15-463 Computational Photography (Fall 2023)

Assignment 2

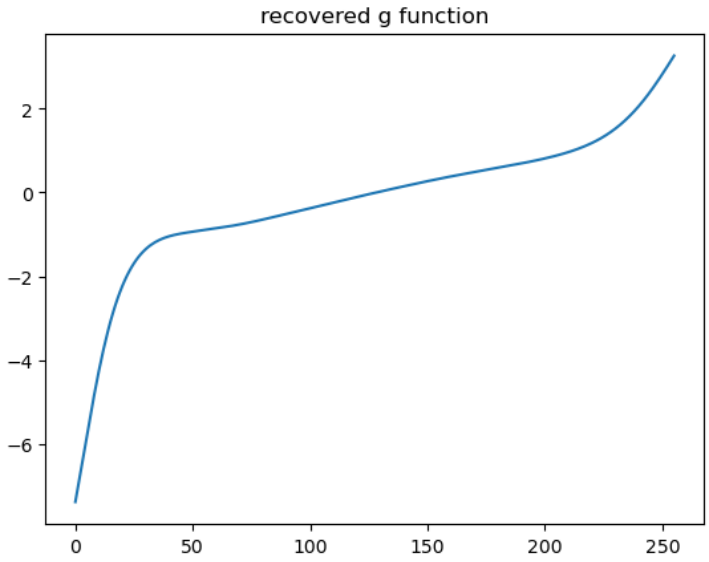
Haejoon Lee

1. HDR Imaging

[Develop RAW images]

(base) HAEJOON@haejoons-mbp myDCRAW % ./dcraw -v -4 -w -o 1 -T exposure1.nef

[Linearize rendered images]



[Weighting schemes]

W_uniform: Z_min = 0.05, Z_max = 0.95

W_tent: Z_min = 0.001, Z_max = 0.999

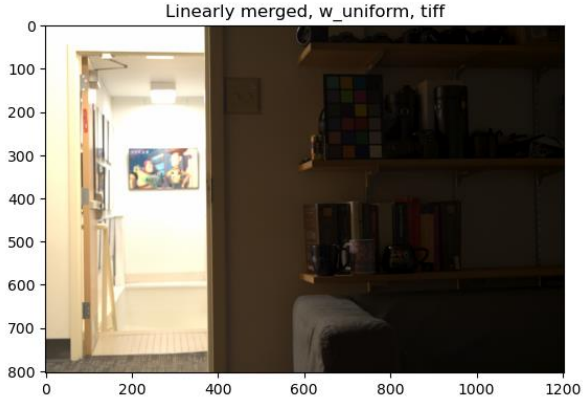
W_gaussian: Z_min = 0.001, Z_max = 0.999

W_photon: Z_min = 0.005, Z_max = 0.95

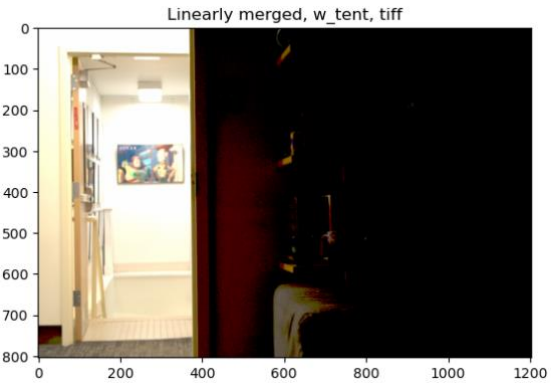
[Make your pick]

From raw images

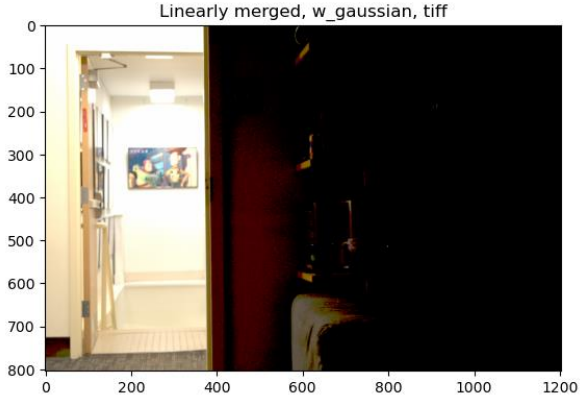
Linearly merged, w_uniform, tiff



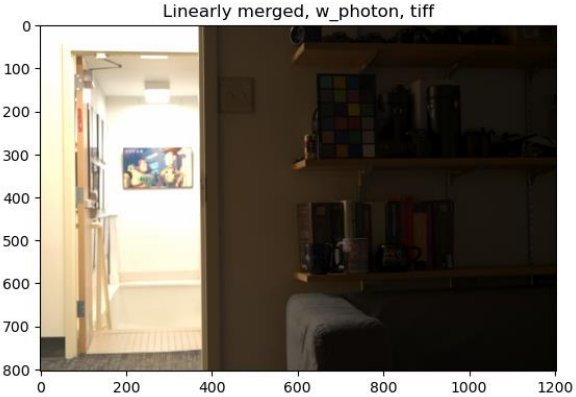
Linearly merged, w_tent, tiff



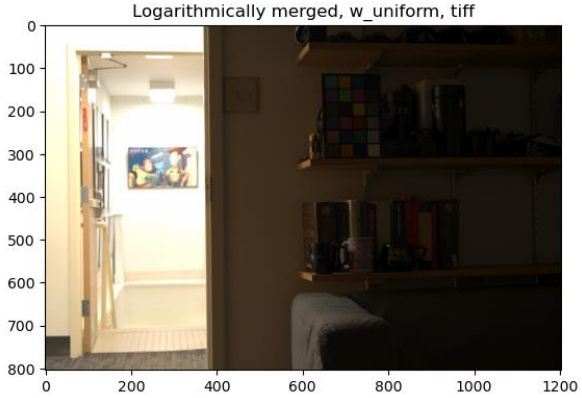
Linearly merged, w_gaussian, tiff



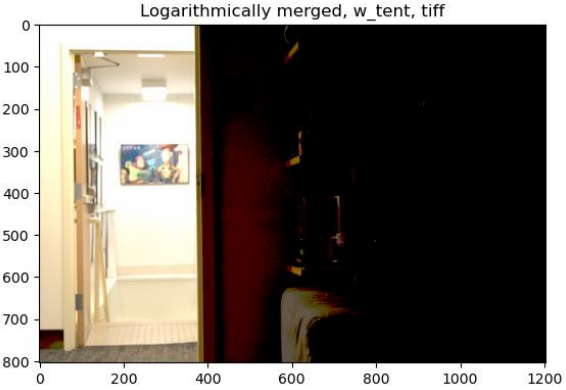
Linearly merged, w_photon, tiff



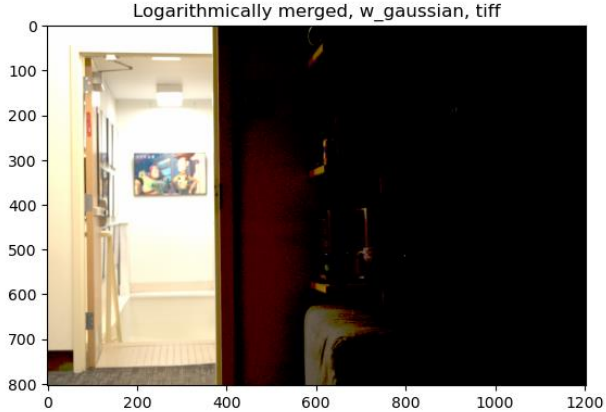
Logarithmically merged, w_uniform, tiff



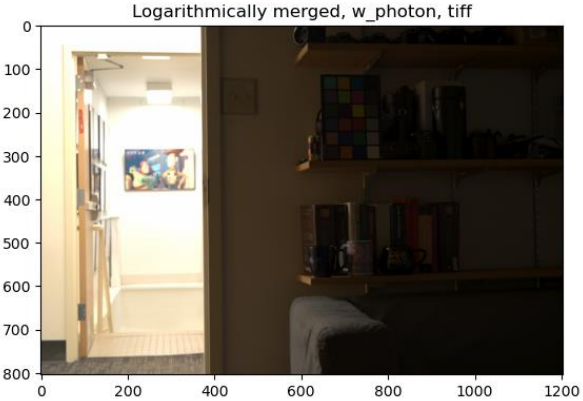
Logarithmically merged, w_tent, tiff



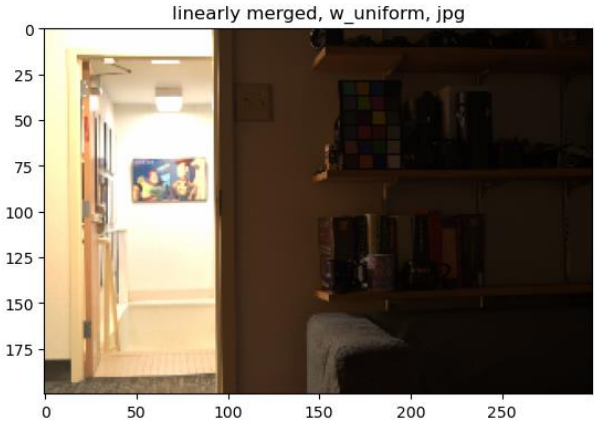
Logarithmically merged, w_gaussian, tiff

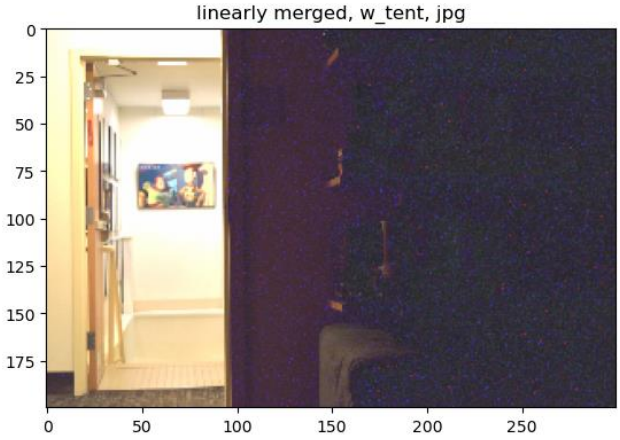


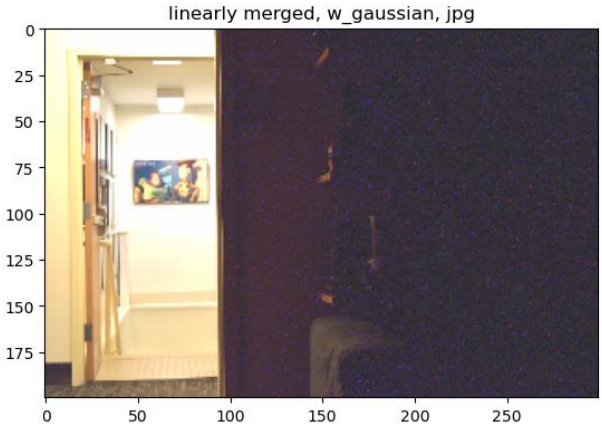
Logarithmically merged, w_photon, tiff

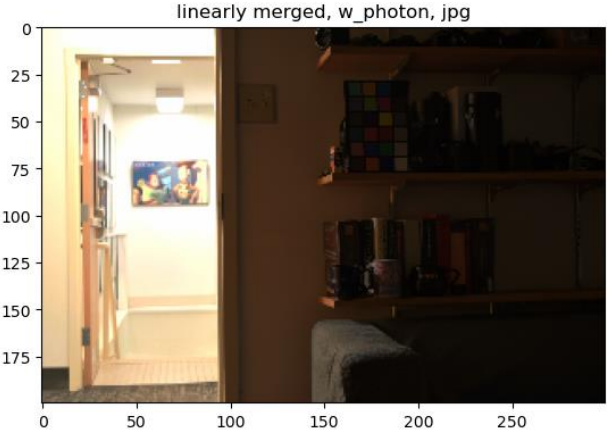


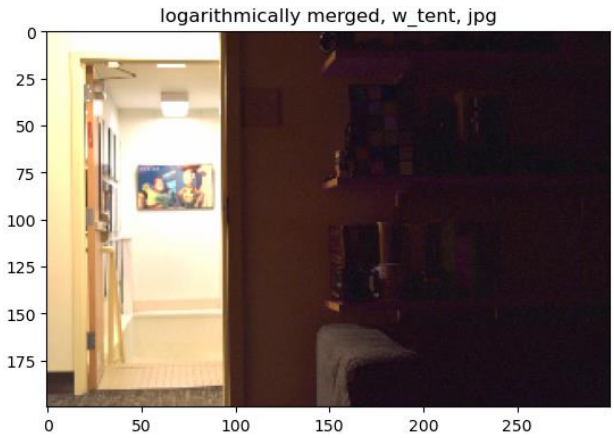
From rendered images

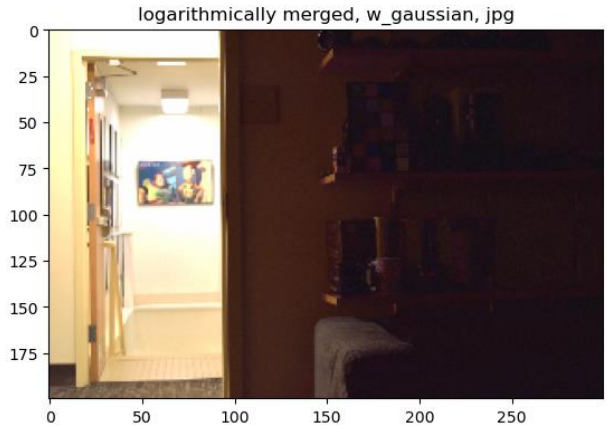


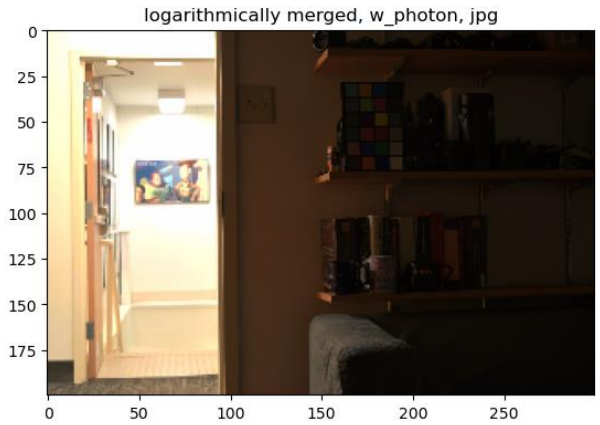






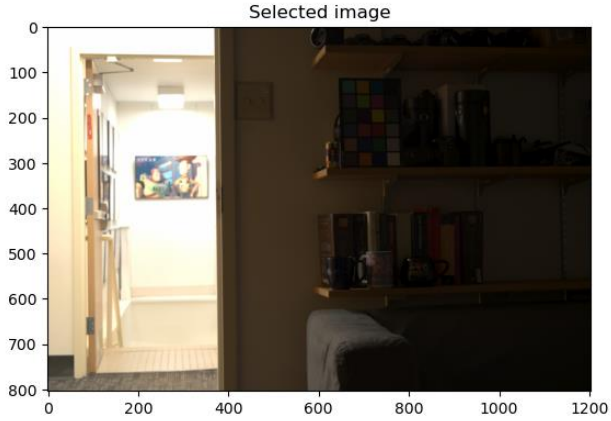


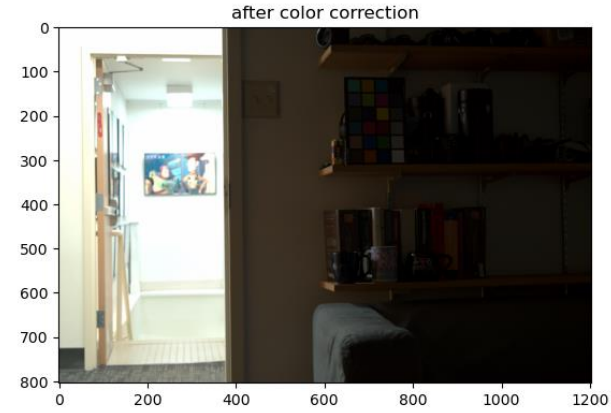




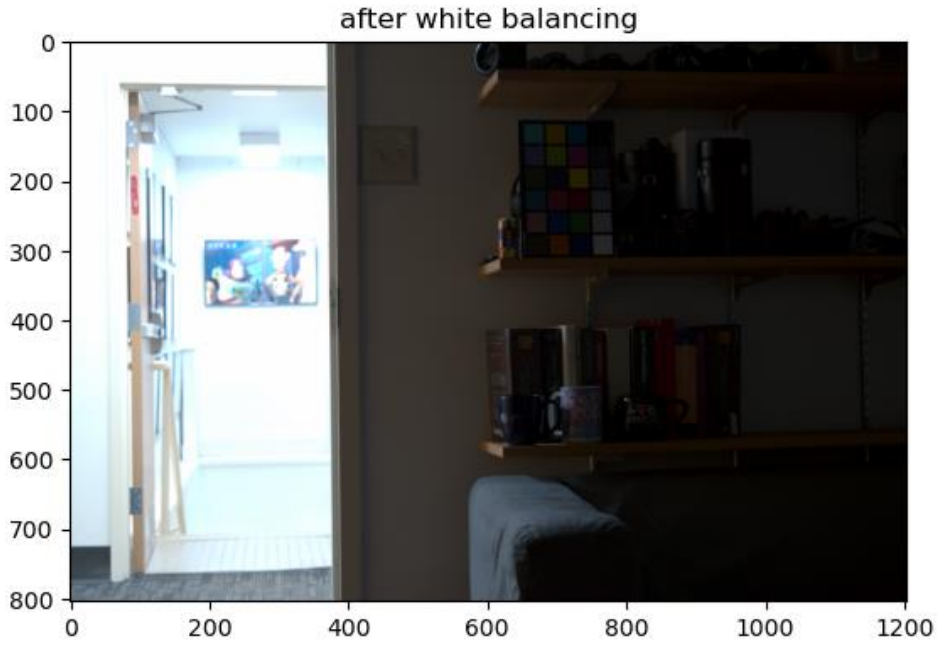
My best pick is linearly merged raw images with w_photon since it is the most natural and shows the dark wall scene to be bright the most. Some HDR images from raw images have noise artifacts probably coming from jpeg compression and incomplete linearization. Also, they are much more yellowish.

2. Color correction and white balancing



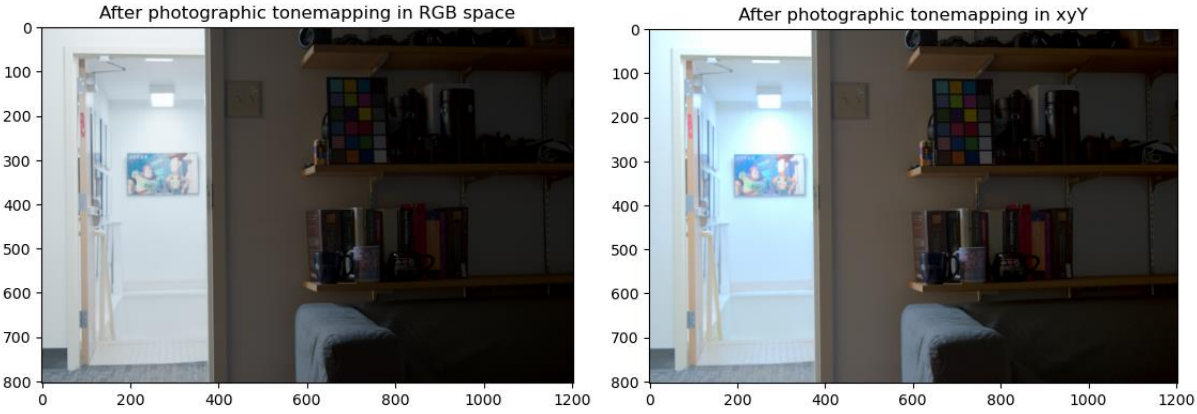


After the color correction, the image even got more natural and less yellowish.



After white balancing, The yellowish color ws gone and became much natural. We can see that the white patch in the color checkerboard is much whiter than before.

3. Photographic tonemapping



After photographic tonemapping in RGB space, the bright illumination got much uniform and natural. After photographic tonemapping in xyZ space, the luminant component got much discernable, and the image became generally more vivid. I like the first one more as it looks more natural to me.

4. Create and tonemap your own HDR photo

Proceeded with tonemapping in RGB space because it showed more preferable result in Part 2.

Small B(0.01)

Large B(1)

With the large value of B, the HDR could hold more details on the both dim and bright part.

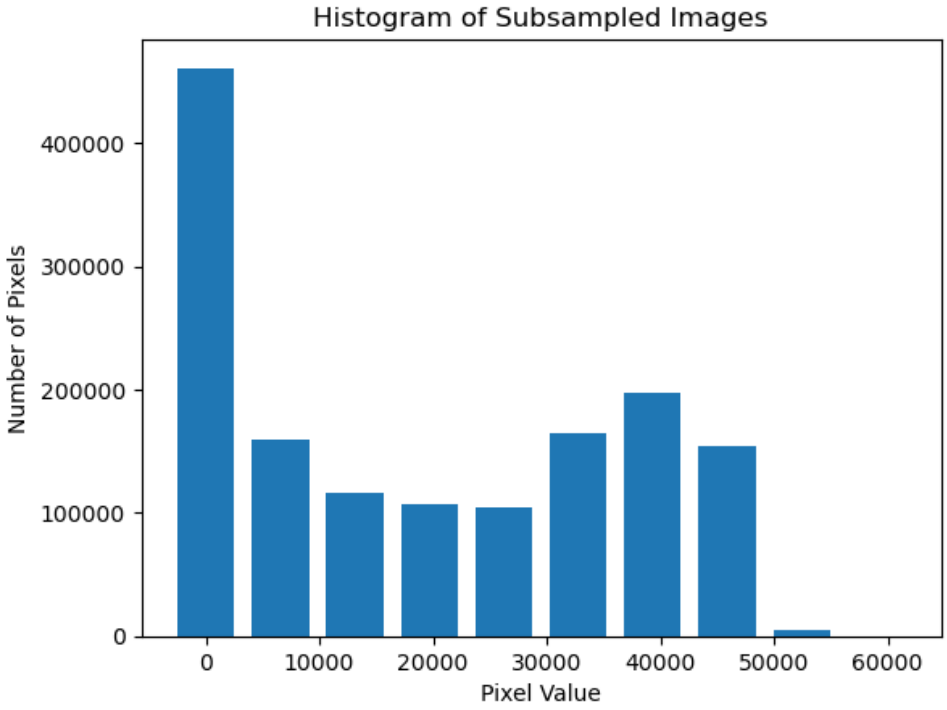
Small K(0.01)

Larger K(0.5)

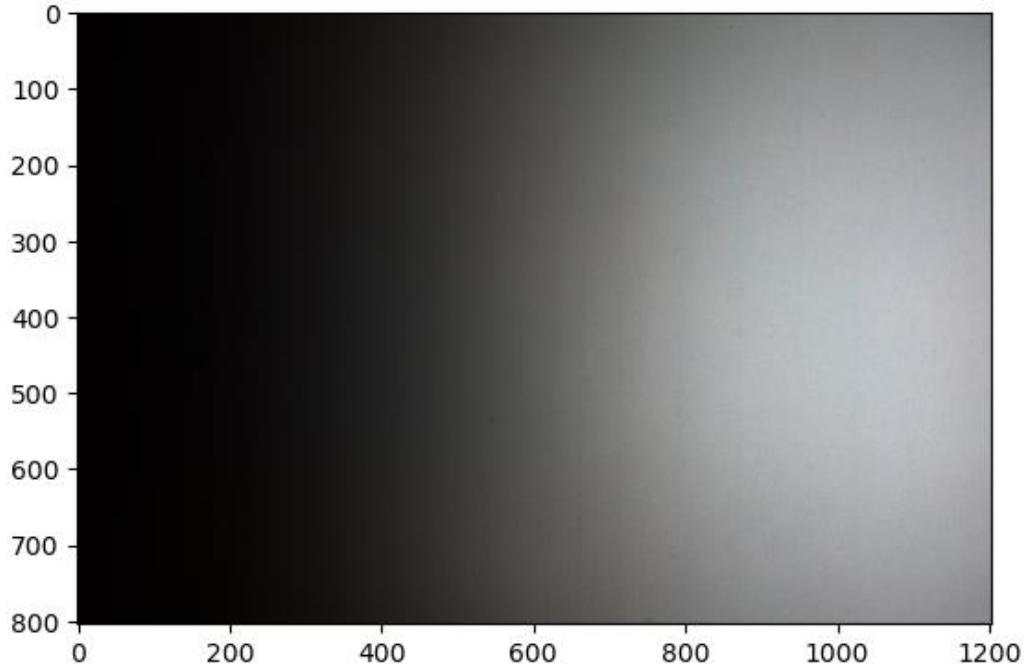
Large K value makes the image more bright, but saturate the outdoor scene.

My pick is the tonemapping with values with K=0.1 B=1 to preserve the decent balance between dark and bright part.

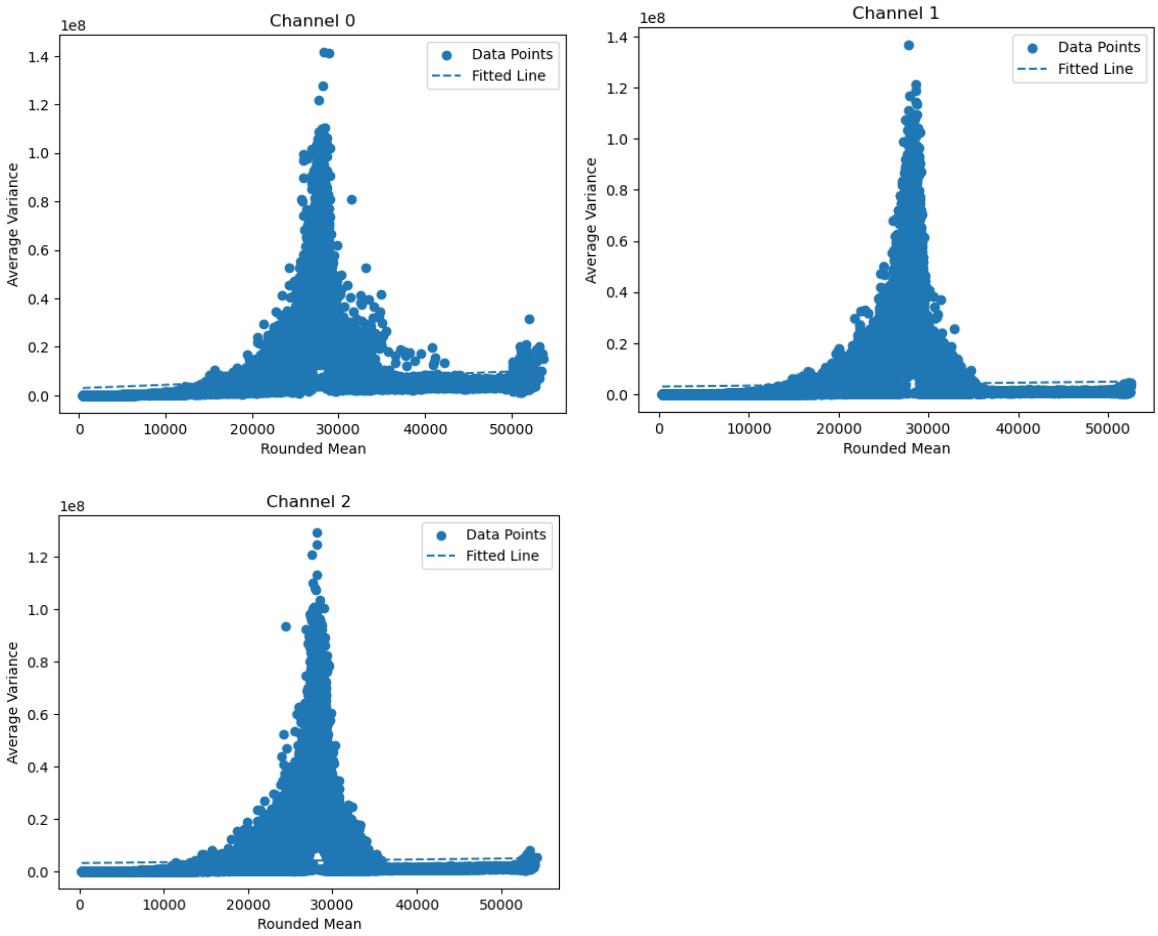
5. Noise calibration and optimal weights



I expected that the histogram will be planar, but the dark pixels are dominant. So I looked the photo of the ramp image taken with my camera and realized that it makes sense.



Even though the ramp pattern I generated was linearly getting bright, the photo shows much more dark pixels, and also regionally brighter part on the right. Probably it came from the illumination on the printed pattern.



The exploding variance in the middle pixel values might coming from the illumination.

For red channel:

Estimated camera gain (g): 138.31875187630737

Estimated total additive noise variance (sigma^2): 2956190.749379316

For green channel:

Estimated camera gain (g): 37.82269262925981

Estimated total additive noise variance (sigma^2): 2971044.0422963495

For blue channel:

Estimated camera gain (g): 34.87946758882906

Estimated total additive noise variance (sigma^2): 3135464.711302983

The optimally merged HDR image shows better contrast in the bright part because the noise calibration helps to optimize the weight.