NTIRE 2022 Challenge on Learning the Super-Resolution Space

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Learnable Image Enhancement and Restoration

Super-Resolution









Generate Fake Data

Super-Resolution























Tracks

- Scale 4X
- Scale 8X



Dataset





Metrics

- Photo-Realism: User Study
- Low-Resolution Consistency: LR-PSNR above 45dB
- Diversity Score: New Metric



- Challenging to measure Diversity
- Naive metric: Pixel-wise standard deviation
 - Does not behave well
 - Easy to maximize by adding noise
 - In some cases, we don't want diversity (e.g. sky)



- How can we measure diversity?
- Challenge:
 - We have one GT
 - High dimensionality



- Approach
 - Sample many SR
 - Fill the space of plausible SRs
 - Can get close to the GT?
 - Compute on a pixel-wise level



$$S_M = \frac{1}{\bar{d}_M} \left(\bar{d}_M - \frac{1}{K} \sum_{k=1}^K \min\left\{ d(y_k, \hat{y}_k^i) \right\}_{i=1}^M \right) \qquad \bar{d}_M = \min\left\{ \frac{1}{K} \sum_{k=1}^K d(y_k, \hat{y}_k^i) \right\}_{i=1}^M$$

 $ar{d}_M$ Base distance (minimal image-wise metric) \hat{y}^i_k SR of the kth patch y_k GT

Interpretation: Improvement in percentage by sampling closer to GT The score is between 0 and 1 Deterministic method: $S_M = 0$



Approaches

		Additional				
Team	Flow	GAN	VAE	IMLE	Diffusion	Data
Deepest	✓					✓
IMAG_WZ					\checkmark	\checkmark
IMAG_ZW					\checkmark	\checkmark
Deepest (21)	 ✓ 					\checkmark
FutureReference				\checkmark		\checkmark
SR_DL		\checkmark	\checkmark			
SSS		\checkmark				\checkmark



Approaches: Diversity Score 4×





Approaches: Diversity Score 8 ~





Results – Scale Factor 4×



SSS (GAN)

Deepest (Flow, 2021)

SRFlow

FutureReference (IMLE)



Results – Scale Factor 4 ×

Team	LPIPS	LR-PSNR	Div. Score S_{10} [%]	MOR	Final Rank
IMAG_ZW	0.171	48.14	21.938 ₍₃₎	3.57 ₍₂₎	2.5
Deepest	0.126	50.13	$28.853_{(1)}$	$3.67_{(3)}$	2.5
IMAG_WZ	0.169	45.20	$27.320_{(2)}$	$3.34_{(1)}$	1.5
FutureReference (IMLE)	0.165	37.51	19.636	-	-
SR_DL (VAE)	0.234	39.80	20.508	-	-
SSS (GAN)	0.110	44.70	13.285	-	-
Deepest (Flow)	0.117	50.54	26.041	-	-
SRFlow	0.122	49.86	25.008	3.62	-
ESRGAN	0.124	38.74	0.000	3.52	-
GT	0	∞	-	3.15	-



Results – Scale Factor 8 ×



Deepest (Flow, 2021)

FutureReference (IMLE)

SRFlow



Results – Scale Factor 8 ×

Team	LPIPS	LR-PSNR	Div. Score S_{10} [%]	MOR	Final Rank
Deepest	0.257	50.37	26.539	4.510	-
FutureReference (IMLR)	0.291	36.51	17.985	4.741	-
SSS (GAN)	0.237	37.43	13.548	4.850	-
SR_DL (VAE-GAN)	0.311	42.28	14.817	4.797	-
Deepest (Flow)	0.259	48.64	26.941	4.503	-
SRFlow	0.282	47.72	25.582	4.775	_
ESRGAN	0.284	30.65	0	4.452	_
GT	0	∞	-	3.173	-



Team IMAG_WZ Diffusion Models for Learning the Super Resolution Space





[1] Denoising diffusion probabilistic models Ho, J., Jain, A. and Abbeel, P. NeurIPS 2020

Team IMAG_ZW Learning the Super-Resolution Space Using Diffusion Gamma Models



Use Gamma Distribution for noise



[1] Denoising diffusion probabilistic models Ho, J., Jain, A. and Abbeel, P. NeurIPS 2020

Team Deepest

FS-NCSR: Increasing Diversity of Super-Resolution Space via Frequency Separation and Noise-Conditioned Normalizing Flow

- Based on SRFlow [2]
- Noise-Conditioned affine coupling
- Frequency Separation
- Add noise on the sparce highfrequency image for more diversity







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