Improving Image De-Raining Using Reference-Guided Transformers

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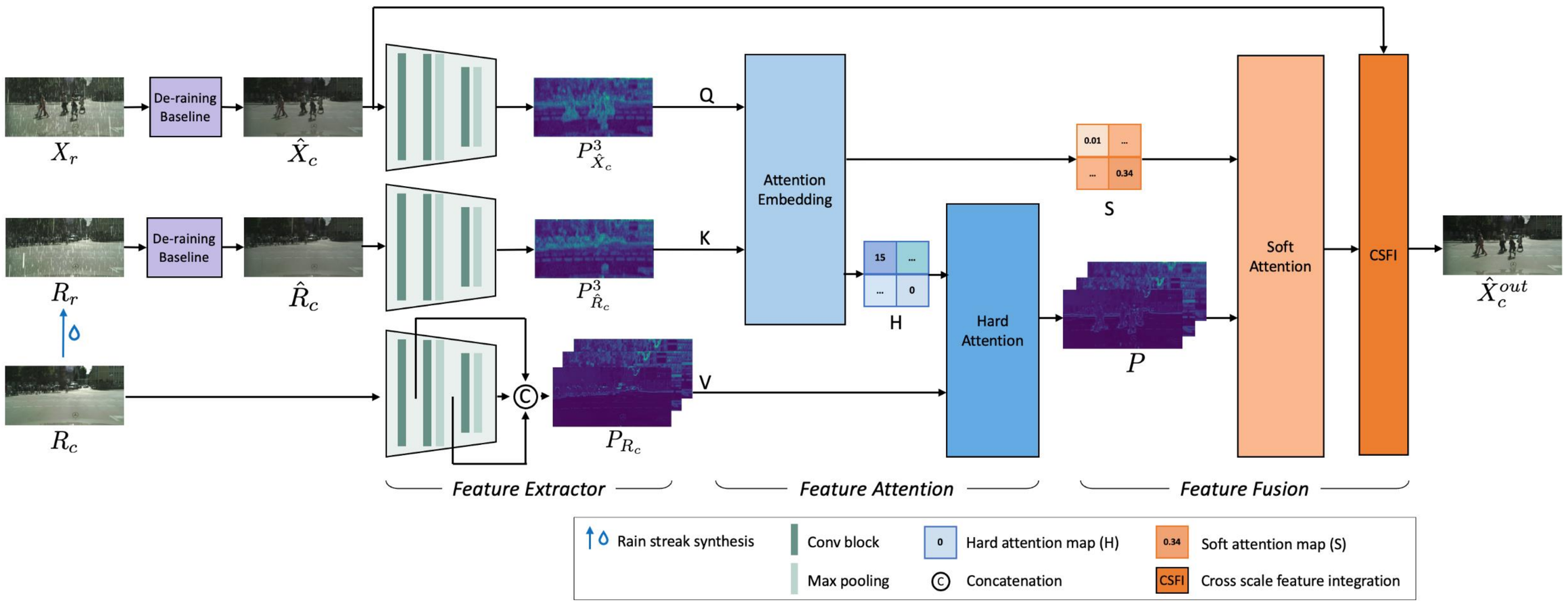
Background & Motivation

- Image de-raining is crucial for enhancing visibility and robustness in outdoor vision systems (e.g., autonomous driving, surveillance) and is essential for preprocessing in various practical applications.
- Existing methods often struggle with complex rain patterns.
- Different but clean images can be reference to de-rain images.

Our Method



- Perform image retrieval to find a reference clean image, and then rain streaks are synthesized
- Extract feature information from reference clean and rainy images
- Improve baseline model's output using cross-attention-based feature fusion

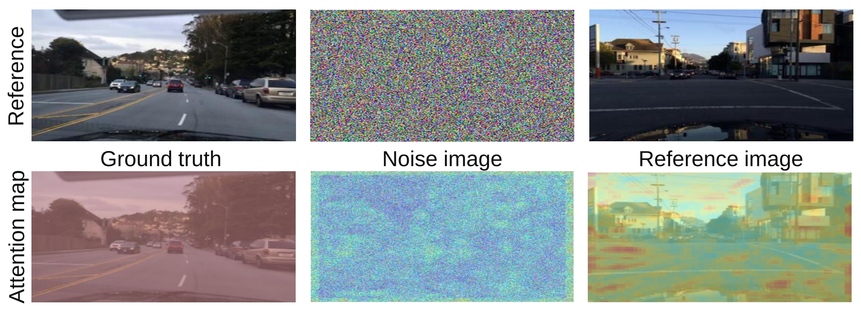
Results

Methods	BDD100K-Rain		KITTI-Rain		Cityscapes-Rain	
Name	PSNR	SSIM	PSNR	SSIM	PSNR	SSIM
GMM [1]	28.37	0.8590	17.08	0.4818	23.333	0.7830
PReNet [2]	33.38	0.9474	22.71	0.7497	23.80	0.9529
Uformer [3]	36.30	0.9619	31.59	0.9694	23.98	0.9509
GMM + **Ours**	$31.44_{+3.07}$	$0.9003_{+0.0412}$	$25.23_{+8.15}$	$0.7933_{+0.3114}$	$23.48_{+0.14}$	$0.8869_{+0.1039}$
PReNet + **Ours**	$33.72_{+0.34}$	$0.9487_{+0.0013}$	$26.92_{+4.21}$	$0.8551_{+0.1054}$	$24.98_{+1.18}$	$0.9595_{+0.0066}$
Uformer + **Ours**	$36.37_{+0.07}$	$0.9627_{+0.0008}$	$33.05_{+1.46}$	$0.9761_{+0.0067}$	$25.64_{+1.66}$	$0.9601_{+0.0091}$

Quantitative evaluation on a prior-based model (GMM), a CNN-based model (PReNet), and a transformer-based model (Uformer), and their improvement using our module highlighted in blue,

[1] Y. Li, R. T. Tan, X. Guo, J. Lu, M. S. Brown, "Rain streak removal using layer priors," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2016.
[2] D. Ren, W. Zuo, Q. Hu, P. Zhu, D. Meng, "Pro-gressive image deraining networks: A better and simplerbaseline," in Proceedings of the IEEE/CVF Conferenceon Computer Vision and Pattern Recognition, 2019
[3] Z. Wang, X. Cun, J. Bao, W. Zhou, J. Liu, H. Li,"Uformer: A general u-shaped transformer for image restoration," in Proceedings of the IEEE/CVF Con-ference on Computer Vision and Pattern Recognition, 2022.

Reference Type	PSNR	SSIM
Ground truth	$35.50_{+2.06}$	$0.9736_{+0.0257}$
Noise image	$33.37_{-0.07}$	$0.9470_{-0.0009}$
Reference image	$33.78_{+0.34}$	$0.9491_{+0.0013}$



Effect of reference images. Quantitative evaluation (top) and input reference images and their attention maps (bottom).

Conclusion & Future Work

- Proposed a reference-guided de-raining filter that improves the performance of existing de-raining models
- Selecting reference images is important: Better enhancement on the KITTI-Rain dataset due to better reference image quality
- Our method shows both universal and baseline-dependent improvements, with larger gains seen for earlier models (e.g., GMM)
- Image retrieval can be time consuming: Using generative models can be an alternative direction

Result Images

Code