How should I take pictures on a rainy day?

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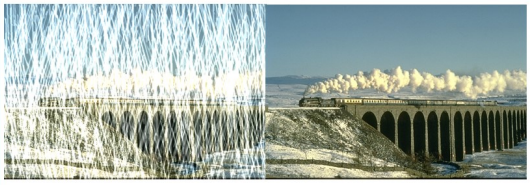
Motivation

Rain removal is an important challenge in the field of computational imaging as rain streaks can cause serious image degradation. Rain causes streaks of different size, shape and direction. Some images can be hard to derain, especially in case of heavy and accumulated rain.

There are many hurdles in both video and single image deraining. Even obtaining a verified dataset of rainy and clear images can be challenging because of light shift, camera motions and motion artifacts.

There have been advances in single image deraining methods. However, as a novice photographer, there remains an open question: Given the state of the art deraining model, how should I be taking my pictures on a rainy day for the best derained result?



Related Work

The state of art methods use convolutional neural networks to tackle data loss and artifacts caused by rain streaks. It is usually hard to obtain a training dataset of real noisy and denoised images for deraining problems, so most of the networks were trained on synthetic data. The authors of [3] proposed a dataset of real rainy and clear images and a deraining model which outperforms state of art methods.

Most of deraining methods are vulnerable to adversarial attacks – noise and perturbations next to rain streaks and objects. [1] provides an effective way to handle additional noise in rainy images. Another challenge is a cumulative noise, which occurs during long exposures. The authors of [2] look into deraining and desnowing for dynamic scenes.

References

[1] Yi Yu et al, Towards Robust Rain Removal Against Adversarial Attacks: A Comprehensive Benchmark Analysis and Beyond, CVPR 2022
[2] Weihong Ren 2t al, Video Desnowing and Deraining Based on Matrix Decomposition, CVPR 2017
[3] Yunhao Ba et al, Not just Streaks: Towards Ground Truth for Single Image Deraining, CVPR 2022

Proposed method

The state of art methods still experience difficulties with reconstructing images in highly textured areas such as bricks and leaves. The deep learning based deraining methods can be also sensitive to adversarial attacks – perturbations near the rain or object area.
So what kind of images would be the best for the model to work with? We propose to explore different options, taking GT-rain as state of art derainer.

- What if we take a video of a rainy scene and derain each frame with our model. Would the results be still constistent?
- How would the model respond to images with perturbations next to rain or some objects?
- Images with different exposures: what is the optimal exposure time to take your images under?
- Would HDR do better for highly textured images?

Experimental Results

Very noisy images

The results are quite consistent even for the images with additional noise around objects after additional training.

PSNR Input	PSNR Output	SSIM Input	SSIM Output
20.0575	24.0174	0.7491	0.7891

HDR data

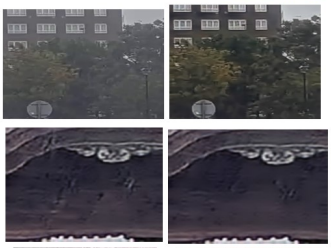
The model performed really well when working images with higher dynamic range.

PSNR Input	PSNR Output	SSIM Input	SSIM Output
28.0912	31.2409	0.7411	0.8220

Video deraining

We took a set of videos of rainy scenes and split each video into frames.

PSNR Input	PSNR Output	SSIM Input	SSIM Output
20.1352	25.3228	0.6101	0.06549



Exposure time measurments

We used the videos to create subsets of pictures with different exposure time. For chosen rain density, the best exposure time was 10-15 sec. due to cumulative noise.