An objective comparison and analysis of the performance of the BM3D and DnCNN image processing algorithms on denoising

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How do we determine which denoising method is best for a given noise type?

Subjectively: have volunteers assign a numerical rating [0-5] based on perceived image quality

Objectively: calculate similarity between denoised images and ground truth using metrics such as **PSNR** and **SSIM**

There is no "gold standard" objective metric--instead, many metrics are applied to determine a consensus

*Image from IQA teaching slides for ECE 6258, by Ghassan AlRegib

In this work, we objectively compare the performance of two denoising techniques, **BM3D** and **DnCNN**, to **five datasets** containing a variety of noise types and levels.

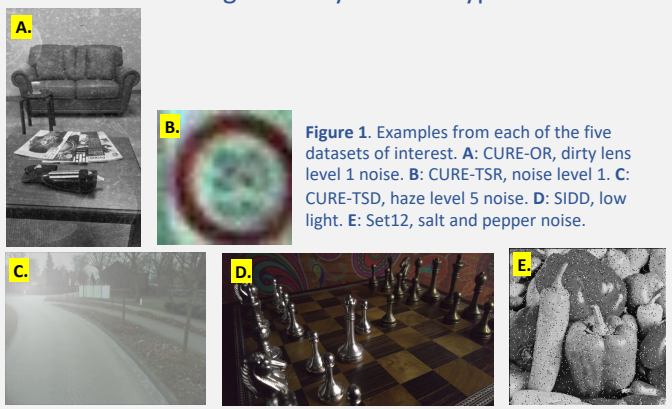


Figure 1. Examples from each of the five datasets of interest. **A**: CURE-OR, dirty lens level 1 noise. **B**: CURE-TSR, noise level 1. **C**: CURE-TSD, haze level 5 noise. **D**: SIDD, low light. **E**: Set12, salt and pepper noise.

Paper and Code available at https://github.com/erinshappell/ECE6258_Project_Fall2023

Architecture of BM3D and DnCNN

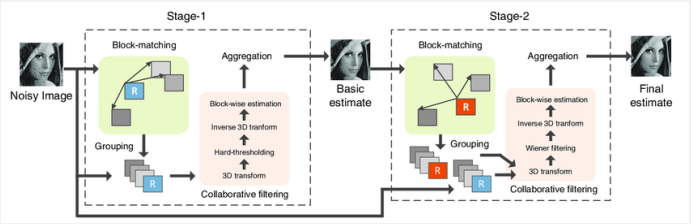


Figure 2. (From Wang et al. 2020) BM3D uses block matching and collaborative filtering to denoise non-local, potentially overlapping groups of similar image segments. These image segments are then weighted and stitched to create the final, denoised image.

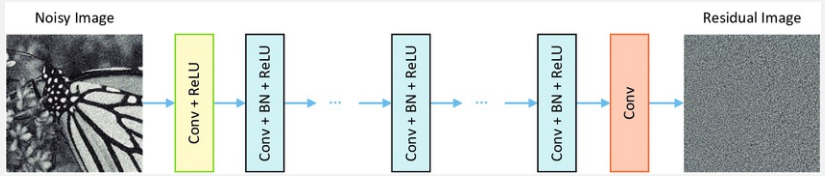
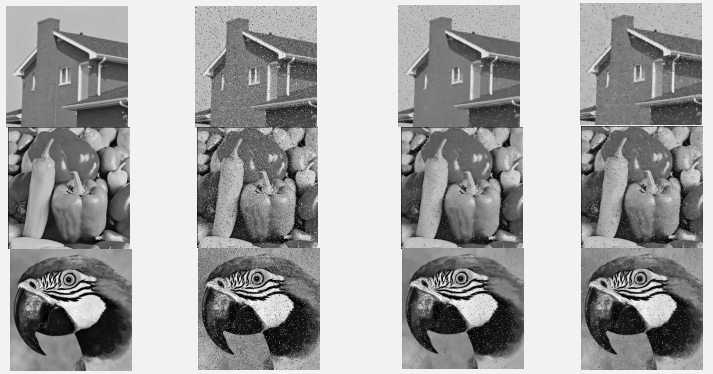


Figure 3. (From Zhang et al. 2016) DnCNN uses a convolutional neural network trained on various levels of Gaussian noise (σ = 0 – 55) to denoise images.

BM3D and DnCNN both performed best on salt and pepper noise



		PSNR	SSIM	CW-SSIM	UNIQUE	MS-UNIQUE	CSV	SUMMER
Salt & Pepper	BM3D	32.971	0.602	0.930	0.442	0.526	0.999	4.951
	DnCNN	32.378	0.616	0.926	0.417	0.493	0.999	4.945

Table 1. Objective metric results from denoising salt & pepper noisy images from the Set12 dataset. Scales for SSIM, CW-SSIM, UNIQUE, MS-UNIQUE, and CSV are [0,1]. Scale for SUMMER is [0,5]

* See paper Appendix for tables of all reported objective metrics

BM3D and DnCNN performance is comparable across all five datasets*