8899
SRN	$1.87 \mathrm{~s}$	30.25	0.9397	29.37	0.9110	32.58	0.9589	28.36	0.9208
DeblurDCTGAN	0.28 s	30.46	0.9428	30.15	0.9205	33.96	0.9632	28.84	0.9322

## 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.