

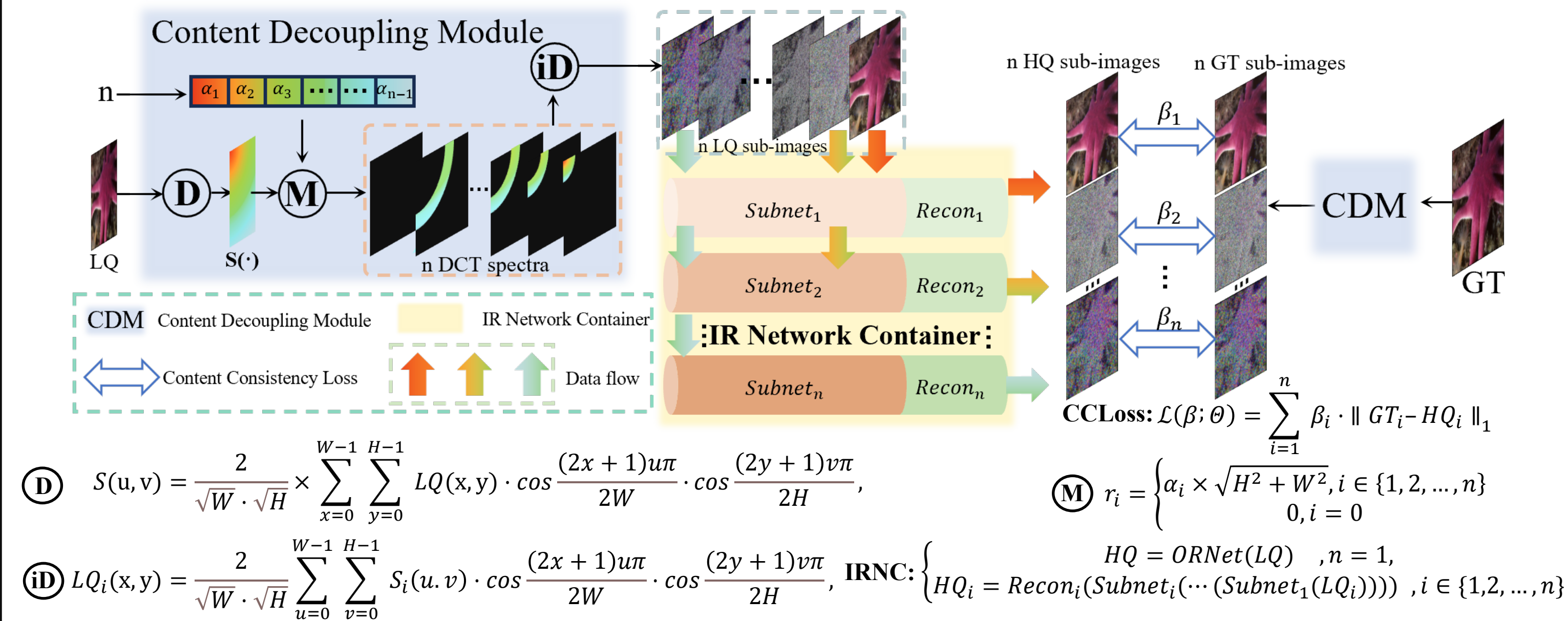
Motivation

The contents in different regions of an image follow different patterns or distributions, i.e., some regions are very smooth while others may contain a lot of high-frequency textures. Treating the different contents equally will compromise the performance in both regions since it is non-trivial to find a good trade-off between low-/high-frequency reconstruction.

Contributions

- **Proposed a General Solution for IR:** We systematically and comprehensively answer the general questions about the image restoration tasks and propose a solution. The exploration of solving these issues can guide us to re-examine the challenges faced by image restoration from a different perspective.
- **An Explicit Framework:** We propose an explicit Content Decoupling framework for image restoration, dubbed CoDe, that is needed to specify neither network architecture nor tasks. It can be applied to any existing image restoration network.
- **Significant Gains:** Extensive experiments have been conducted on several real and synthetic IR tasks, demonstrating that our proposed framework can take the original network to a new state-of-the-art level in both performance and visual quality while maintaining attractive computational costs.

Method



Results and Analysis

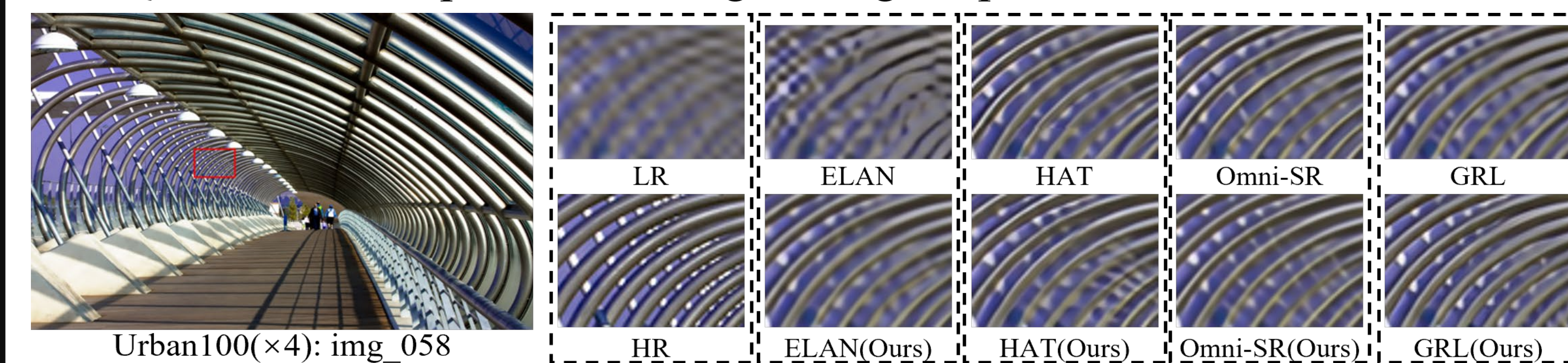
Quantitative comparison (PSNR) on color image denoising.

Method	CBSD68 [30]			Kodak24 [15]			McMaster [54]			Urban100 [18]		
	$\sigma=15$	$\sigma=25$	$\sigma=50$	$\sigma=15$	$\sigma=25$	$\sigma=50$	$\sigma=15$	$\sigma=25$	$\sigma=50$	$\sigma=15$	$\sigma=25$	$\sigma=50$
RNAN [57]	-	-	28.27	-	-	29.58	-	-	29.72	-	-	29.08
Ours	-	-	28.40	-	-	29.63	-	-	29.89	-	-	29.52
SwinIR [27]	34.42	31.78	28.56	35.34	32.89	29.79	35.61	33.20	30.22	35.13	32.90	29.82
Ours	34.56	32.01	28.74	35.41	33.03	29.92	35.74	33.29	30.33	35.21	33.09	29.95
DRUNet [52]	34.30	31.69	28.51	35.31	32.89	29.86	35.40	33.14	30.08	34.81	32.60	29.61
Ours	34.41	31.76	28.57	35.43	32.97	29.92	35.51	33.20	30.13	34.90	32.67	29.65
GRL [25]	34.45	31.82	28.62	35.43	33.02	29.93	35.73	33.46	30.36	35.54	33.35	30.46
Ours	34.52	31.89	28.68	35.56	33.11	29.99	35.84	33.54	30.41	35.69	33.48	30.51

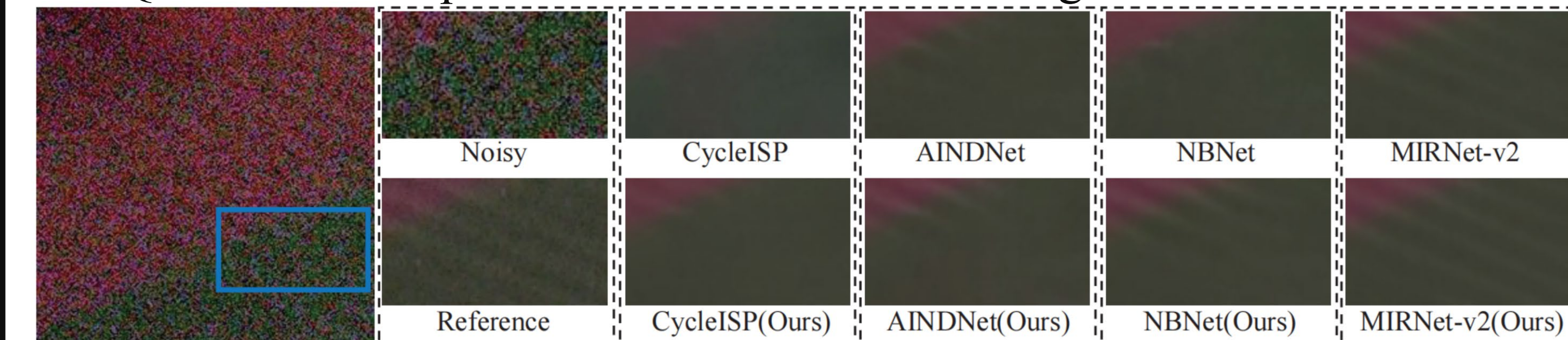
Qualitative comparison on single image motion deblurring.



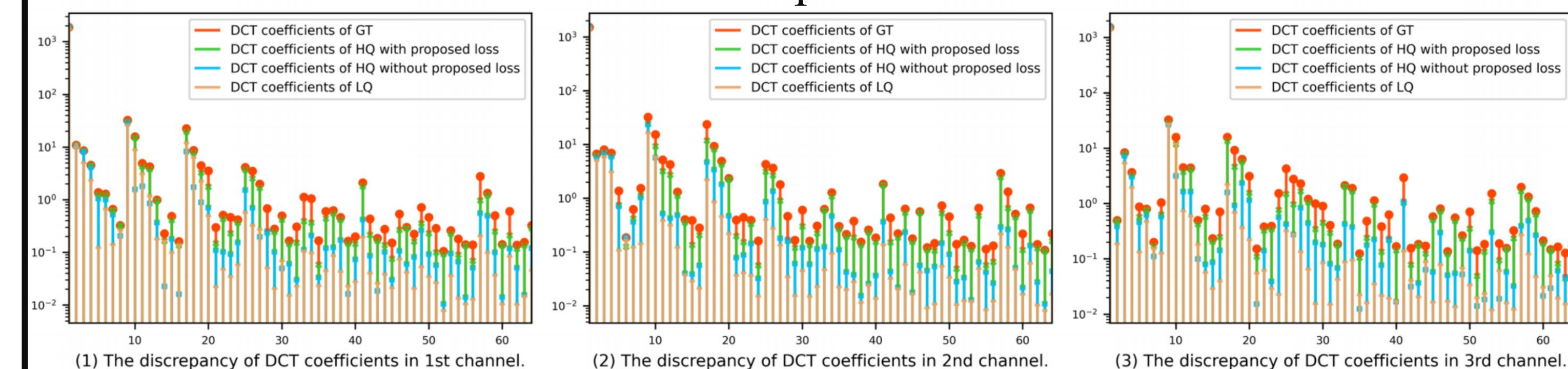
Qualitative comparison on single image super-resolution.



Qualitative comparison on real-world denoising.



The effectiveness of the CCLoss. The discrepancy of DCT coefficients of the 3 channels in RGB color space.



Conclusion

We propose a framework, **CoDe**, with content decoupling capacities for image restoration, which explicitly models the mapping between the content patterns of the inputs and outputs through a divide-and-conquer-like architecture in an end-to-end manner. Comprehensive experiments across various tasks, including image super-resolution, denoising, and deblurring, conducted in both real-world and synthetic scenes, show the effectiveness of the proposed paradigm.