Image Denoising Using a U-net

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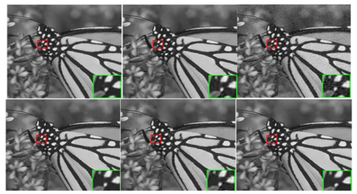
Motivation

- While image denoising techniques require parameters to be manually set and complex optimization increases computational cost, in recent years, CNNs have proven to be more computationally efficient while producing better results. In medical imaging, U-nets are extensively used instead of the traditional image processing pipeline.
- Using a current U-net, tune hyperparameters to get best PSNR on the CIFAR-10 dataset



a Original image
b BM3D/31.85 dB
c Noisy/24.59 dB
d WNNM/32.71 dB
e EPLL/32.10 dB
f ECNDNet/33.11 dB

Fig 1. Calculated PSNRs for traditional image denoising and CNNs such as ECNDNet[1]

Related Work

- GANs have been used to remove unknown noise from images[2] while various CNN models on different deep learning frameworks have been trained for medical applications for CT and MRI scans[3]
- Every CNN model has different number of layers and hyperparameters tuned based on computational power and time needed to run. Some have traditional denoising techniques along with CNNs fused.
- Due to limited computing power resources, goal is to train a U-net to get decent PSNR results without being too time intensive and add super-resolution to compare results from literature

References

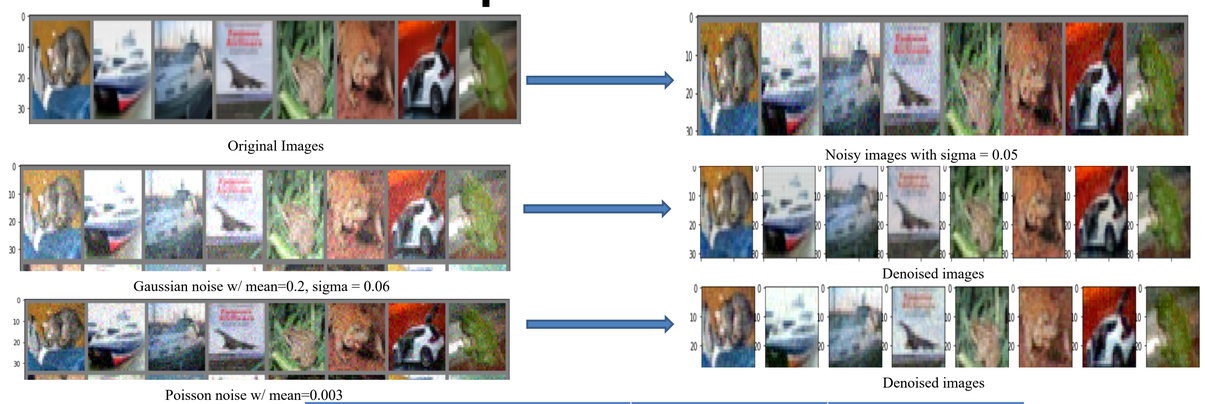
[1] Fei,Luo, Tian, et.al., "Enhanced CNN for Image Denoising", *The Institution for Engineering and Technology*, 2018
[2] Chao, Chen, Chen, et.al., "Image Blind Denoising With Generative Adversarial Network Based Noise Modeling", *CVPR*, 2018
[3] Buzuk, Heinrich, and Stille, "Residual U-Net Convolutional Neural Network Architecture for Low-Dose CT Denoising", *Current Directions in Biomedical Engineering*, 2018

New Technique

Load CIFAR-10 dataset and split into training and test set → Choose optimizer for training. Eg: Adam, RMSProp, SGD → Add noise (Gaussian/Poisson /S&P) to data and train to denoise on selected U-net → Select optimizer and hyperparameters after tuning for 1 epoch → Denoise noisy test set and calculate mean PSNR

- Based on the minimum loss from the optimizer on the training set, choose the best hyperparameters and denoise for the test set
- Various U-nets and datasets can be plugged in to train and tune hyperparameters
- **Further work:** Introduce super-resolution where training set is downsampled before sending through the u-net and then upsampled, and calculate PSNR

Experimental Results



Optimizer & parameters	Mean noisy PSNR	Mean PSNR
Optimizer: Adam with learning rate=0.001 Noise: Gaussian noise with sigma = 0.05	26.18	28.38
Optimizer: RMS with learning rate=0.001 Noise: Gaussian noise with sigma = 0.05	26.18	24.42
Optimizer: SGD with learning rate=0.001, momentum = 0.9 Noise: Gaussian noise with sigma = 0.05	26.18	28.18
Optimizer: Adam with learning rate=0.01 Noise: Gaussian noise with mean=0.2, sigma = 0.06	14.14	24.38
Optimizer: Adam with learning rate=0.01 Noise: Poisson noise with mean=0.003	25.39	25.43