

# 15-663 Homework Assignment 3 Report

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## 1 Bilateral filtering

Figure 1 shows the results of the bilateral filtering algorithms and their corresponding parameters. The first set of images has  $\sigma_r = 0.1, \sigma_s = 3$ . The second set of images has  $\sigma_r = 0.1, \sigma_s = 9$ . The third set of images has  $\sigma_r = 0.25, \sigma_s = 3$ . The fourth set of images has  $\sigma_r = 0.25, \sigma_s = 9$ . Within each set, the first four images are results from simple bilateral filtering, joint-bilateral filtering, detail transfer, shadow and specularity masking, respectively. The last three images are the absolute differences between the simple bilateral result and the other three results, multiplied by 10.

We observe that while all the methods have a certain level of differences in regions of the lamp, the joint-bilateral method has an additional difference in the specular regions of the jars, the detail transfer method has an overall difference in all regions of the jars, and the final method removes the differences in the specular regions, while keeping some of the differences in other parts of the jars.

We observe that increasing  $\sigma_r$  increases the overall differences from the basic bilateral method, and increasing  $\sigma_s$  makes the results generally blurrier. For the best result, I choose to use  $\sigma_r = 0.1, \sigma_s = 3$ .



Figure 1: Bilateral filtering results

## 2 Gradient-domain processing

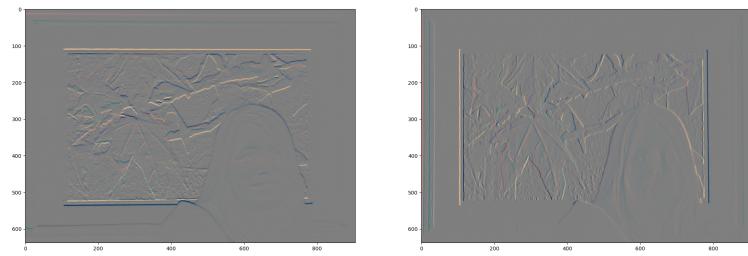
Figure 2 shows the vertical and horizontal gradients of ambient, flash, and fused images. I used  $\sigma = 150$  and  $\tau_s = 0.2$ . Figure 3 shows the fused image, which uses the average of

ambient and flash image as intial value and boundary condition. We observe that while the fusion illuminates the human face, we observe some artifacts resulting from the flash on the painting. The painting is still visible, but we observe a highlighted region which results from the flash. This is possibly because of bad parameter tuning and my method of handling zero gradients in calculating the gradient orientation coherency map (I simply add a small number to the denominator to avoid division by zero).

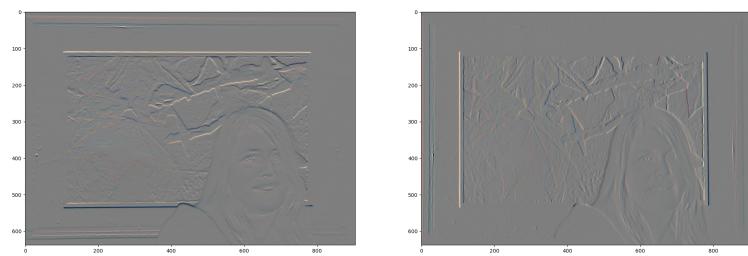
### 3 Capture your own flash/no-flash pairs

Figure 4 shows a triplet of ambient, flash, bilateral filtered images, procecssed using  $\sigma_r = 0.4$ ,  $\sigma_s = 12$ . The filtered image preserves the color tone from the ambient image, while reducing the overall noise. The specular region on the AC unit is also handled properly. Because the ambient image is too noisy, I increased the parameters. However, we still observe some lower-frequency noises in the filtered image, which appears as larger color spots.

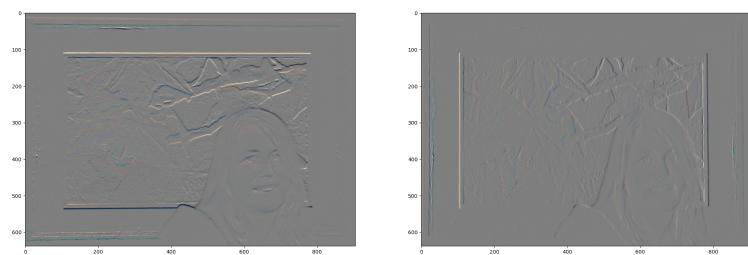
Figure 5 shows a triplet of ambient, flash, and fused images, processed using  $\sigma = 150$  and  $\tau_s = 0.5$ . Just as in the previous section, we observe that while the contents in the specular part is recovered, the flare from the flash light is not completely removed.



(a) Ambient gradient



(b) Flash gradient



(c) Fused gradient

Figure 2: Image gradients

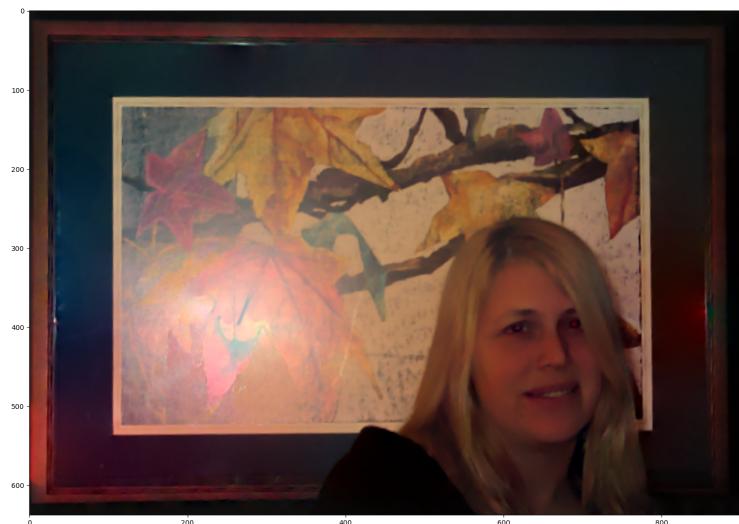
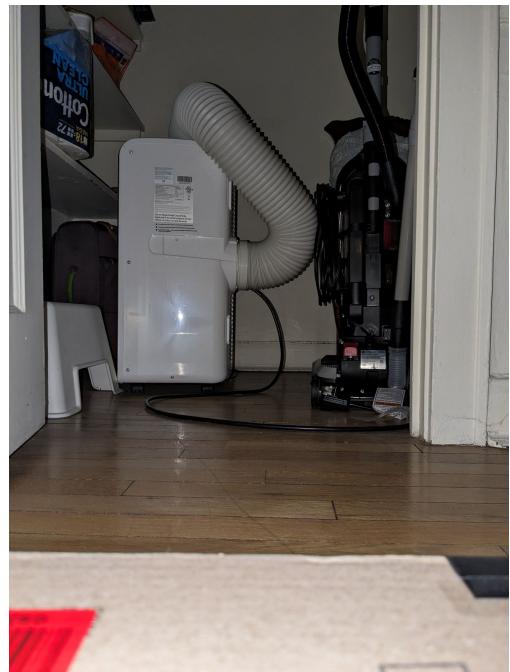


Figure 3: Fused image



(a) Ambient image

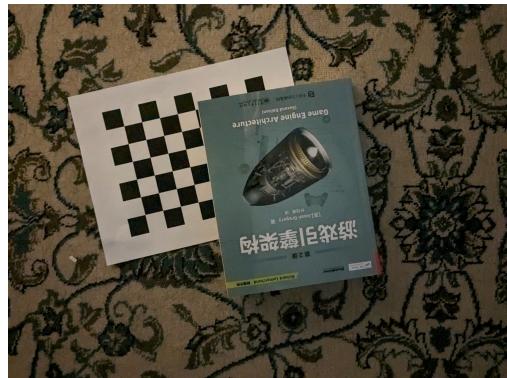


(b) Flash image

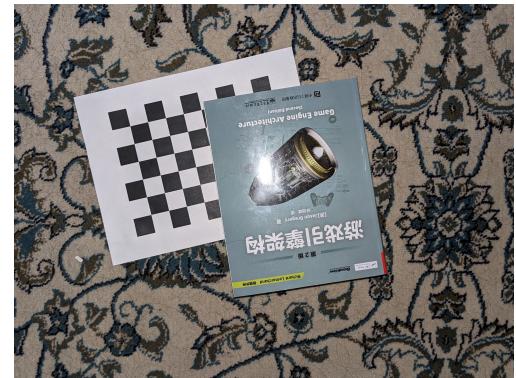


(c) Filtered image

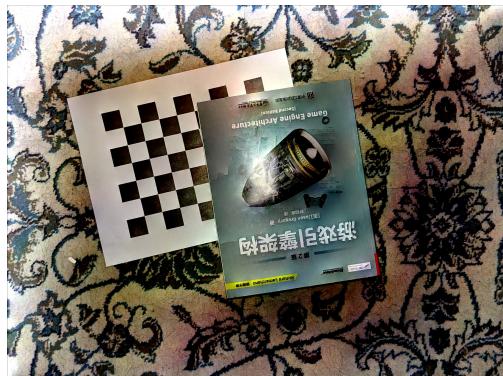
Figure 4: Bilateral filtering



(a) Ambient image



(b) Flash image



(c) Filtered image

Figure 5: Gradient-domain processing