# COMP576: Image Denoising using Convolutional Neural Network

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## Introduction and Motivation

- Taking photos with smartphones has become a popular way for people to record their lives. However, image denoising still remains one of the most challenging tasks when it comes to processing smartphone images.
- Deep learning techniques have received much attention in the area of smartphone image denoising.

## Goal

Developing and training a CNN-based model that can demonstrate better performances of image denoising by comparing results of different network structures.

## Dataset

- Smartphone Image Denoising Dataset (SIDD)[1][2]
- Captured under different lighting conditions using five representative smartphone cameras
- Generated ground truth images
- 160 image pairs (noisy and ground-truth), 160 scene instances

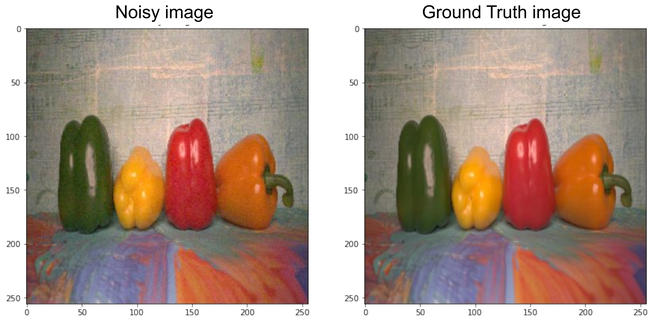


Figure 1. A pair of sample dataset

## Our Model

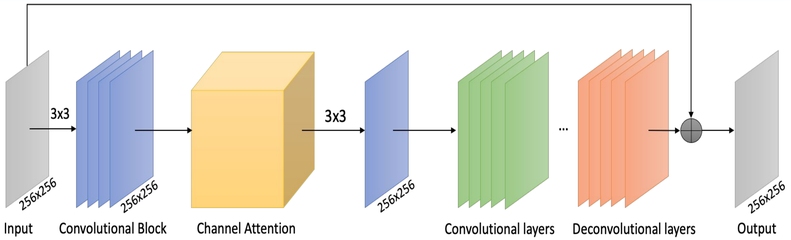


Figure 2. Architecture of the Model

- Build a new CNN-based image denoising model which contains channel attention and a REDNet (Residual Encoder-Decoder Networks).
- Compare our model with previous methods, REDNet[3] , and PRIDNet[4].
- Vary convolution and deconvolution layers in our model and REDNet.

## Experiments

We test our trained model on noisy images to visualize denoising performance. The eye-closeup and rail train image were from Online Dataset. We can see that noise in predicted images is much less than original images.

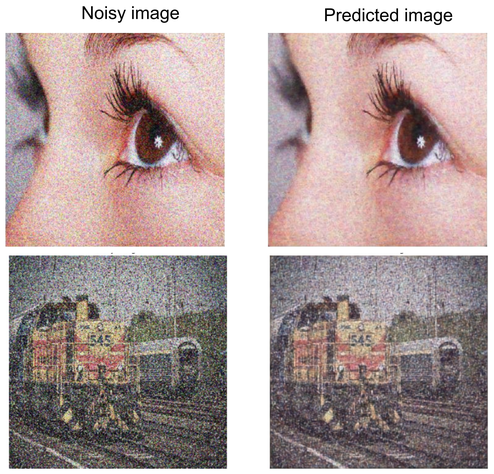


Figure 3. Test images

## Results & Discussion

| Model | PSNR | SSIM | PSNR Improvement | SSIM improvement |
|---|---|---|---|---|
| Original X-y pairs (No Model) | 26.3779 | 0.6000 | - | - |
| REDNet_5layers | 32.1988 | 0.7725 | 5.8209 | 0.1725 |
| REDNet_9layers | 32.7721 | 0.7728 | 6.3942 | 0.1728 |
| REDNet_15layers | 33.1718 | 0.7738 | 6.7939 | 0.1738 |
| REDNet_5layers (using Attention) | 33.5744 | 0.7785 | 7.1965 | 0.1785 |
| PRIDNet (using Attention) | 33.3105 | 0.8049 | 6.9326 | 0.2049 |

Table 1. Result of different CNN based image denoising methods

- Our model (REDNet_5layers (using Attention)) has about 7.2 increase in PSNR and 0.18 increase in SSIM from original pairs, which means predicted image using our model can have a “closer” quality and structural similarity to the ground truth image.
- Adding layers will increase the quality of image by denoising

## Conclusion & Further Work

- We proposed a new CNN-based image denoising model by combing channel attention and a REDNet.
- The new model demonstrated higher performance with its better metrics (PSNR, SSIM) and structural simplicity (compared to PRIDNet).
- Potential improvements/considerations include:
  - Training on larger dataset (SIDD-Full Dataset)
  - Using larger number of epochs
  - Using K-Fold Cross Validation, if possible

## References

[1] Abdelrahman Abdelhamed, Lin S., Brown M. S. "A High-Quality Denoising Dataset for Smartphone Cameras", IEEE Computer Vision and Pattern Recognition (**CVPR**), June 2018.
[2] Abdelrahman Abdelhamed, Timofte R., Brown M. S., et al. "NTIRE 2019 Challenge on Real Image Denoising: Methods and Results", IEEE Computer Vision and Pattern Recognition Workshops (**CVPRW**), June 2019.
[3] Mao, Xiao-Jiao, et al. Image Restoration Using Convolutional Auto-Encoders with Symmetric Skip Connections. 30 Aug. 2016, doi:10.48550/arXiv.1606.08921.
[4] Y. Zhao, Z. Jiang, A. Men and G. Ju, "Pyramid Real Image Denoising Network," *2019 IEEE Visual Communications and Image Processing (VCIP)*, 2019, pp. 1-4, doi: 10.1109/VCIP47243.2019.8965754.