BBM 446 - Computational Photography Laboratory
Assignment 2 Report

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1. HDR imaging

a. Develop RAW images

We run the dcraw with the following flags to convert the RAW .NEF images into linear 16-bit .TIFF images:

```
dcraw -v -w -q 3 -o 1 -4 -T exposure1.nef
```

Used flags:

- -w White Balancing: Image is white balanced using the camera data.
- -q 3 Demosaicing: Set interpolation algorithm to Adaptive Homogeneity-Directed (AHD) interpolation, which provides the highest quality.
- -o 1 Color Space Correction: Set the output color space to sRGB D65.
- -4 It generates a linear 16-bit file.
- -T It outputs a TIFF image file instead of PPM.
- -v Provides textual information about the development process.

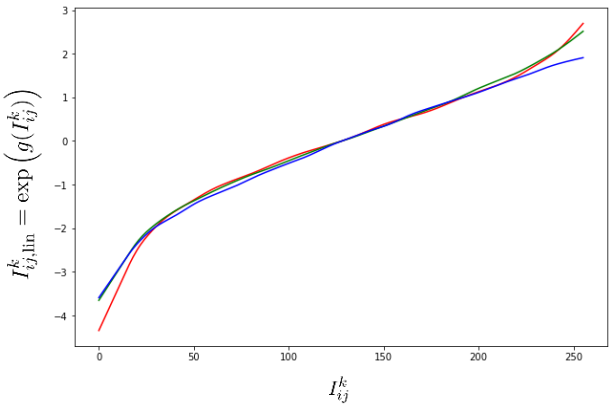
b. Linearize Rendered Images

To linearize rendered images, I used the method proposed by Debevec and Malik [1] and implemented it by converting the MATLAB code at the end of the paper to the Python version and making the necessary additions.

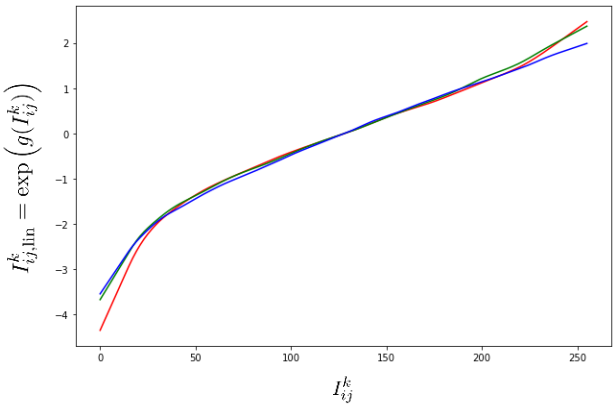
I recovered the function $g := log(f^{-1})$ for each channel as proposed by Debevec and Malik [1]. When I use clipping values of $Z_{min} = 0.05$ and $Z_{max} = 0.95$, I obtained meaningless g functions except the *photon* weighting scheme. However, when I use no clipping values ($Z_{min} = 0$ and $Z_{max} = 1.0$), I get g functions that looked more accurate for all weighting schemes.

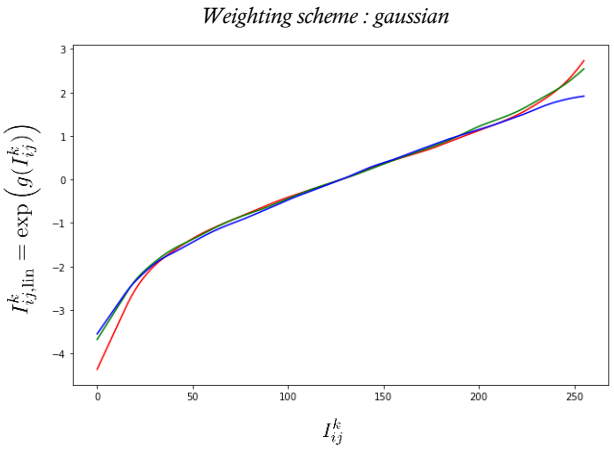
Plots of g functions obtained from different weighting schemes:

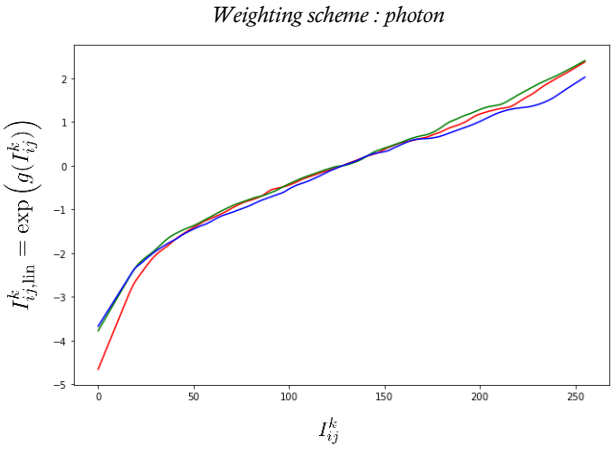
Weighting scheme : uniform



Weighting scheme : tent

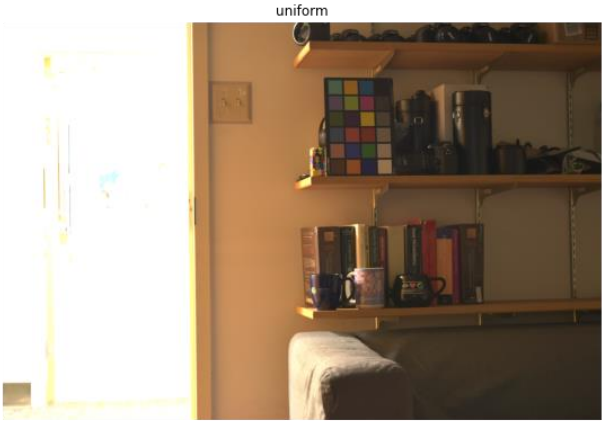


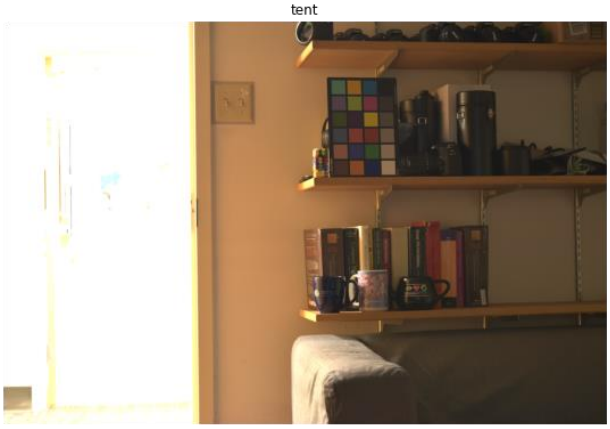


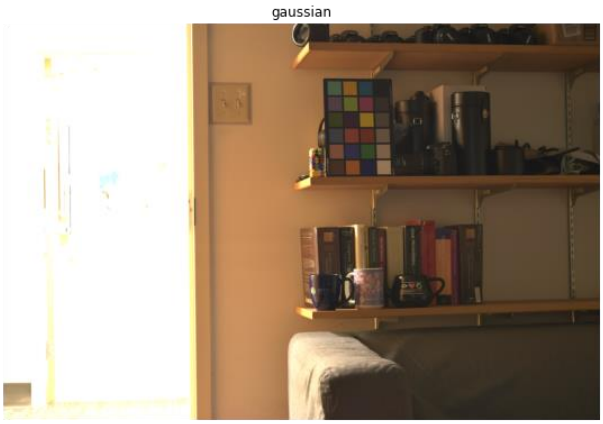


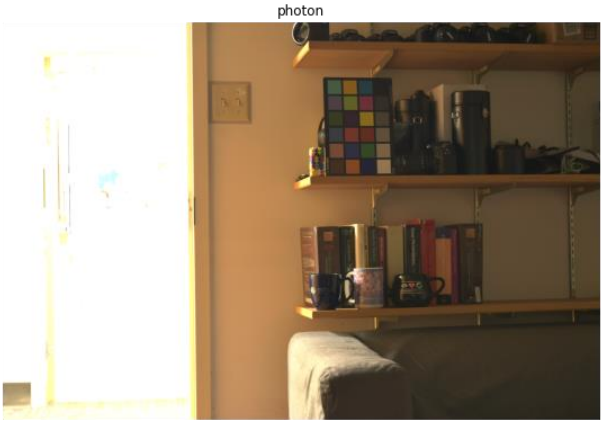
c. Merge exposure stack into HDR image

rendered – linear merging:



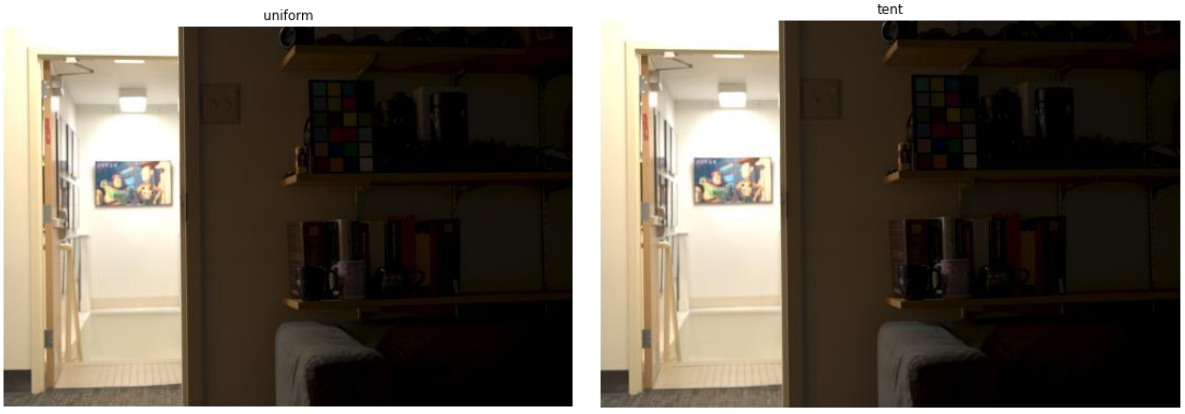


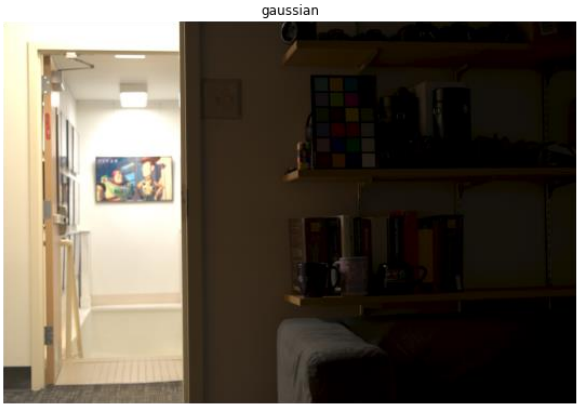


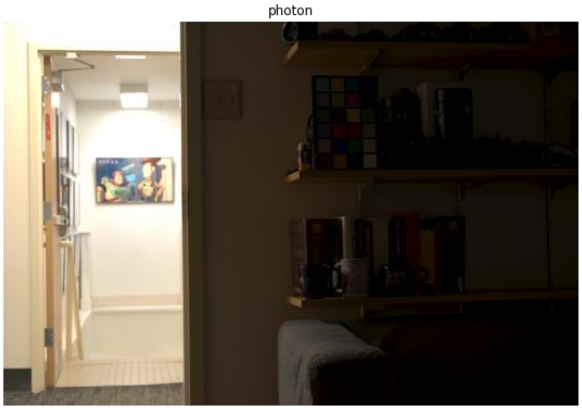


rendered – logarithmic merging:

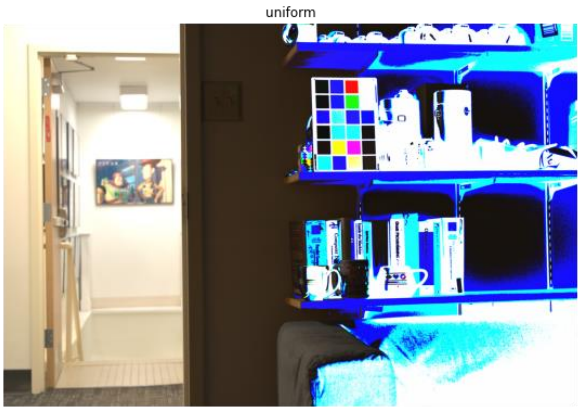
RAW – linear merging:

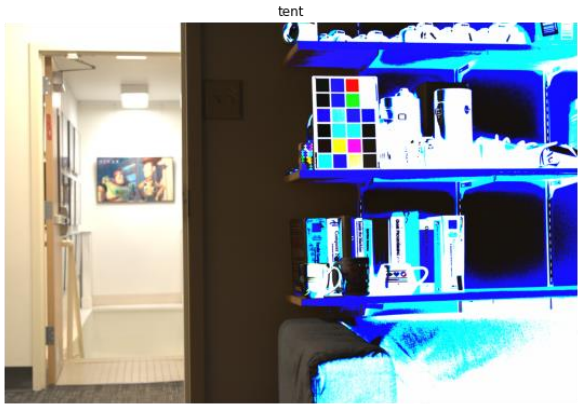


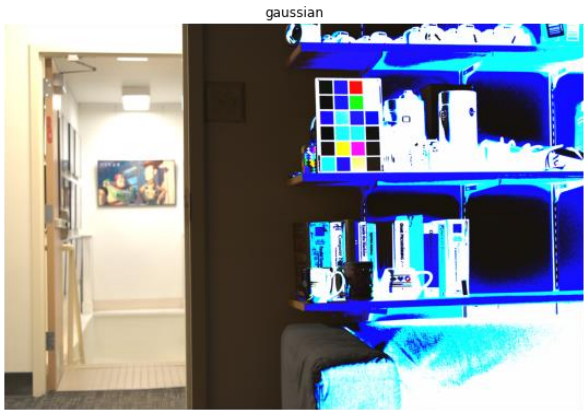


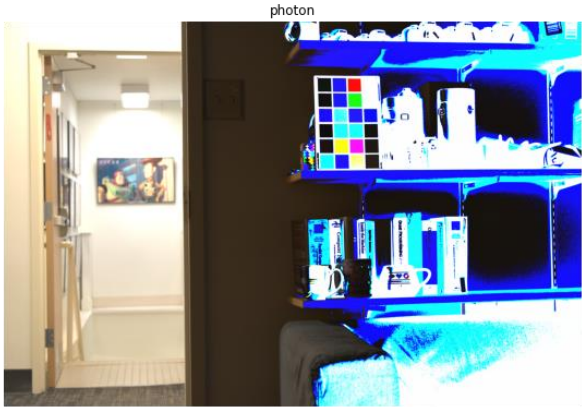


RAW – logarithmic merging:









Gamma encoding has been applied to all the images shown above.

The first thing I would like to mention is that when applying logarithmic merging to RAW LDR images, areas that remain dark at low exposure have a meaningless bright bluish appearance as seen above. Even though I applied the logarithmic merging formula exactly as stated in the assignment paper, I could not figure out why such a view would occur. Again, as seen above, I did not encounter such a problem when applying logarithmic merging to rendered LDR images.

I will continue to the next steps with the HDR image obtained by applying **linear merging** to **rendered** images using the **photon** weighting scheme. Actually, there is no particular reason for me to choose this HDR image. As seen above, there is no significant difference between the HDR images obtained by applying different weighting schemes. The reason why I chose rendered over RAW is because I believe that the color accuracy of HDR images obtained with rendered images is more accurate.

2. Color correction and white balancing

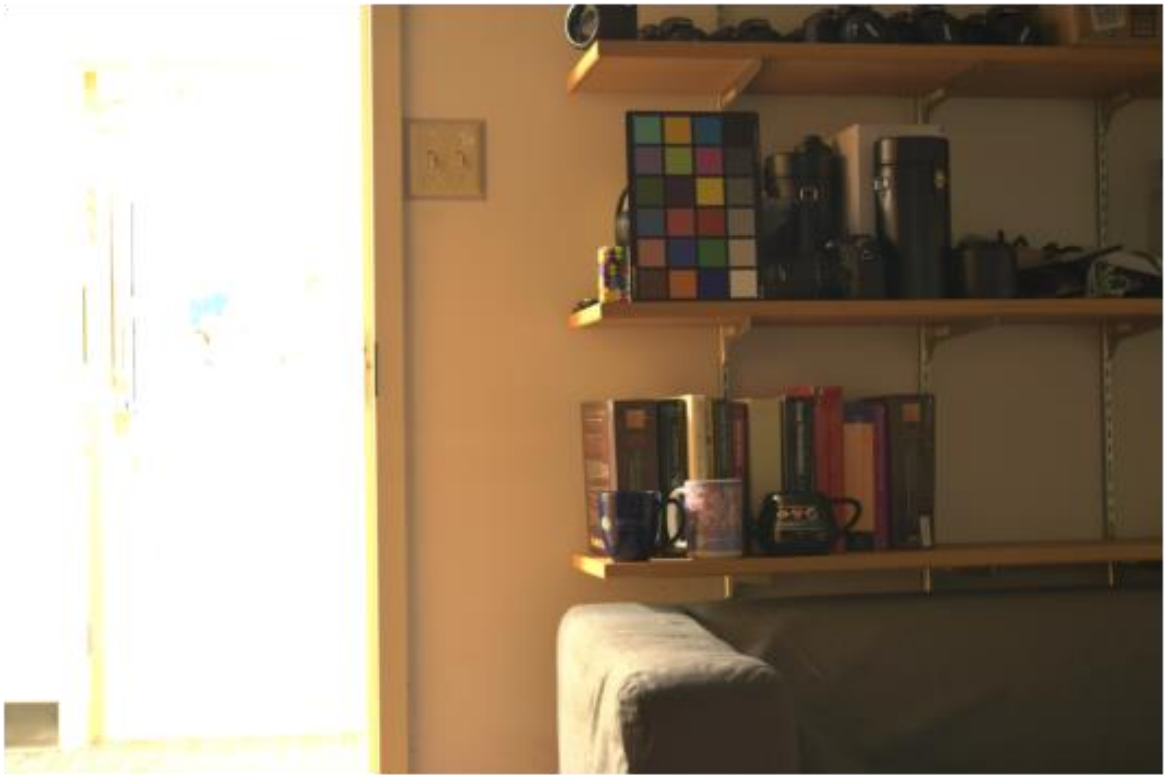
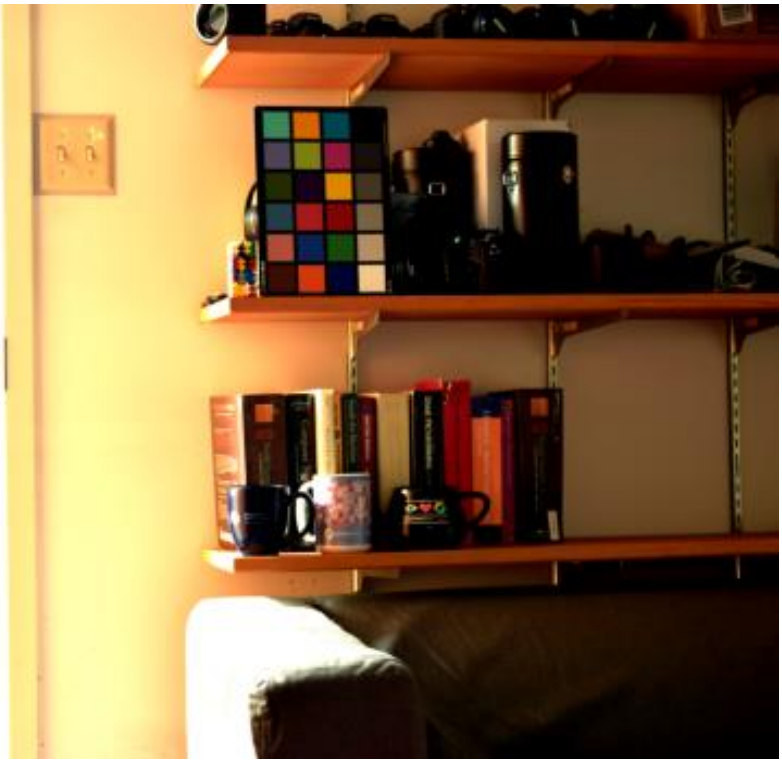
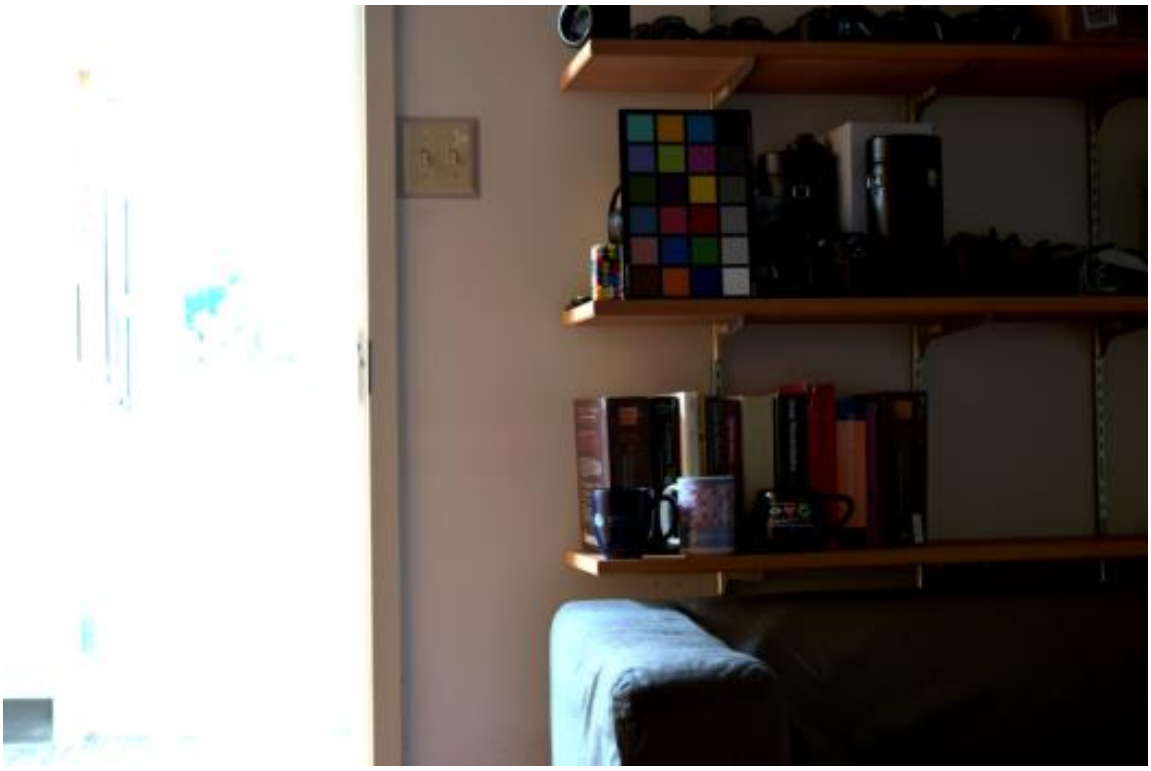


Figure. HDR image obtained by applying linear merging to rendered images using the photon weighting scheme

After applying color correction to the above image:



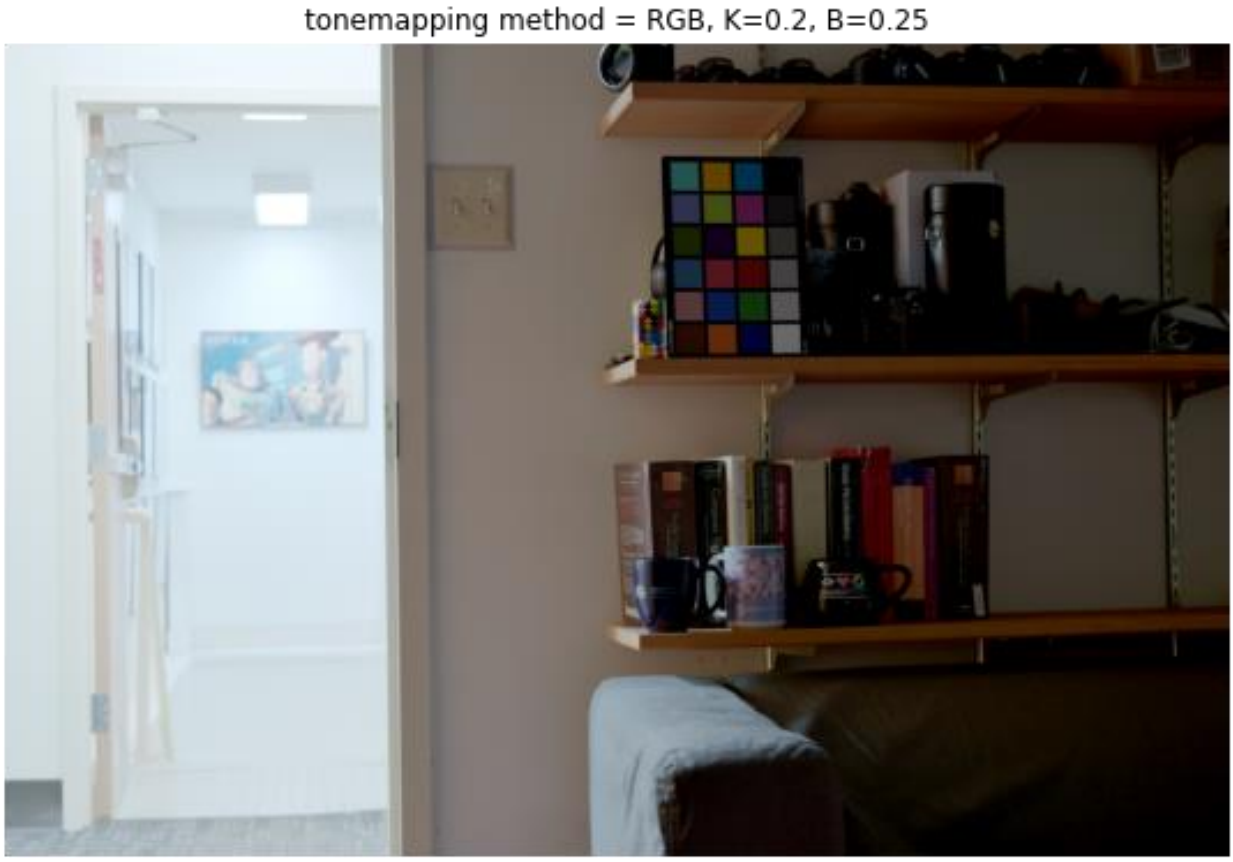
After applying white balancing to the above image:



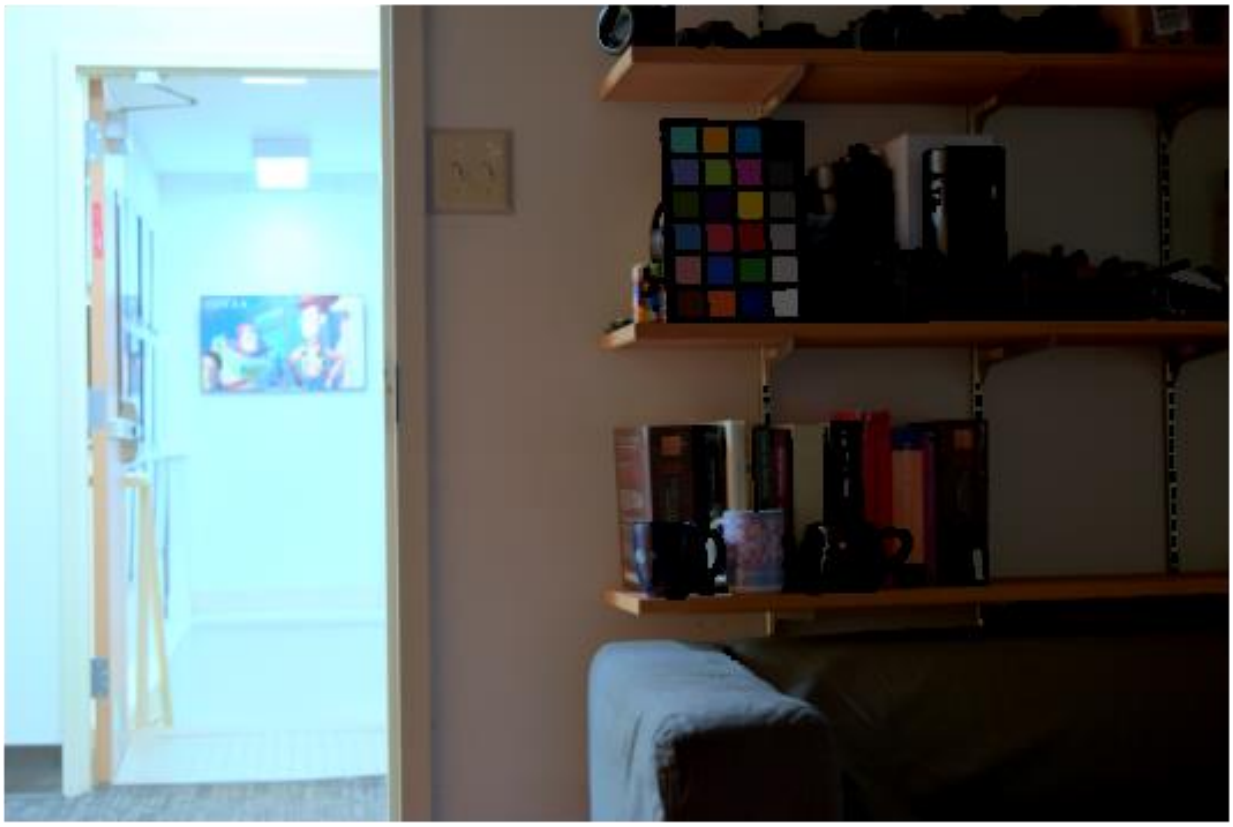
As you can see from the pictures above, there are color and saturation differences between the first HDR image and the image after color correction and white balancing has been applied. Colors now look more accurate and distinct compared to the first image, as we do color calibration and white balancing by using color checker. But since we still haven't applied tonemapping, the image doesn't look the way we want.

3. Photographic Tonemapping

After experimenting with different key and burn values, I obtained the final HDR image, which is color corrected, white-balanced and tone-mapped.



tonemapping method = Luminance, K=0.2, B=0.2



First image above shows the first tonemapping method which is that tonemapping is applied to all color channels simultaneously in the same way. The second image above shows that the second method which is that tonemapping is applied to only luminance channel Y (xyY). As can be seen from the images, the first method is more successful than the second one.

References

[1] P. E. Debevec and J. Malik. Recovering high dynamic range radiance maps from photographs. In Proceedings of the 24th Annual Conference on Computer Graphics and Interactive Techniques, SIGGRAPH '97, pages 369–378, New York, NY, USA, 1997. ACM Press/Addison-Wesley Publishing Co.