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LOW-LIGHT IMAGE ENHANCEMENT WITH WAVELET-BASED DIFFUSION MODELS

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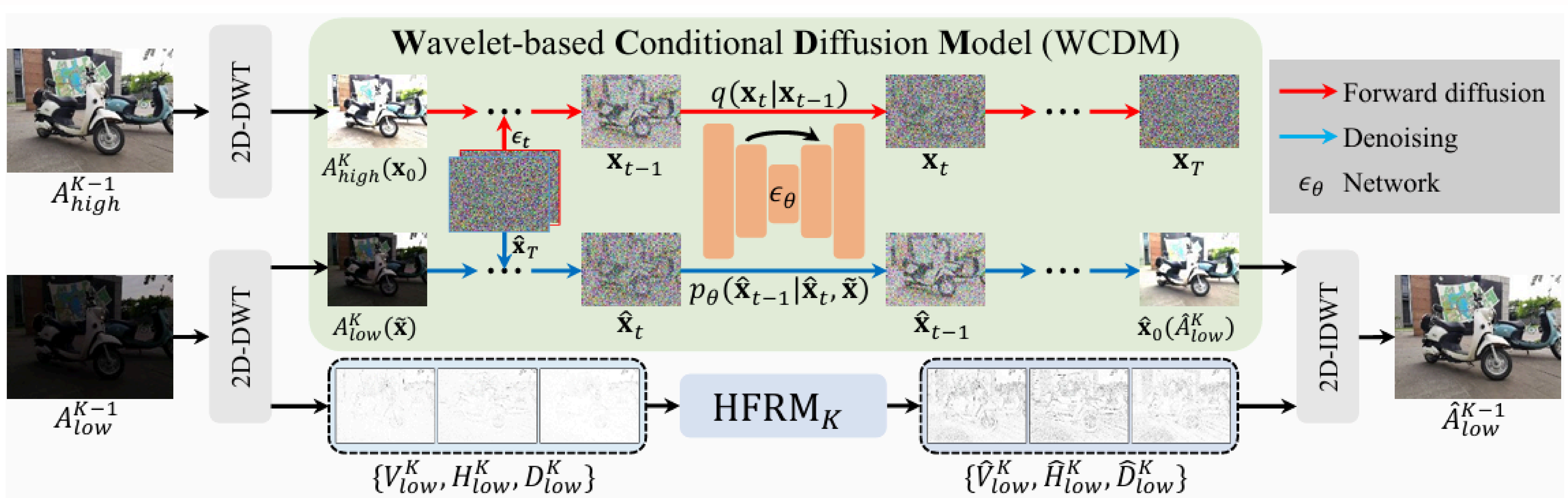
Diffusion models have achieved promising results in image restoration tasks, yet suffer from time-consuming, excessive computational resource consumption, and unstable restoration. To address these issues, this work proposes a robust and efficient Diffusion-based Low-Light image enhancement approach, dubbed DiffLL.

METHODOLOGY



Wavelet-Based Conditional Diffusion Model (WCDM)

- Leverages the generative ability of diffusion models and the strengths of wavelet transformation for robust and efficient low-light image enhancement.

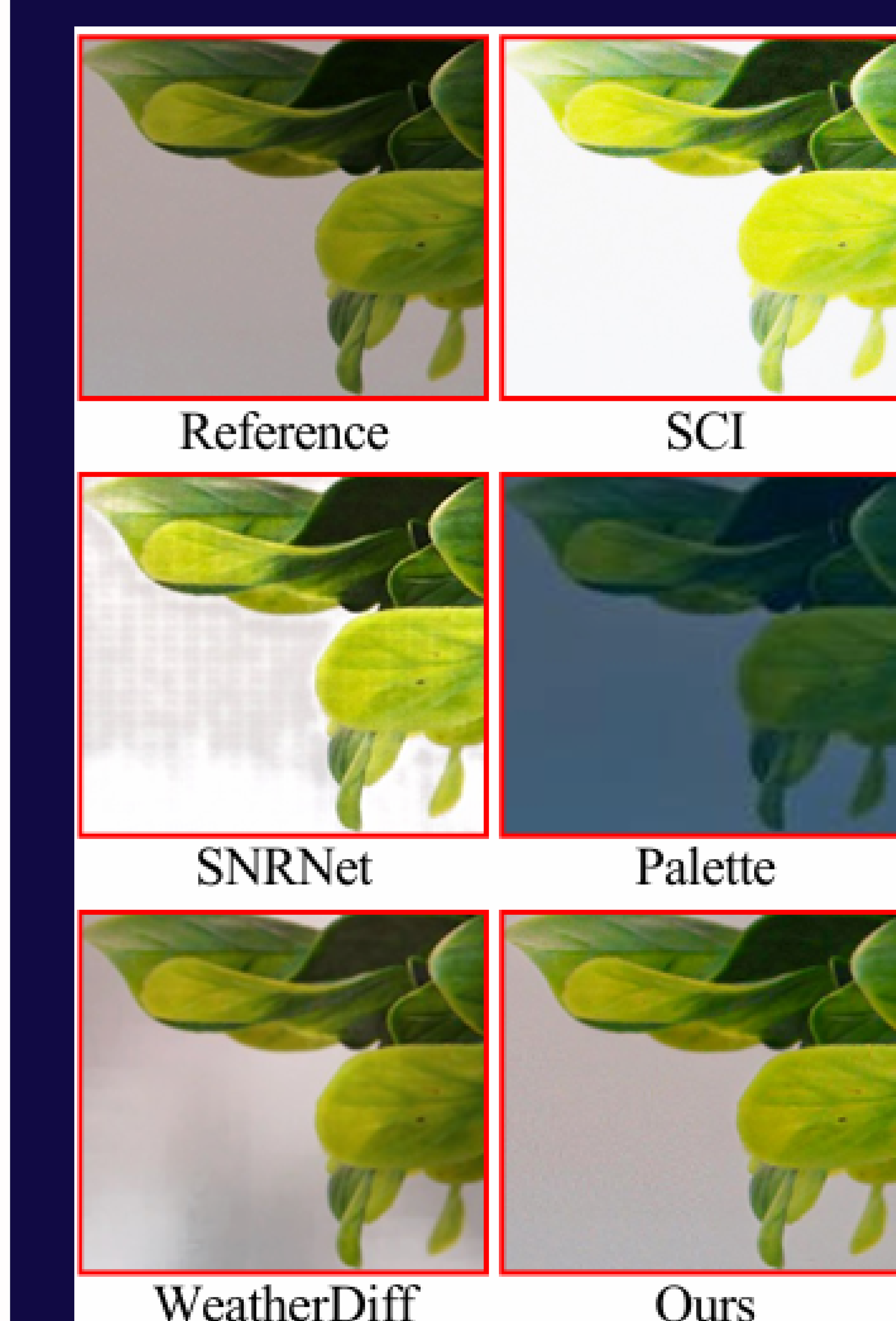
Forward Diffusion and Denoising

- To avoid chaotic content and diversity, both forward diffusion and denoising are performed in the training phase of WCDM, enabling the model to achieve stable denoising and reduce randomness during inference.

High-Frequency Restoration Module (HFRM)

- Utilizes both vertical and horizontal information to complement the diagonal details for local details reconstruction for better fine-grained restoration, enhancing texture quality in low-light images.

RESULTS



Previous methods appear incorrect exposure, color distortion, or artifacts to degrade visual quality, while this method properly improves global contrast and presents a vivid color without introducing chaotic content.

ANALYSIS

Methods	Reference	LOLv1			
		PSNR ↑	SSIM ↑	LPIPS ↓	FID ↓
NPE	TIP' 13	16.970	0.484	0.400	104.057
SRIE	CVPR' 16	11.855	0.495	0.353	88.728
LIME	TIP' 16	17.546	0.531	0.387	117.892
RetinexNet	BMVC' 18	16.774	0.462	0.417	126.266
DSLR	TMM' 20	14.816	0.572	0.375	104.428
DRBN	CVPR' 20	16.677	0.730	0.345	98.732
Zero-DCE	CVPR' 20	14.861	0.562	0.372	87.238
MIRNet	ECCV' 20	24.138	0.830	0.250	69.179
EnlightenGAN	TIP' 21	17.606	0.653	0.372	94.704
ReLLIE	ACM MM' 21	11.437	0.482	0.375	95.510
RUAS	CVPR' 21	16.405	0.503	0.364	101.971
DDIM*	ICLR' 21	16.521	0.776	0.376	84.071
CDEF	TMM' 22	16.335	0.585	0.407	90.620
SCI	CVPR' 22	14.784	0.525	0.366	78.598
URetinex-Net	CVPR' 22	19.842	0.824	0.237	52.383
SNRNet	CVPR' 22	24.610	0.842	0.233	55.121
Uformer*	CVPR' 22	19.001	0.741	0.354	109.351
Restormer*	CVPR' 22	20.614	0.797	0.288	72.998
Palette*	SIGGRAPH' 22	11.771	0.561	0.498	108.291
$\text{UHDFour}_{2\times}$	ICLR' 23	23.093	0.821	0.259	56.912
WeatherDiff*	TPAMI' 23	17.913	0.811	0.272	73.903
GDP	CVPR' 23	15.896	0.542	0.421	117.456
DiffLL(Ours)	-	**26.336**	**0.845**	**0.217**	**48.114**

CONCLUSION

Experimental results show that this method achieves state-of-the art performance on both distortion metrics and perceptual quality while offering noticeable speed up compared to previous diffusion-based methods.