Image Fixed Pattern Noise Correction

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Problem Statement

- Photon shot noise can hide fixed pattern noise, if the ratio is 10:1 or better. Our customers require 20:1. In low light, with little shot noise, uncorrected FPN can be higher than the signal.

- Image correction can be done by calibrating individual die, but some customers do not have a budget for this time-consuming step.

- We need a universal FPN corrector, good for all die, and we are training an 11-layer convolutional network to do that.

Network

- Following the approach of He, Cao, Dong et al (“Single-image-based nonuniformity correction.”) Applied Optics, Vol 57, No 18, 20-June-2018

- Convolution with a 5x5 kernel (to span four sequential row types), with 32 filters.

Training

Loss Function:

\[ J = \frac{1}{MN} \sum_{i=1}^{M} \sum_{j=1}^{N} |p_{ij} - t_{ij}| \]

where M,N are the number of rows and columns of the input images respectively, and P is the predicted image output and T is the original clean image output.

Training Data

Discussion and Future work

- Using percentage error for loss might have emphasized smaller pixel values as we wished, but would require more work with dataset to remove zero values.

- 120x speed improvement with AWS makes huge difference in minimum error that can be achieved.

- Expand to larger image sizes (e.g. from 4K sensors)

- Debayering for colored sensors.

References: