ASSIGNMENT 3

15663 Computational Photograpy Fall 2023
DUE: October 13, 2023

1 Bilateral Filtering

Implement bilateral filtering (40 points) We compared the results acquired with Gaussian kernel size $3, 7, 15$ and $\sigma_r = 0.02, 0.1, 0.5$. σ_s is set to 40 for all images. The results are as follow:

Figure 1: kernel size = 3

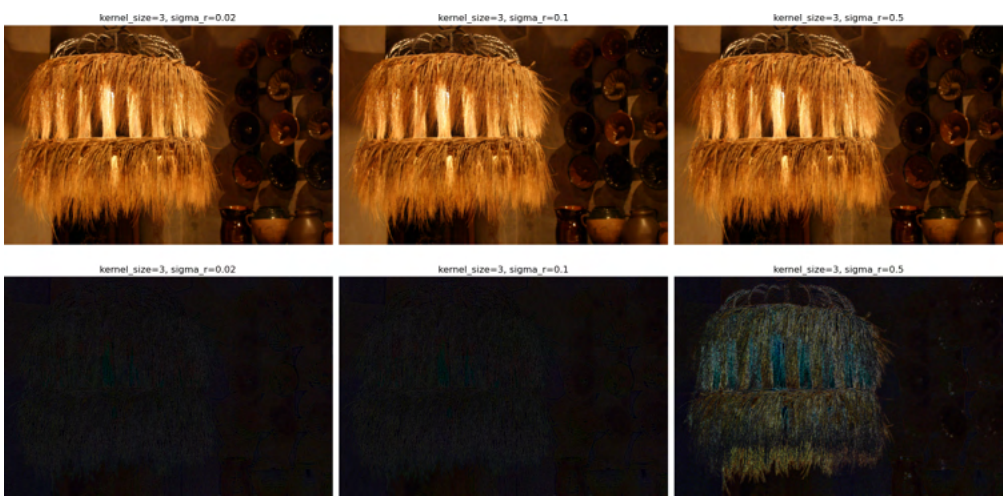

Figure 2: kernel size = 7

Figure 3: kernel size = 15

The image below is computed using kernel size 5, $\sigma_r = 0.05$ and $\sigma_s = 40$.

Figure 4: Lamp image after bilateral filtering

Implement joint bilateral filtering (30 points) We compared the results acquired with Gaussian kernel size $3, 7, 15$ and $\sigma_r = 0.02, 0.1, 0.5$. σ_s is set to 40 for all images. The results are as follow:

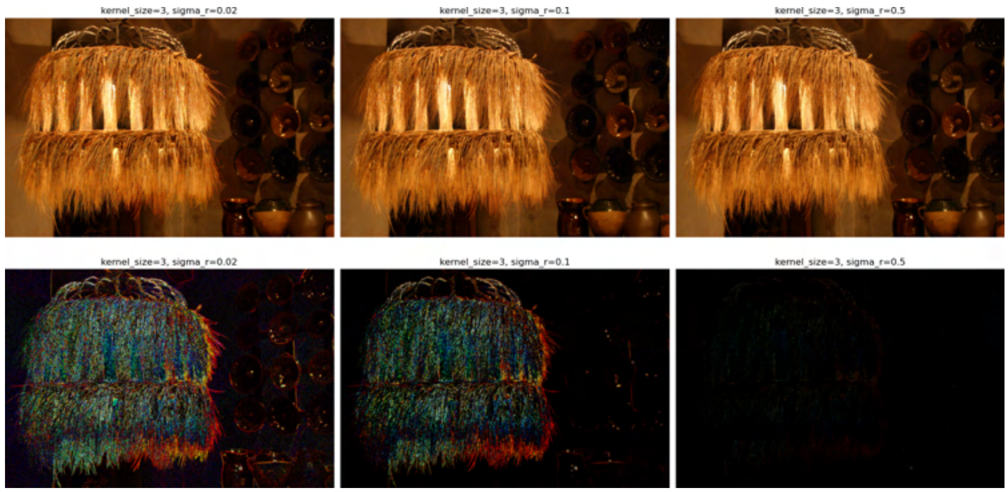

Figure 5: kernel size = 3

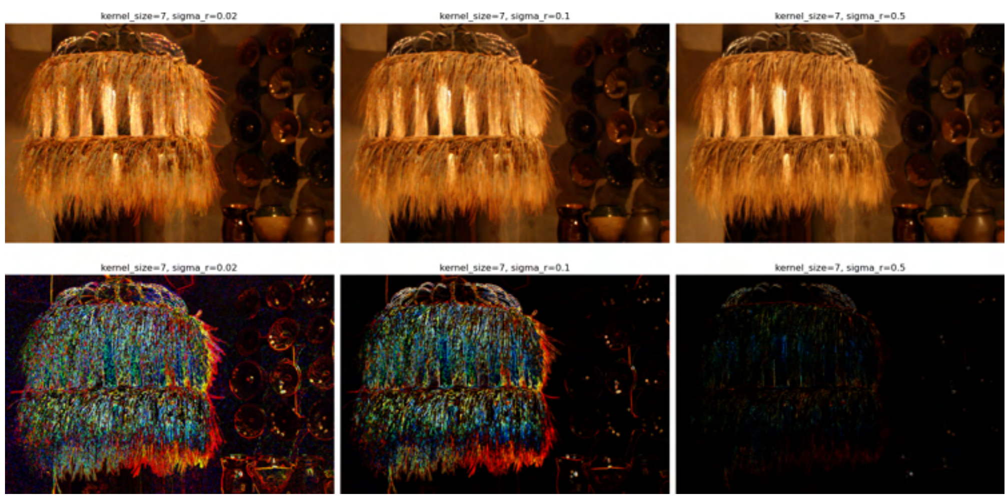

Figure 6: kernel size = 7

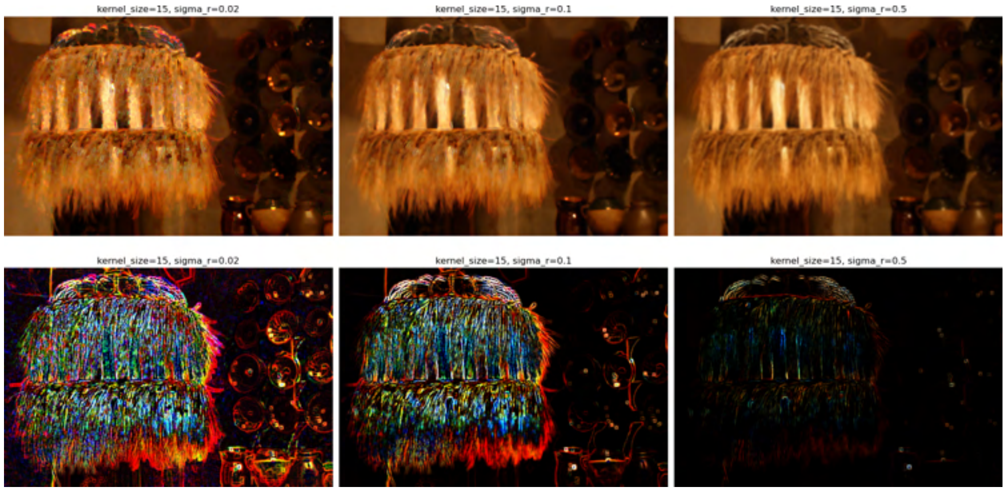

Figure 7: kernel size = 15

The image below is computed using kernel size 3, $\sigma_r = 0.02$ and $\sigma_s = 40$.

Figure 8: Lamp image after joint bilateral filtering

Implement detail transfer (20 points) We denote the flash image F and the result of bilateral filtering F^{Base}, the result of joint-bilateral filtering A^{NR}, the new estimate for the ambient image is then formed as

$$A^{Detail} = A^{NR} \frac{F + \epsilon}{F^{Base} + \epsilon}$$

We compared the results acquired with Gaussian kernel size $3, 7, 15$ and $\sigma_r = 0.02, 0.1, 0.5$. σ_s is set to 40 for all images. The results are as follow:

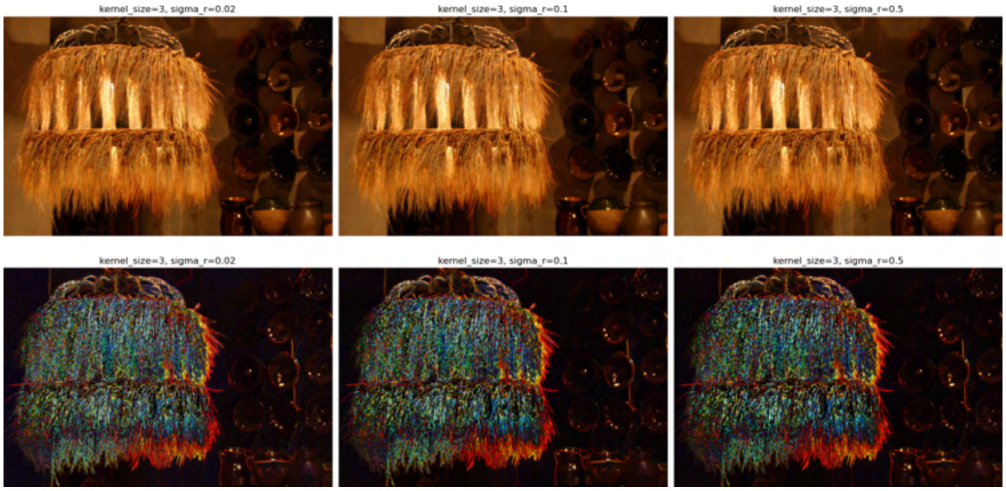

Figure 9: kernel size = 3

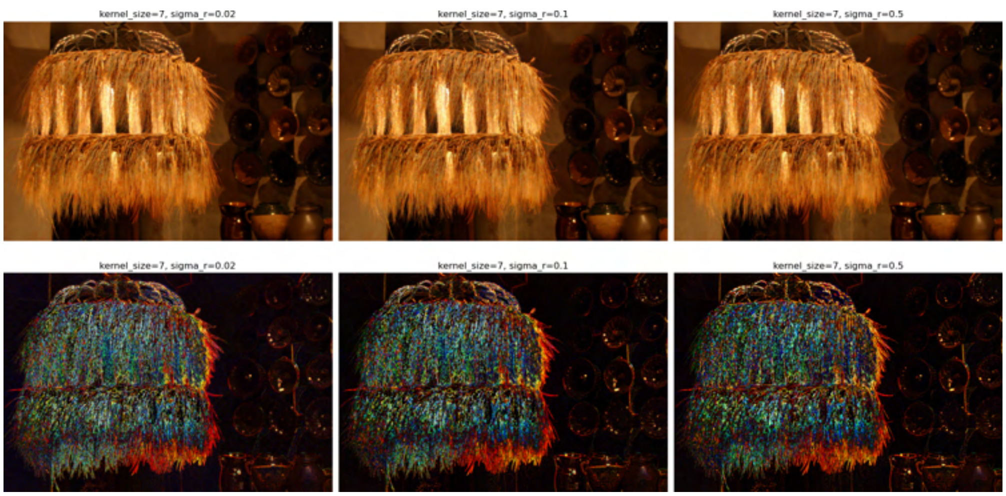

Figure 10: kernel size = 7

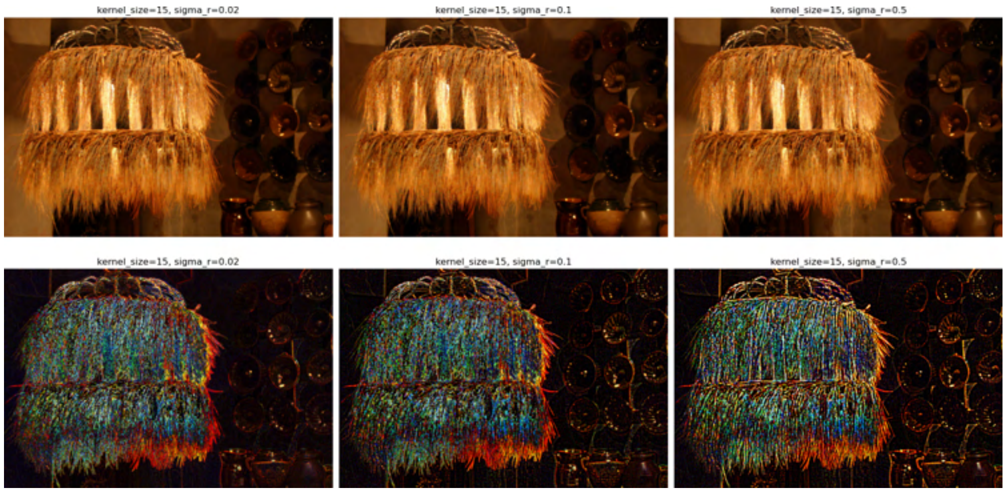

Figure 11: kernel size = 15

The image below is computed using kernel size 3, $\sigma_r = 0.02$ and $\sigma_s = 40$.

Figure 12: Lamp image after detail transfer

Implement shadow and specularity masking (10 points) The mask is used to detect regions in the flash image that have shadows or specularities not present in the ambient image.

We first applied the gamma correction operator to the image, then normalize the linearized ambient image so that its ISO is the same as that of the linearized flash image (The ISO of the flash image is 200 and the ISO of the ambient image is 1600). The we applied the opening, closing and dilation operators to the mask to remove the disconnected areas. The resulting mask is shown as follows:

Figure 13: The shadow and specularity mask

We compared the results acquired with Gaussian kernel size $3, 7, 15$ and $\sigma_r = 0.02, 0.1, 0.5$. σ_s is set to 40 for all images. The results are as follow:

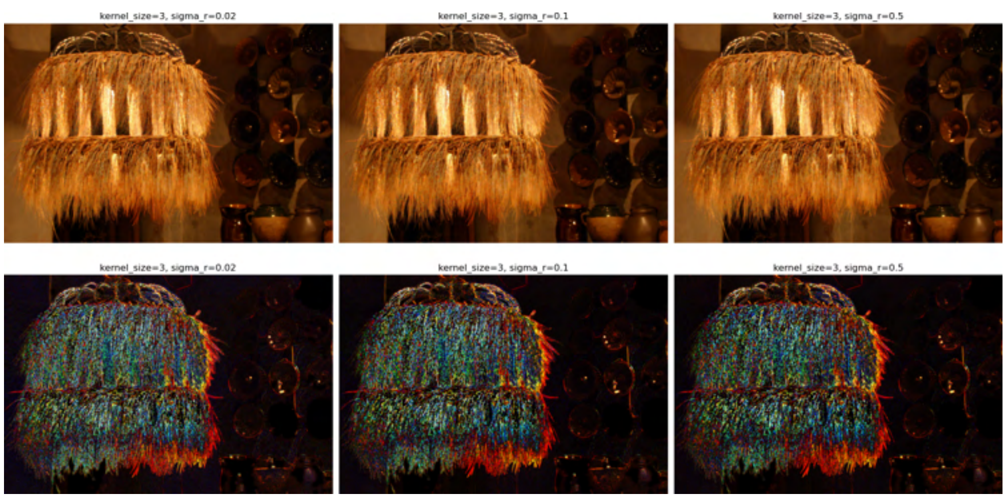

Figure 14: kernel size = 3

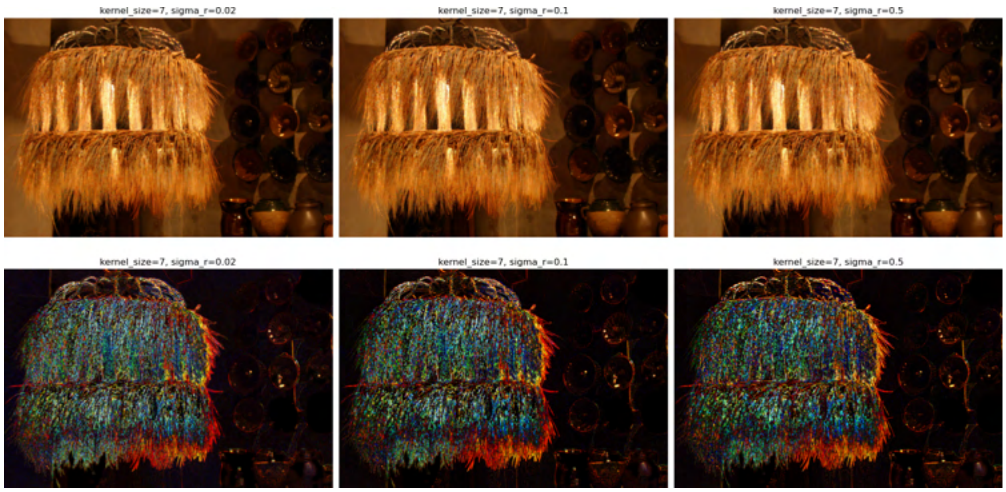

Figure 15: kernel size = 7

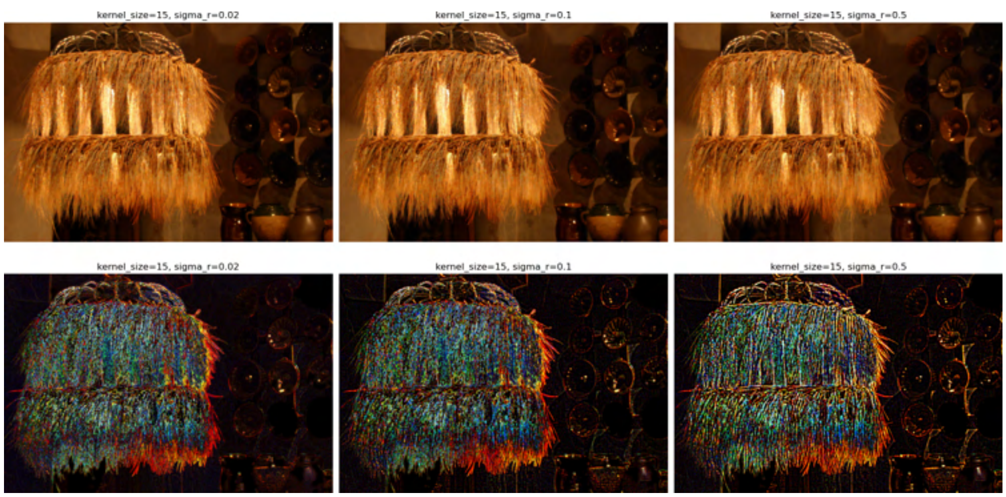

Figure 16: kernel size = 15

The image below is computed using kernel size 3, $\sigma_r = 0.02$ and $\sigma_s = 40$.

Figure 17: Lamp image after detail transfer

2 Gradient-domain processing

Differentiate and then re-integrate an image (75 points) To make it easier to view the gradient fields, The following images are acquired by taking the original gradient fields and multiplying them by 10.

The gradient field $\nabla \mathbf{a}$:

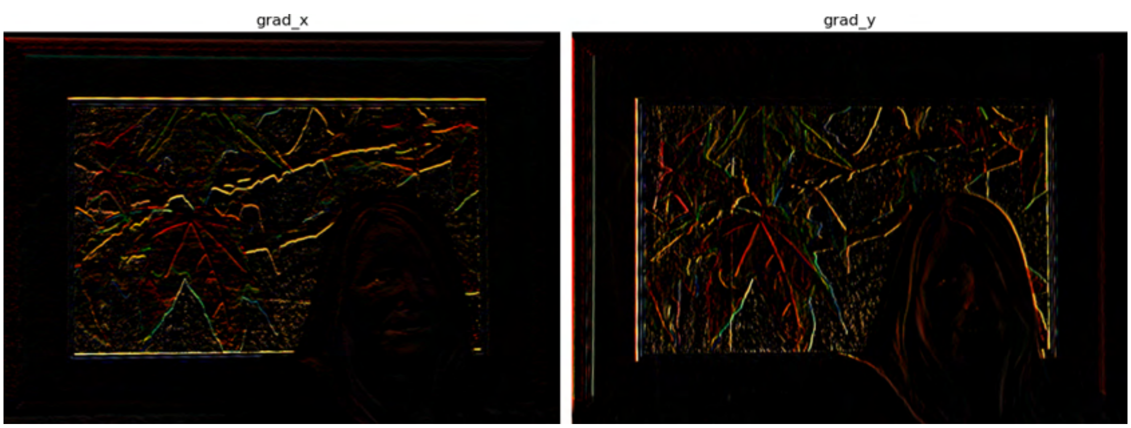

Figure 18: The gradient field $\nabla \mathbf{a}$

The gradient field $\nabla \mathbf{\Phi}'$:

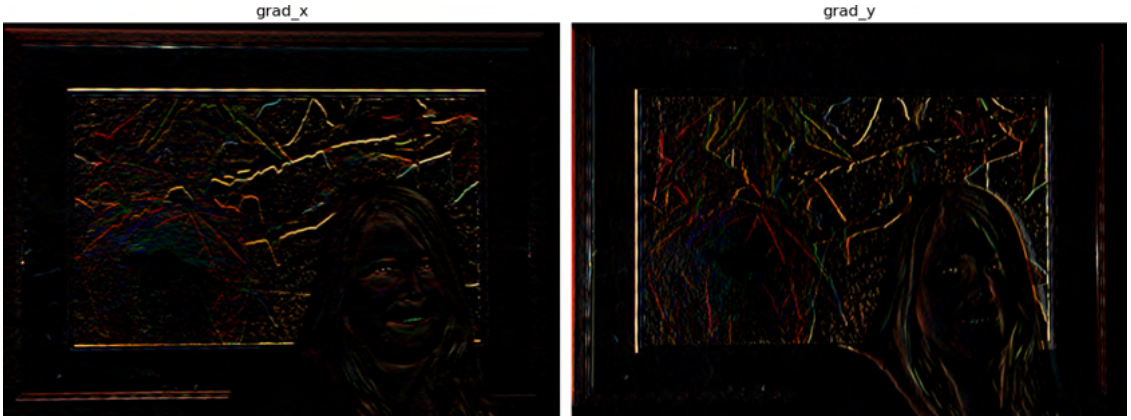

Figure 19: The gradient field $\nabla \mathbf{\Phi}'$

Create the fused gradient field (25 points) We experimented with parameters $\sigma = 10, 20, 40, 80$ and $\tau_s = 0.3, 0.5, 0.7$, the results are as follow:

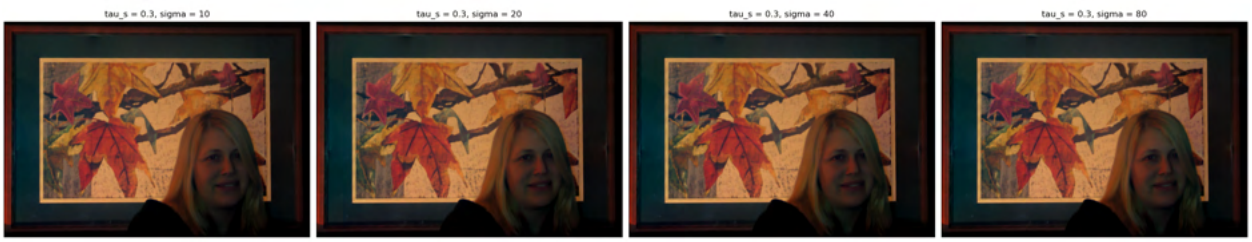

Figure 20: $\tau_s = 0.3$

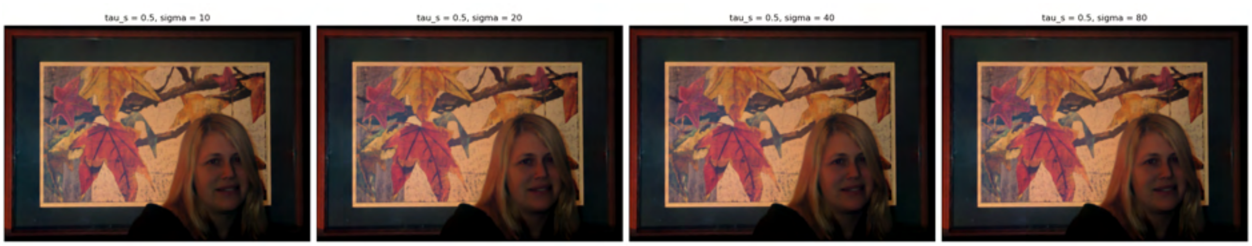

Figure 21: $\tau_s = 0.5$

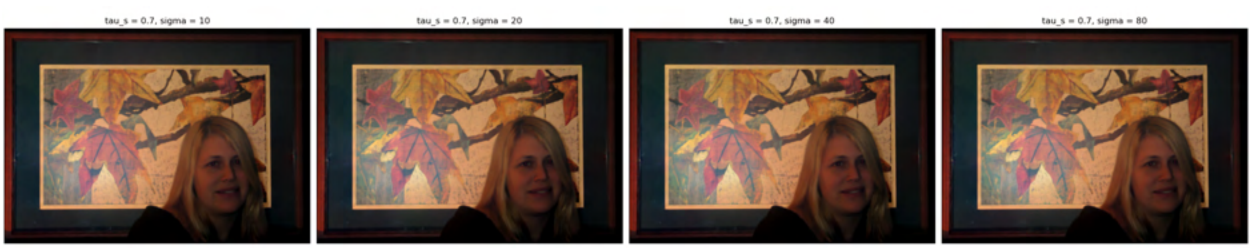

Figure 22: $\tau_s = 0.7$

We chose $\sigma = 20$ and $\tau_s = 0.5$ and computed the final result:

Figure 23: The fused image

The gradient field of the fused image $\nabla\mathbf{\Phi}^*$:

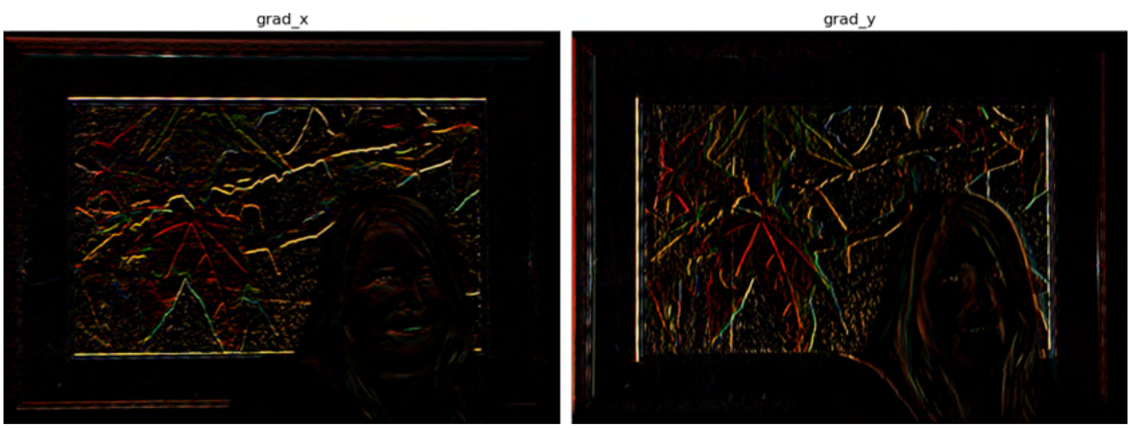

Figure 24: The gradient field of $\nabla\mathbf{\Phi}^*$

Here, the outermost pixels at all four image edges are set to equal the corresponding pixels of the ambient image.

3 Capture your own flash/no-flash pairs (100 points)

The first pair of images:

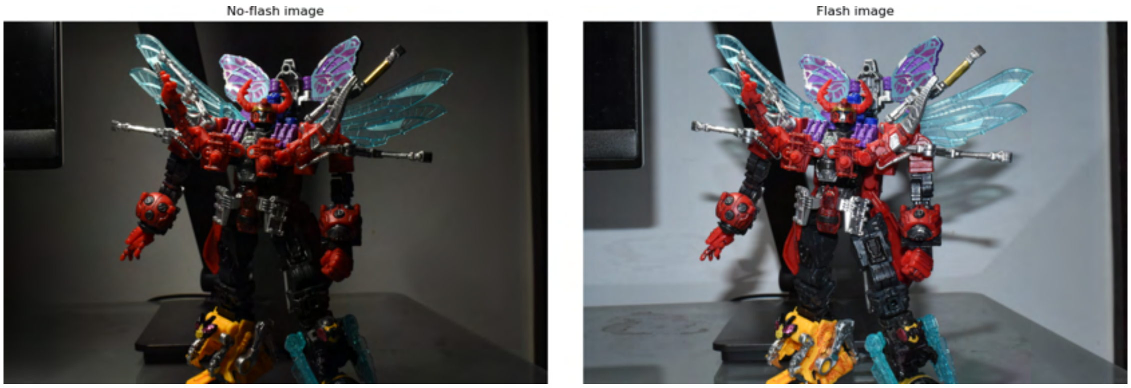

Figure 25: The no-flash/flash pair

The mask for shadow and specularity masking:

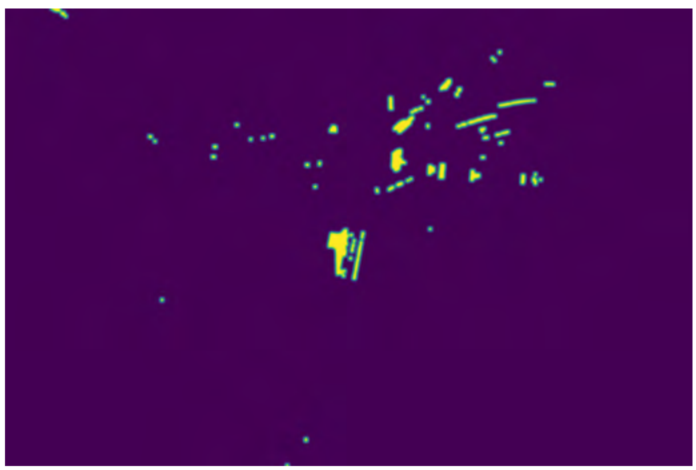

Figure 26: Mask for shadow and specularity masking

The result of bilateral filtering:

Figure 27: The fused image

The second pair of images:

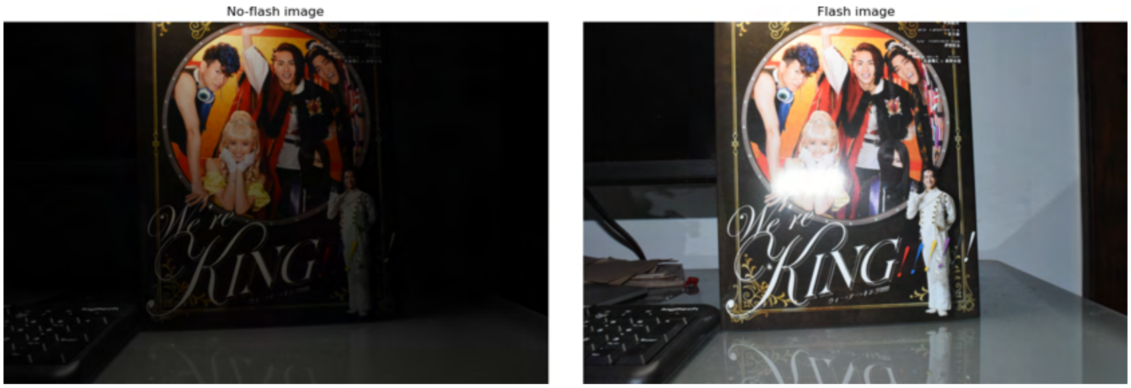

Figure 28: The no-flash/flash pair

We experimented with parameters $\sigma = 10, 20, 40, 80$ and $\tau_s = 0.5, 0.7, 0.9$, the results are as follow:

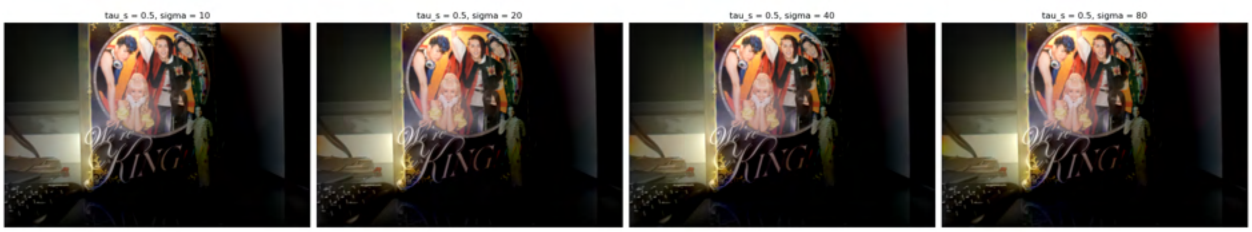

Figure 29: $\tau_s = 0.5$

Figure 30: $\tau_s = 0.7$

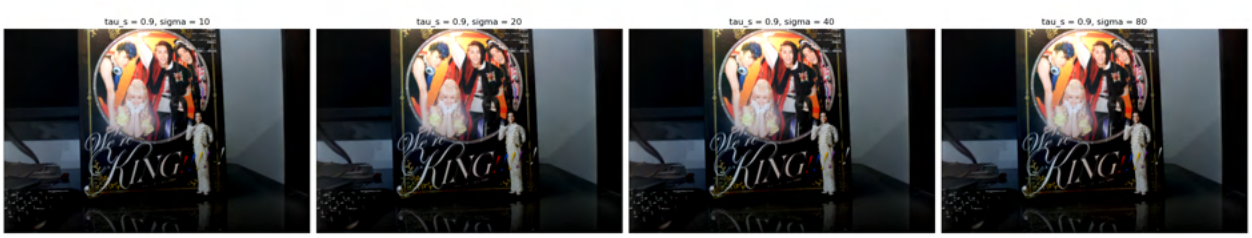

Figure 31: $\tau_s = 0.9$

We chose $\sigma = 20$ and $\tau_s = 0.9$ and computed the final result:

Figure 32: The final result