­­­Implementation of classical image denoising methodologies:

Dataset used for comparative analysis:

1. BSD68 : <https://github.com/clausmichele/CBSD68-dataset>
2. Set12. : dataset downloaded to google drive , <https://figshare.com/articles/dataset/PSNR_results_of_denoising_by_different_methods_on_Set12_dataset_/21503325>

We can add AWGN of variance 25 and 50 to get noisy image and verify our algorithm

1. Kodak24: https://github.com/MohamedBakrAli/Kodak-Lossless-True-Color-Image-Suite
2. Urban100 : downloaded to google drive
3. SIDD. : will use for deep learning portion
4. SenseNoise : will use for deep learning portion

Comparative analysis metrics:

1. Visual analysis
2. Performance metric
   1. PSNR [Insert equation for PSNR]
   2. SSIM [Insert equation for SSIM]

Gaussian noise Image denoising through Wiener filtering:

The Wiener filter is the MSE-optimal stationary linear filter for images degraded by additive noise and blurring. This filter is implemented under the assumption that the signal and the noise processes are second-order stationary. Hence , only noise processes with zero mean are considered.

The method is founded on considering images and noise as random variables and the objective is to find an estimate of the uncorrupted image f such that mean square error between them is minimized. The error measure is defined as :

Where E{.} is the expected value.

Below assumptions are made:

1. Noise and image are uncorrelated
2. One or the other has zero mean
3. Intensity levels in the estimate are a linear function of the levels in the degraded image

Frequency domain expression for Wiener filter is given by:

Where

From the equations, it can be observed that Wiener filtering has two separate parts:

1. An inverse filtering part
2. A noise smoothing part

So it does high pass filtering through inverse filtering and removes the noise with a compression operation, which is a lowpass filtering operation.

Observations: As observed from the implementation of the weiner filter, the major bottleneck is the assumption about white noise variance. By varying the white noise variance value over a range, we calculated ssim value for each result and chose the best one.

Plot of ssim vs variance is given as below:

Bilateral filtering

A bilateral filter is a non-linear edge-preserving and noise reducing smoothing filter for images. It replaces the intensity of each pixel with a weighted average of intensity values from nearby pixels.

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Wavelet based transforms for image denoising

Wavelet: A function applied for processing digital signals and compression. Wavelet transforms a high-resolution signal into an approximated and detailed coefficients.

The approximated coefficients are low-resolution approximations because they do not show what has changed. On the other hand, the detailed coefficient shows the changes and makes it possible to recover the original image from the approximated coefficients.

Wavelet transform provides a time series approximation of fourier transform