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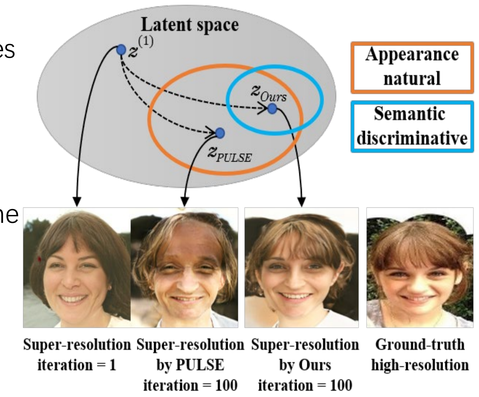
REGULARIZED LATENT SPACE EXPLORATION FOR DISCRIMINATIVE FACE SUPER-RESOLUTION

Ruixin Shi, Junzheng Zhang, Yong Li, Shiming Ge

Institute of Information Engineering, Chinese Academy of Sciences

Motivation

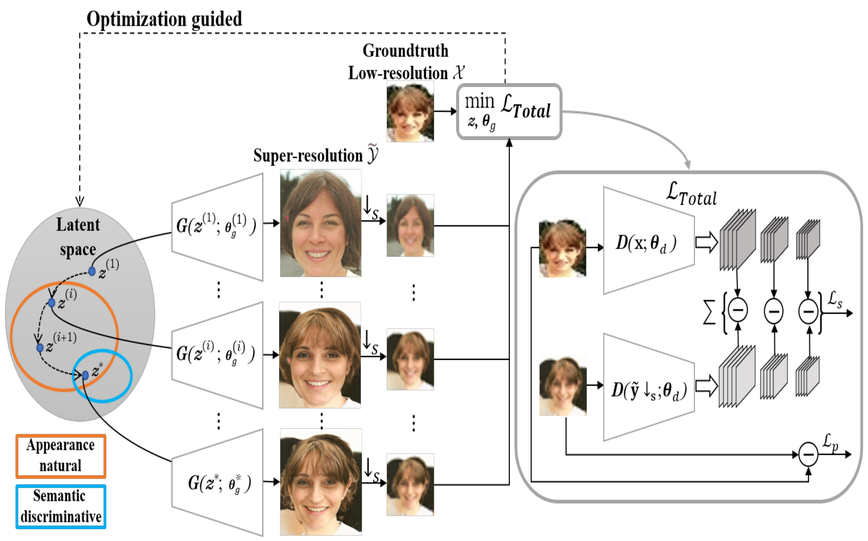
- Recent self-supervised super-resolution approaches usually have poor control over appearance and the super-resolved faces may look unnatural.
- Our approach regularizes the generation by considering both appearance and semantics in latent space exploration.



Framework

Our approach fully uses a pretrained GAN in an online latent space exploration manner.

- During iteration, the generator $\boldsymbol{G}$ continually generates super-resolution faces $\widetilde{\boldsymbol{Y}}$ from a random initialized latent code $\boldsymbol{z}^{(1)}$.
- The generation is evaluated by measuring the *discriminator semantic loss* as well as *pixel loss* between $\boldsymbol{x}$ and $\tilde{\boldsymbol{y}}\downarrow_{\boldsymbol{s}}$.
- The exploration is regularized by the total loss to get the discriminative result $\tilde{\boldsymbol{y}}^{*}$.



Experiments

- Comparison with other super-resolution approaches including unsupervised and supervised ones:

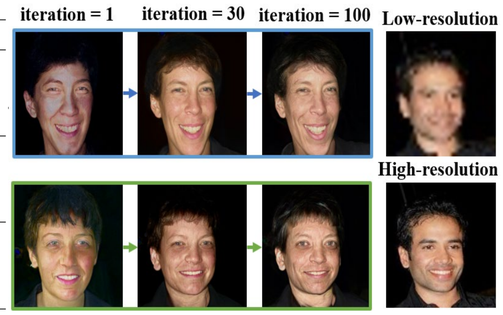
Table 1. Comparison with other super-resolution approaches based on unsupervised (left) and supervised learning (right).

Scale	Dataset	Metric	Bilinear	mGANprior [18]	PULSE [15]	**Ours**	VDSR [6]	ESRGAN [13]	FSRNet [11]
8×	CelebA	PSNR↑	25.84	21.29	22.54	23.52	23.18	23.74	25.08
		SSIM↑	0.73	0.53	0.54	0.56	0.76	0.63	0.56
		LPIPS↓	0.57	0.32	0.28	0.25	0.28	0.30	0.23
	TinyFace	NIQE↓	15.01	13.28	9.81	8.94	15.12	16.84	16.53
16×	CelebA	PSNR↑	22.73	20.53	21.43	21.74	22.42	21.83	23.04
		SSIM↑	0.56	0.50	0.48	0.49	0.59	0.46	0.62
		LPIPS↓	0.65	0.36	0.30	0.27	0.33	0.31	0.28
	TinyFace	NIQE↓	18.44	14.55	11.98	10.55	16.95	15.64	15.90

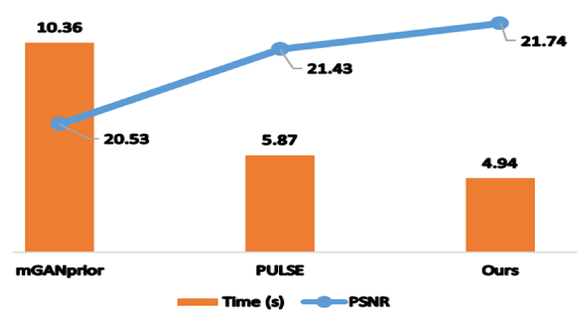
- Effects of discriminator semantic loss:

Table 2. Effects of discriminator semantic loss.

Scale	Metric	Without $\mathcal{L}_s$	With $\mathcal{L}_s$	Improvement
16×	PSNR↑	22.66	23.04	0.38
	SSIM↑	0.54	0.55	0.01
	LPIPS↓	0.24	0.20	0.04
32×	PSNR↑	19.93	20.78	0.85
	SSIM↑	0.42	0.44	0.02
	LPIPS↓	0.27	0.24	0.03
64×	PSNR↑	18.93	19.15	0.22
	SSIM↑	0.33	0.34	0.01
	LPIPS↓	0.30	0.29	0.01



- Inference time of unsupervised approaches



Summary

- We study the control ability of generative models over face appearance and propose a regularized latent space exploration approach by fully using the pretrained GAN to control the exploration of face generation in an iterative optimization manner.
- We introduce a semantic loss measured by the discriminator feature differences between the input low-resolution face and the downsampled super-resolution one to achieve appearance natural and semantic discriminative super-resolution results.
- We conduct extensive experiments to validate the effectiveness of our approach in terms of quantitative metric and visual quality, especially on few-sample scenario.