Pre-trained and Shared Encoder in Cycle-Consistent Adversarial Networks to Improve Image Quality

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1. Introduction

1.1 CycleGAN

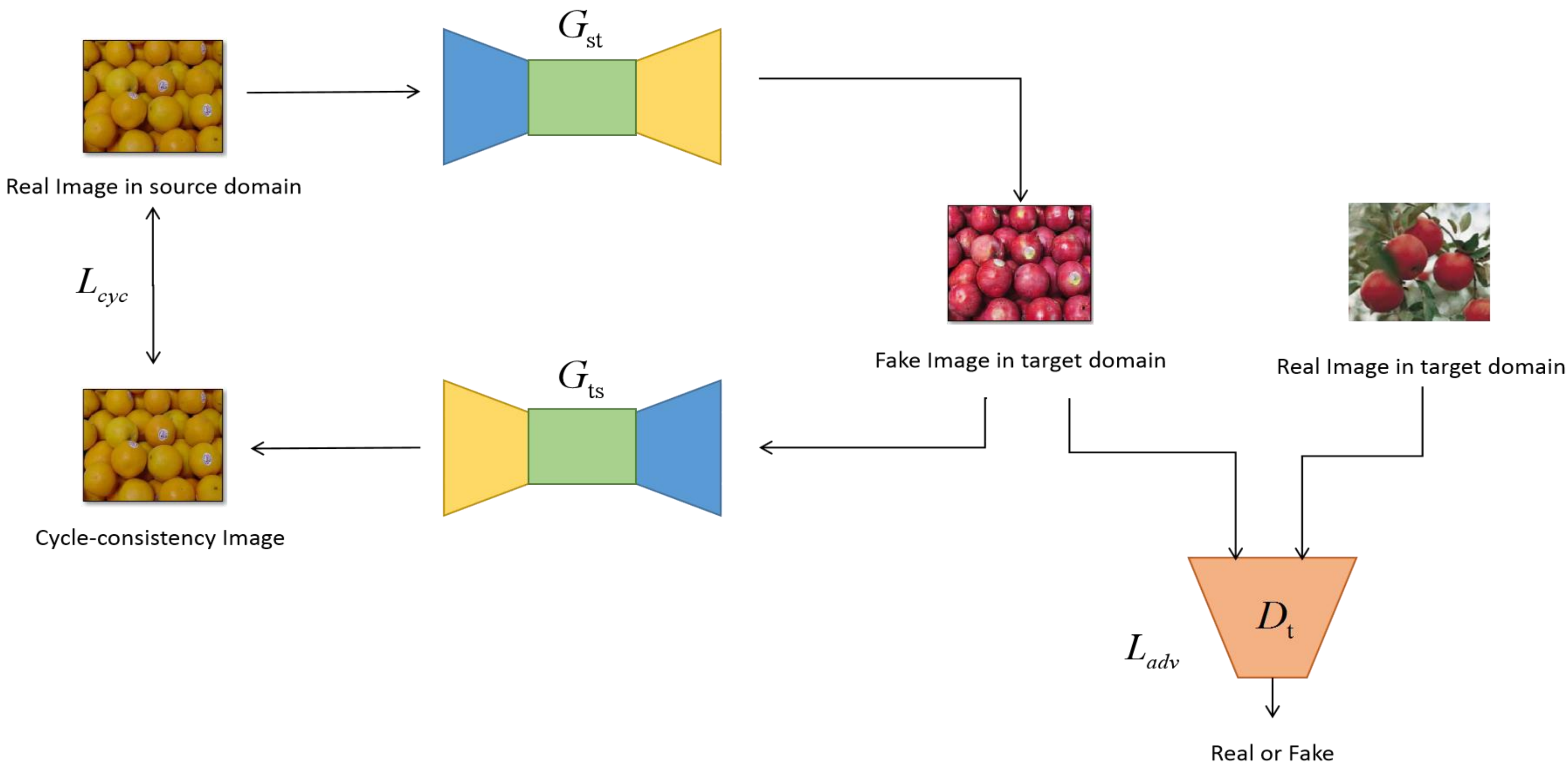


Fig.1 Process in CycleGAN

- Zhu, J.Y., Park, T., Isola, P., Efros, A.A.: Unpaired image-to-image translation using cycle-consistent adversarial networkss. In: Computer Vision (ICCV), 2017 IEEE International Conference on (2017)

The words in the right-bottom of the picture is much blurrier compared with input.

Input Output

Fig.2 Enlarged images

1.2 Problem

Edge information will lost in encoding process and cannot be restored in decoder.

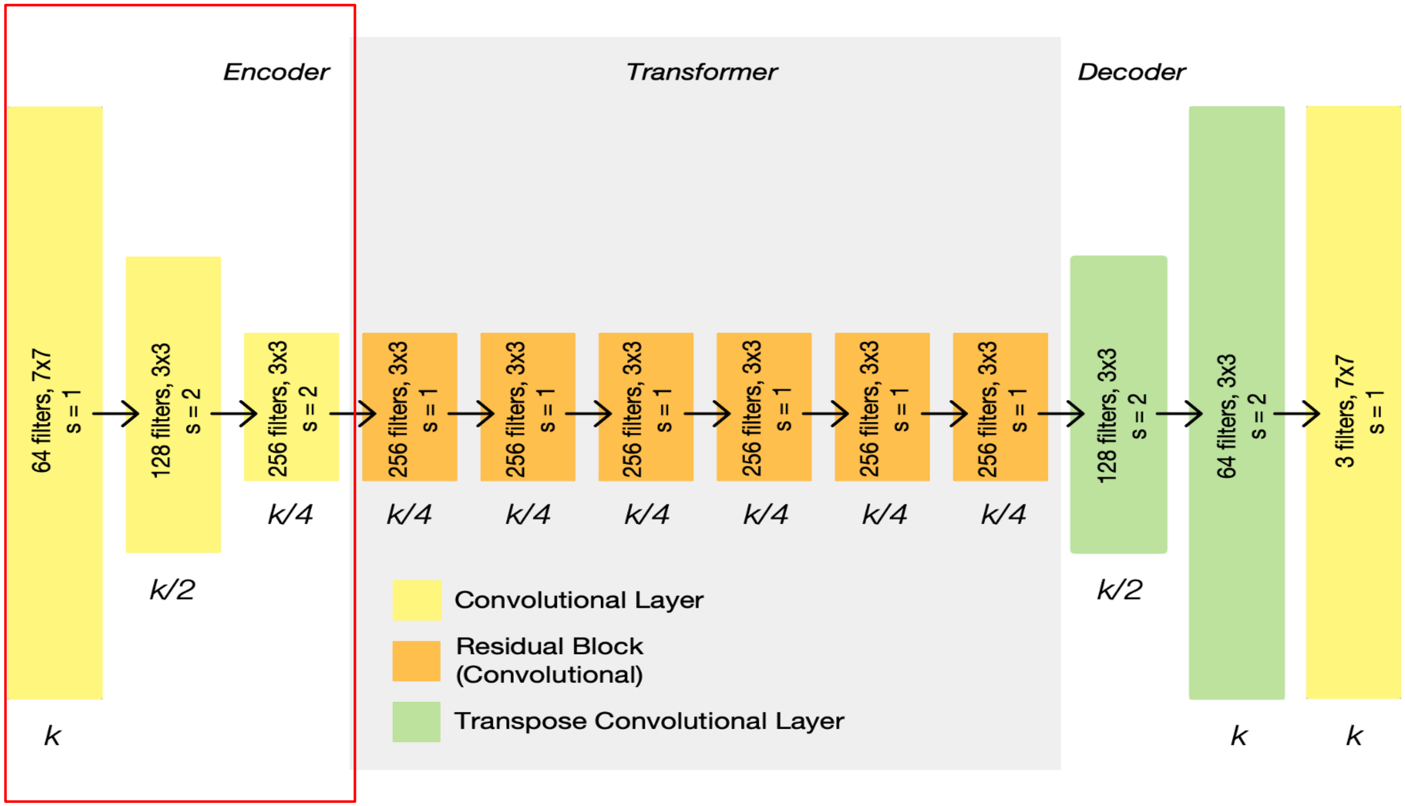


Fig.3 Generator Structure of CycleGAN

2. Method

2.1 ED-Block

ED-Block consists of an encoder and decoder and is trained at first to get a difference map by subtraction.

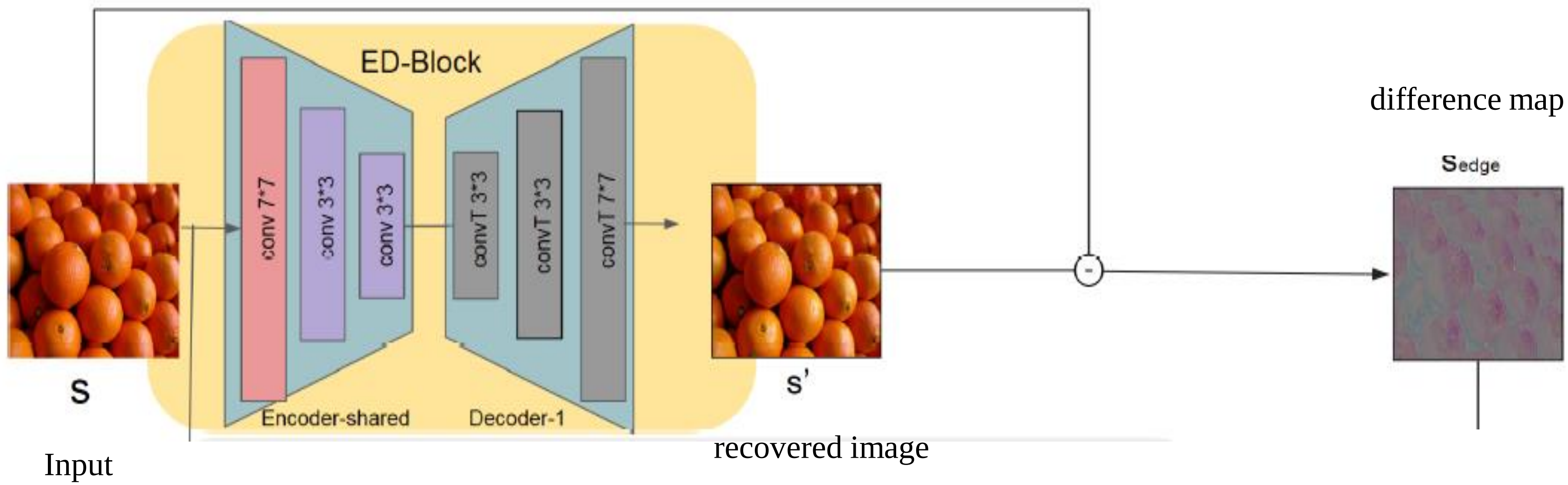


Fig.4 Structure of ED-Block

$$\mathcal{L}_{recover}(s, s') = ||s - s'||_1 \quad (1)$$

$$s_{edge} = s - s' \quad (2)$$

2.2 Our Structure

After ED-Block being trained well, encoders in generators of CycleGAN share its parameters and will be frozen during training. Finally, by adding the output from generators to the difference map, we can get images with much better quality.

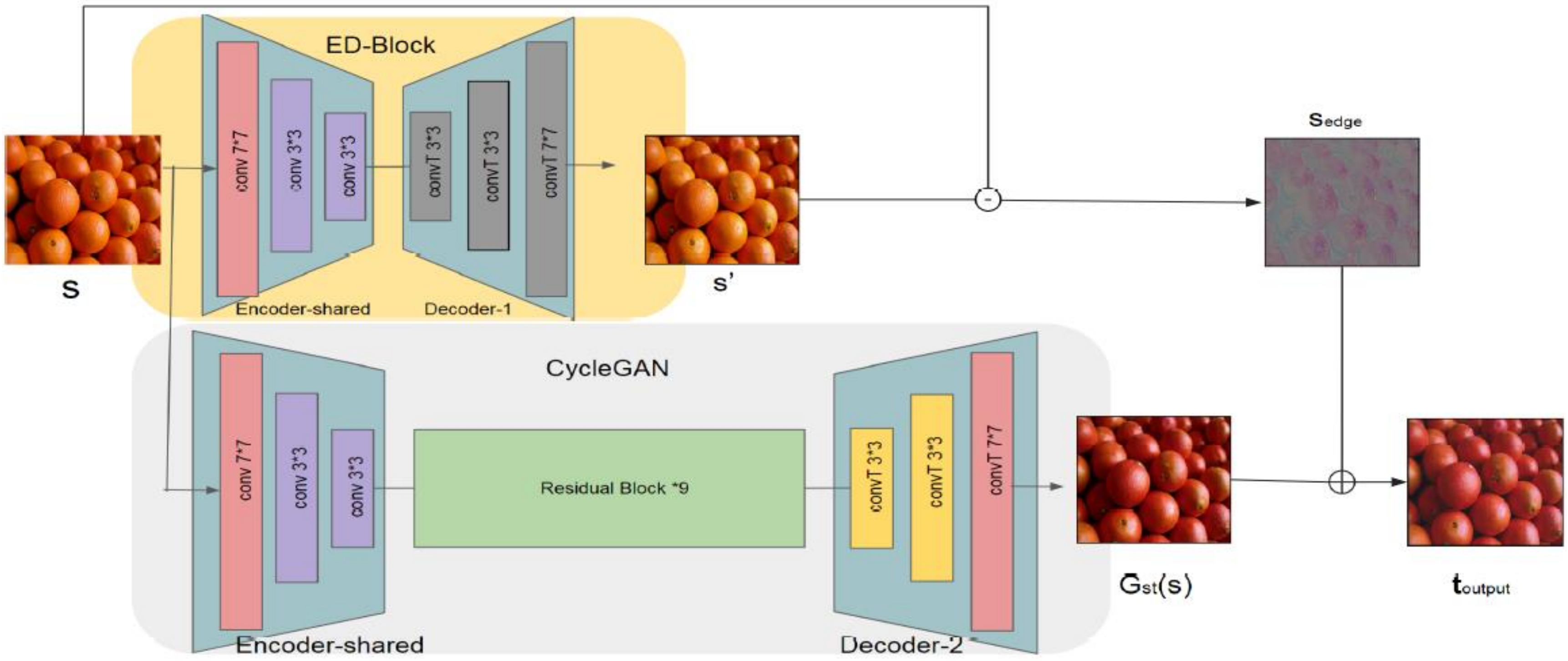


Fig.5 Our Structure

2.3 Formulas

$$\mathcal{L}^{s}_{adv}(G_{st}, D_T) = \mathbb{E}_{t\sim P_T(t)}[\log D_T(t)] + \mathbb{E}_{s\sim P_S(s)}[\log(1 - D_T(G_{st}(s) + \boxed{s_{edge}}))] \quad (3)$$

$$s'' = G_{ts}\big(G_{st}(s) + \boxed{s_{edge}}\big) + \boxed{s_{edge}} \quad (4)$$

$$\mathcal{L}^{s}_{cyc}(s, s'') = ||s - s''||_1 \quad (5)$$

$$\mathcal{L}(G_{st}, G_{ts}, D_s, D_t) = \mathcal{L}^{s}_{adv} + \mathcal{L}^{t}_{adv} + \lambda(\mathcal{L}^{s}_{cyc} + \mathcal{L}^{t}_{cyc}) \quad (6)$$

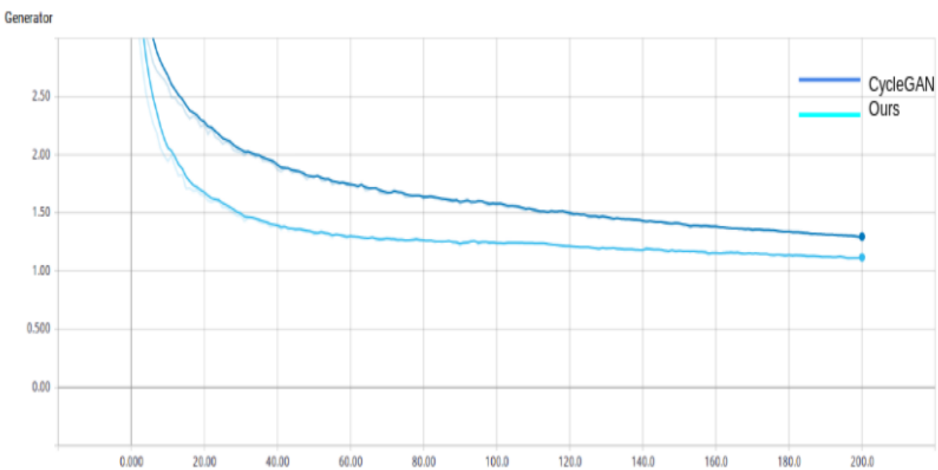
3. Experiment

3.1 Training ED-Block

In images of 10,50,100 epochs, some color information are remained. But in higher training epochs, the smaller color distortion effect. However, the time expense of 500 is much higher than that of 200.

Fig.6 Difference map from different training epochs

3.2 Loss Graph



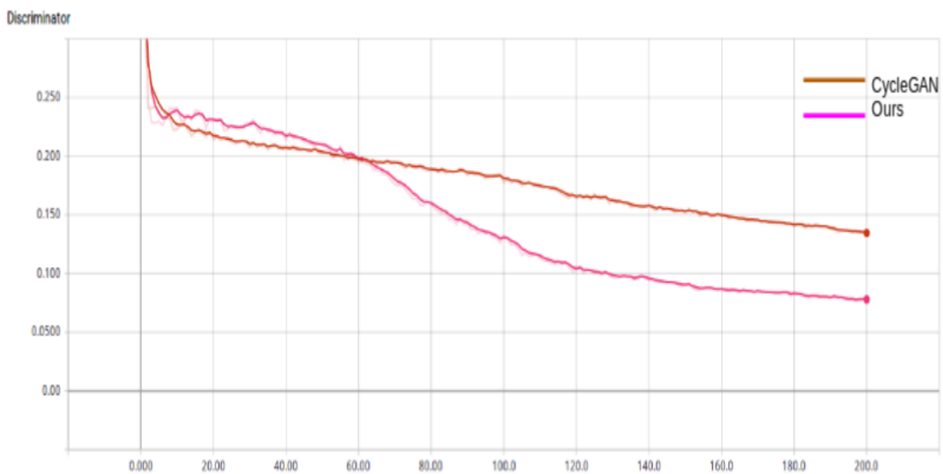


Fig.7 Loss values of generator and discriminator in each epoch

4. Evaluation Scores

4.1 SSIM&PSNR Scores

we use "Apple2Orange", "Summer2Winter" and "blond-hair2brown-hair" datasets. The third one is selected from celebA dataset by us.

Table 1. SSIM and PSNR scores on "Apple2Orange" dataset.

Model	SSIM		PSNR(dB)	
	consistent-apple	consistent-orange	consistent-apple	consistent-orange
Ours	**0.8029**	**0.7503**	**19.266**	17.068
Ours (with t_{edge})	0.7535	0.7021	16.764	15.582
CycleGAN	0.7329	0.6927	19.035	17.985
CycleGAN-Skip	0.7412	0.7061	18.654	17.743
Unit	0.6948	0.6705	18.449	**18.297**
Disco	0.4403	0.4107	13.424	14.462

$$s'' = G_{ts}\left(G_{st}(s) + s_{edge}\right) + \boxed{s_{edge}} \quad (4)$$

4.1 SSIM&PSNR Scores

Table 2. SSIM and PSNR scores on "Summer2Winter" dataset.

Model	SSIM		PSNR(dB)	
	consistent-summer	consistent-winter	consistent-summer	consistent-winter
Ours	**0.8410**	**0.8318**	**21.267**	**20.622**
Ours (with t_{edge})	0.8059	0.8089	19.433	19.314
CycleGAN	0.7842	0.7911	20.259	20.013
CycleGAN-Skip	0.7726	0.7850	19.903	20.054
Unit	0.7025	0.7188	19.031	18.878
Disco	0.6688	0.6699	18.765	18.124

Table 3. SSIM and PSNR scores on "Blond-hair2Brown-hair" dataset.

Model	SSIM		PSNR(dB)	
	consistent-blond	consistent-brown	consistent-blond	consistent-brown
Ours	**0.8682**	**0.8903**	**24.679**	**24.744**
Ours (with t_{edge})	0.8189	0.8283	22.188	20.731
CycleGAN	0.8222	0.8554	22.799	23.553
CycleGAN-Skip	0.6821	0.6910	17.028	16.206
Unit	0.7889	0.8046	22.521	22.583
Disco	0.7637	0.7924	20.539	21.248

4.2 Comparison

Table 4. SSIM and PSNR scores comparison.

	CycleGAN	Unit	DiscoGAN
SSIM	+7.50%	+15.77%	+31.70%
PSNR	+1.20%	+4.78%	+20.76%

5. Result Images

5. Resulted Images

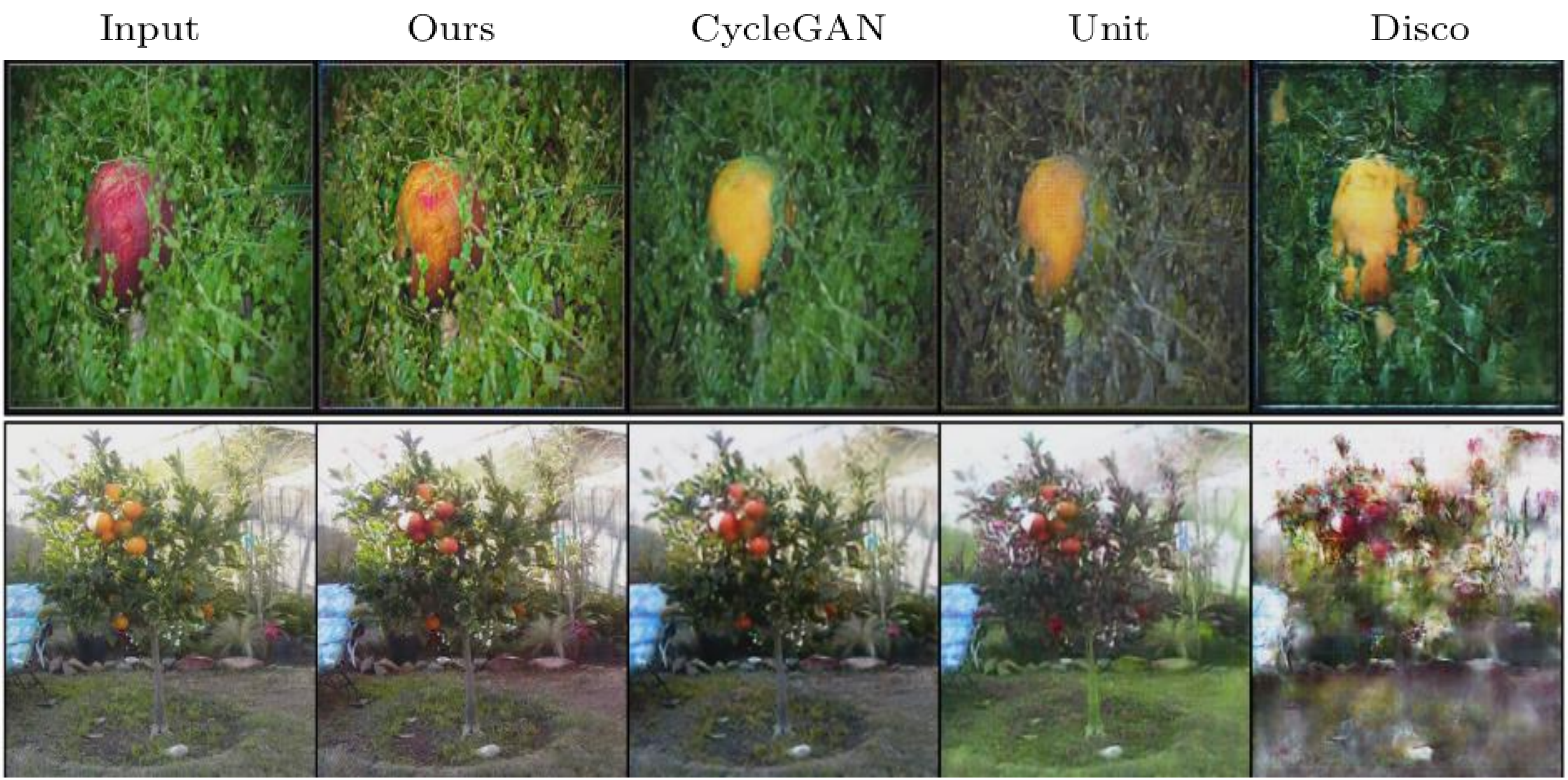


Fig.8 Result Images in Apple2Orange dataset

5. Resulted Images

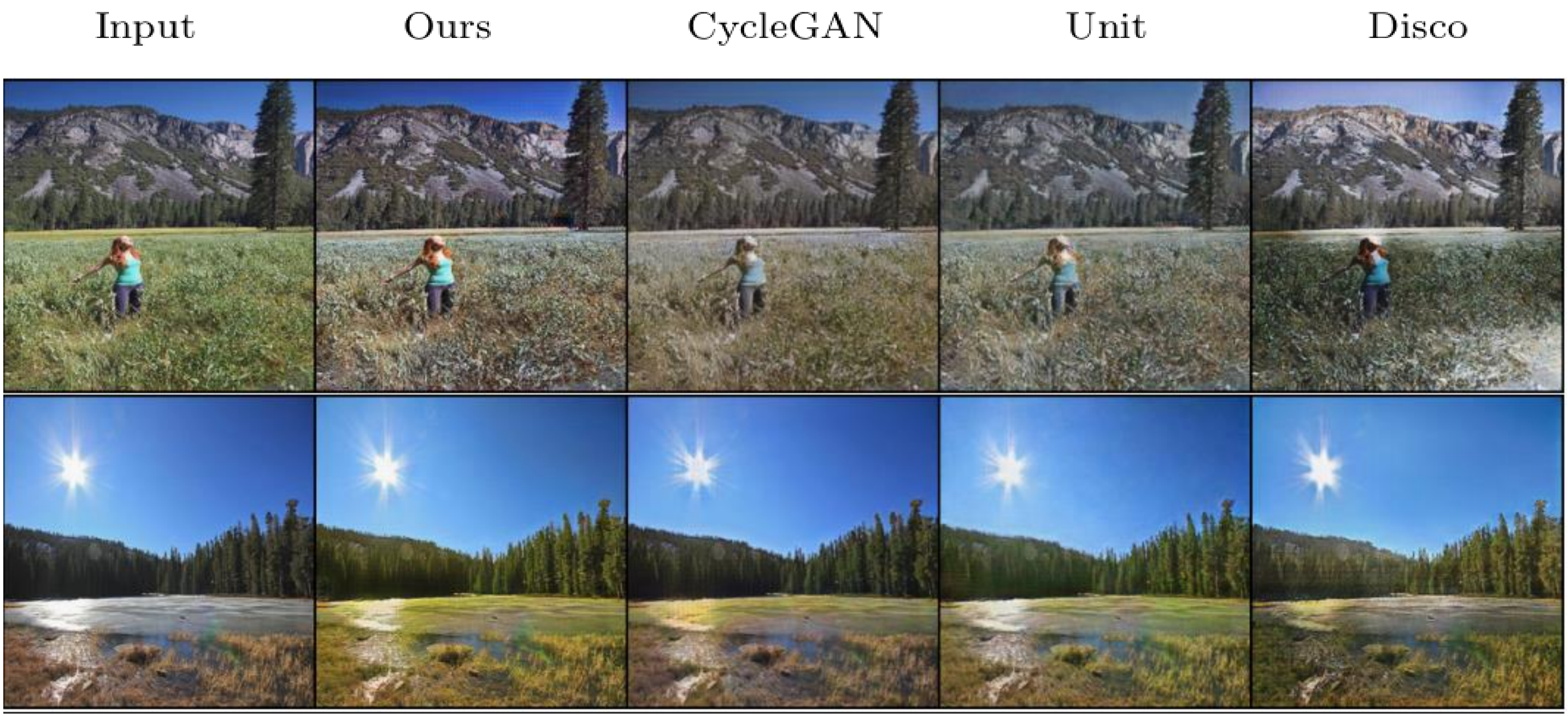


Fig.9 Result Images in Summer2Winter dataset

5. Resulted Images

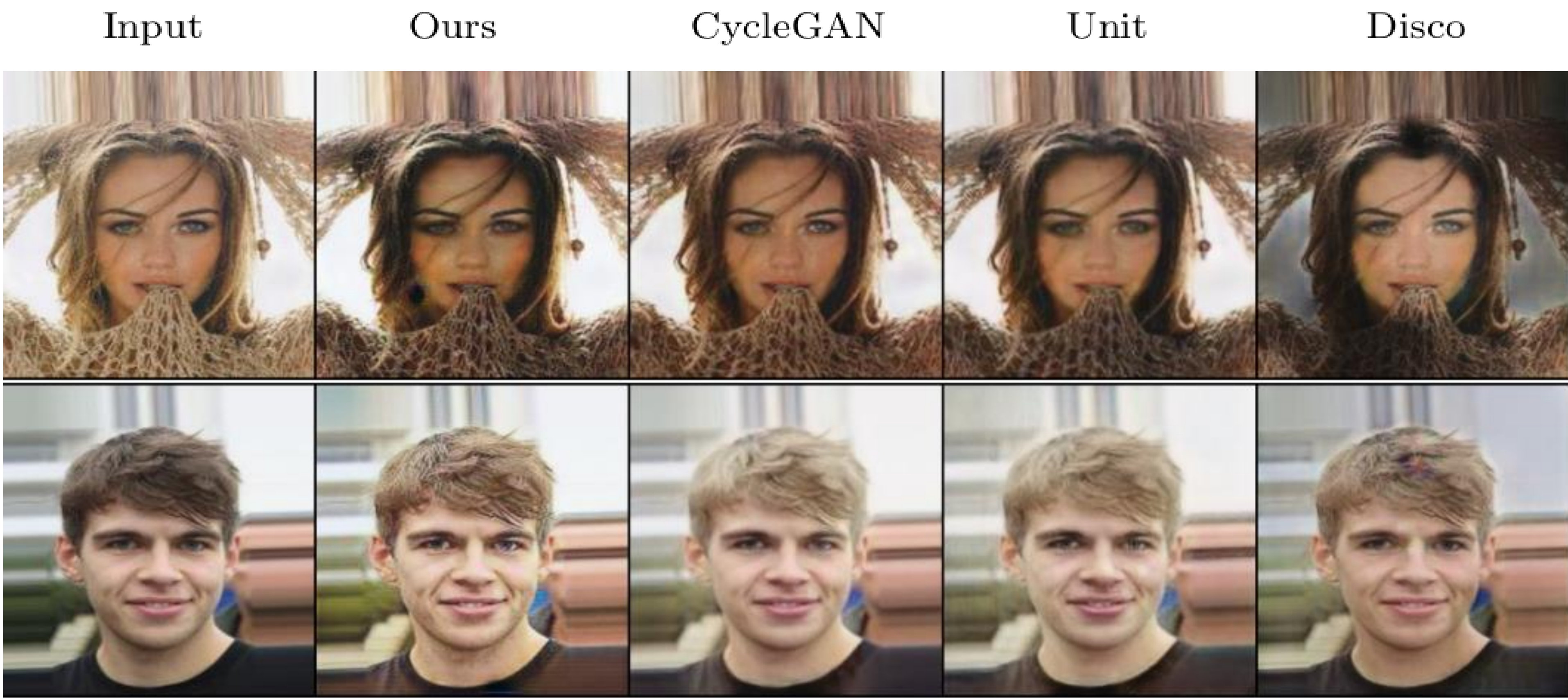


Fig.10 Result Images in Blond-hair2Brown-hair dataset

6. Conclusion

6. Conclusion

- We designed a novel block, called ED-Block, to extract edge information and save it in difference map.
- We proposed ED-CycleGAN and by adding the output from generators to the difference map, we can get images with much better quality.
- Our model get notable better SSIM and PSNR scores compared with CycleGAN, Unit and DiscoGAN.

Thanks for your attention.