HACETTEPE UNIVERSITY

DEPARTMENT OF COMPUTER ENGINEERING
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BBM 415
Image Processing Laboratory
Problem Set-3

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Contents

1 Introduction

In this experiment, i enhance photographs shot in dark environments by combining a picture taken with the available light and one taken with the flash. I preserve the ambiance of the original lighting and insert the sharpness from the flash image. I use the bilateral filter to decompose the images into detail and large scale. I reconstruct the image using the large scale of the available lighting and the detail of the flash. So this combines the advantages of available illumination and flash photography.

At first, i didn't fully understand how to get the color layer. But with grayscale, formula, lab or hsv color spaces i get intensity and when i divide it into each channel of the color space, so by making them i obtain a color layer. I encountered problems when showing the images with matplotlib plt and with cv2.imshow and cv2.imwrite. The pictures appeared black or out of color(dark) or output in a wrong color. For example, the picture was read as a bgr at first, and when I did matplpotlib plt, it gave a blue result instead of red. So if plt is used, the picture should be converted from bgr to rgb. One of the biggest problem is np uint8 and normalize usage. It was very important to make and use them in the right place. For example, if i didn't set them before applying the bilateral filter it gave me an error and i also encountered a lot of errors while displaying the pictures on the screen for same reason. In lab and hsv color spaces, in lab i get the intensity taking L channel, in hsv i get the intensity taking H channel. Their channel locations are different, so I set them separately in the function. Finally in the reconstruction part, when multiplying three separate layers, i had to multiply the largescale and detail layer that had a single channel first. Then i created a 3-channel reconstruction array similar to color layer. The result of multiplying largescale and detail layer has one channel, since the reconstruction has 3 channels, i multiply with each channel of reconstruction and i get the enhanced image.

2 Implementation Details

First of all i take two images, flash image and no-flash image. Then i find the intensity of the flash image by converting it to gray. Since the details in the flash image are certain, i eliminate the noise and reach the lines with the bilateral filter. The bilateral filter is a spatially varying filter that better preserves edges than the Gaussian filter. So it is the best option to remove noise. I also get the color layer

of the flash picture because the colors in the flash picture are more pronounced. I divide the intensity layer into all the bgr channels of the image and i get the color layer. I can't take large scale of flash image, because i have to extract the lighting ambiance from no flash image.Since the color and details are not clear in the picture no flash, I get them from the flash picture. But I find the intensity in the no flash image and get a large scale layer with doing Bilateral filter to intensity for denoising. The reason and advantages for doing with Bilateral filter is smoothing an image without blurring its edges, edge-preserving filter, better denoising then Gaussian filter. Furthermore the bilateral filter is designed to average together pixels that are spatially near one another and have similar intensity values. It combines a classic low-pass filter with an edgestopping function that attenuates the filter kernel weights when the intensity difference between pixels is large. After that, with large scale i obtain the lighting ambiance. I also have fine details of the flash picture, so lastly i combine it both and obtain enhanced image.

3 Experimental Results

3.1 Intensities

Intensities in all color spaces

3.2 Color Layers

bgr color layer
formula is more colorful

- color layer using formula

color layer in lab
hsv is more colorful

- color layer in hsv

3.3 Details

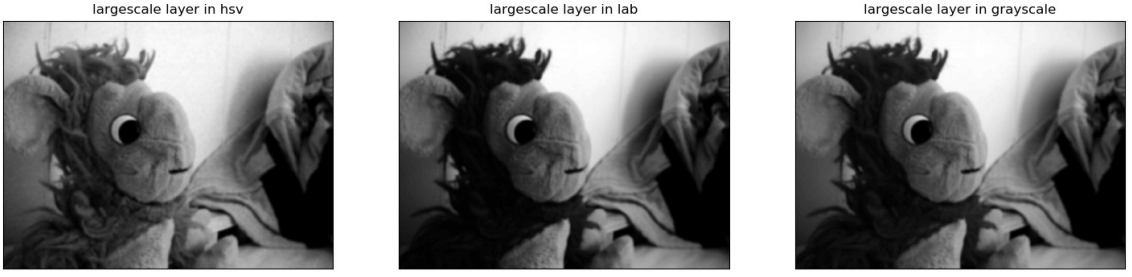
detail in bgr - formula, bgr little dark
Bilateral filter diameter = 15, sigma c = 75, sigma s = 75

detail in hsv - lab, lab slightly dark
Bilateral filter diameter = 15, sigma c = 75, sigma s = 75

details in bgr - formula - hsv - lab
Bilateral filter diameter = 5, sigma c = 25, sigma s = 25
parameter values are a bit small, details are not very clear

3.4 Large-scale Layer of No-flash Image

Bilateral filter diameter = 5, sigma c = 25, sigma s = 25



Bilateral filter diameter = 15, sigma c = 75, sigma s = 75

3.5 Results


inputs: flash - no flash image


results in bgr color space, using by formula - with grayscale

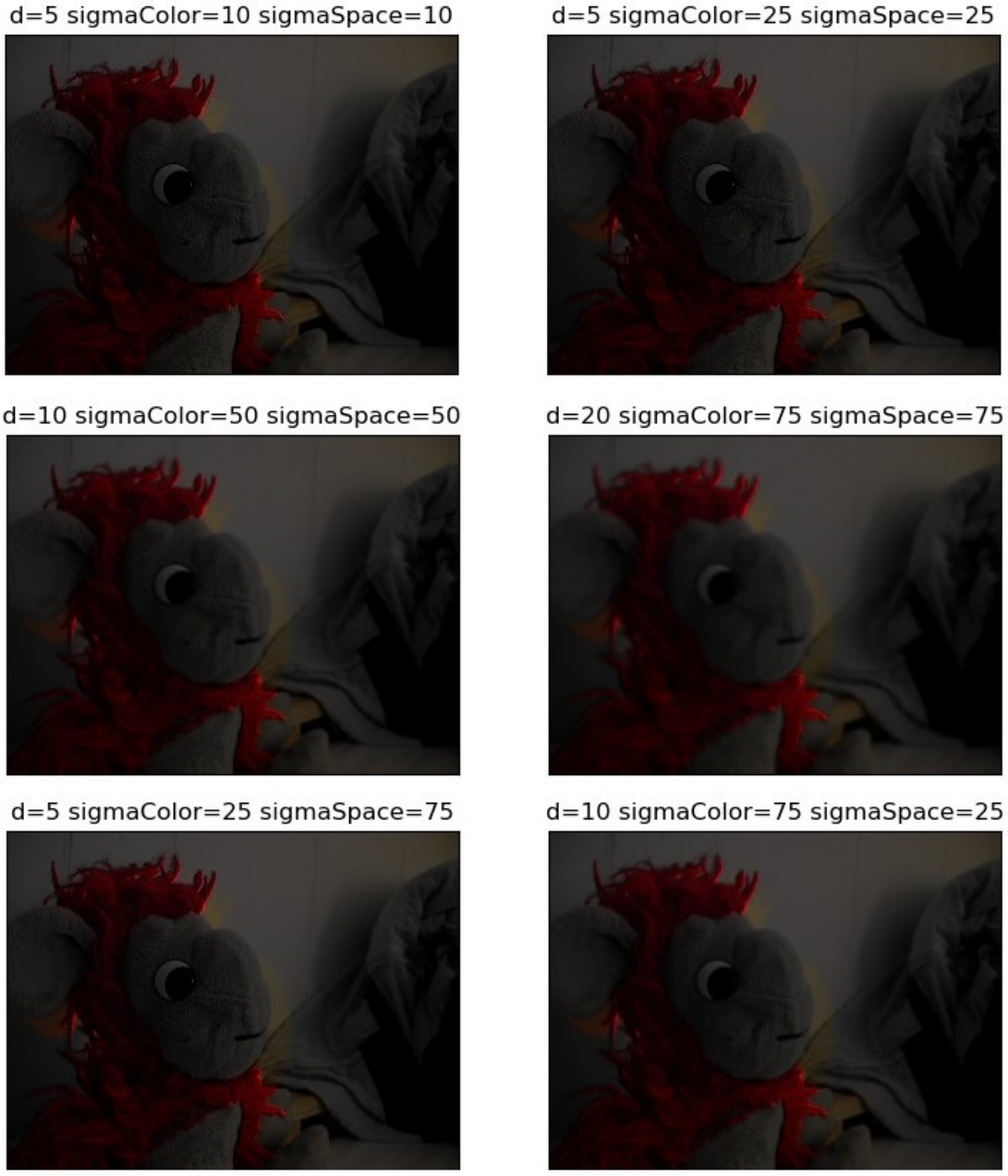

result in hsv - in lab color space

In all bilateral filters, diameter = 5, sigma c = 25, sigma s = 25

results in bgr color space, using by formula - with grayscale

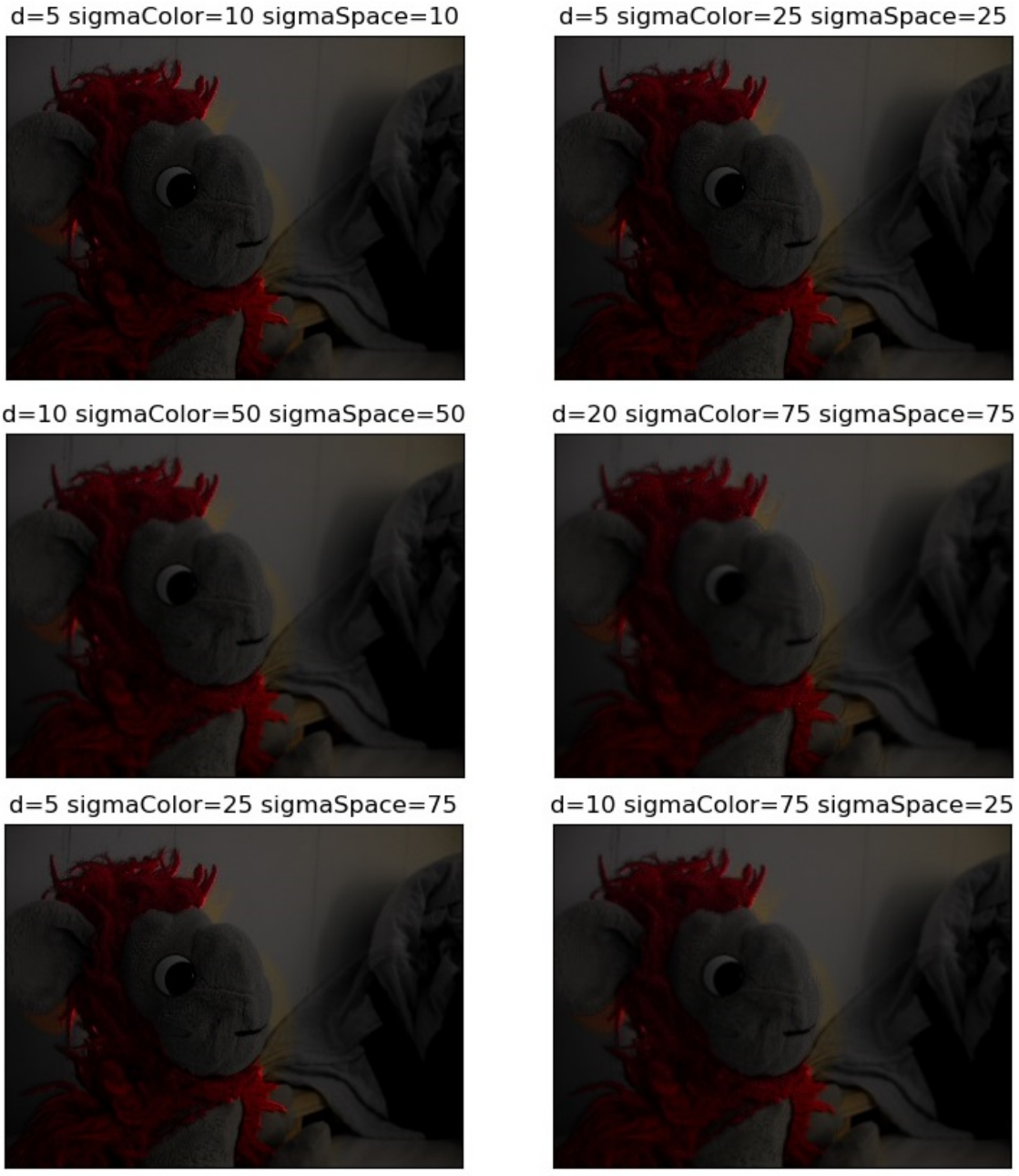
result in hsv - in lab color space
In all bilateral filters, diameter = 15, sigma c = 75, sigma s = 75

In lab color space, results are little dark then hsv color space. In bgr color space, in the results the red pixels of the fur become too bright. But using using non-linear formula in the paper the colors are not too bright.
The higher values of bilateral filter parameters effects the picture a little more soft



Results for different parameters for bilateral filter in largescale layer
In detail layer parameters are d=5 sigmaColor=25 sigmaSpace=25

Results for different parameters for bilateral filter in details
In largescale layer parameters are d=5 sigmaColor=25 sigmaSpace=25



Results for different parameters for bilateral filters in detail and largescale layer
Detail and largescale layers have same parameters

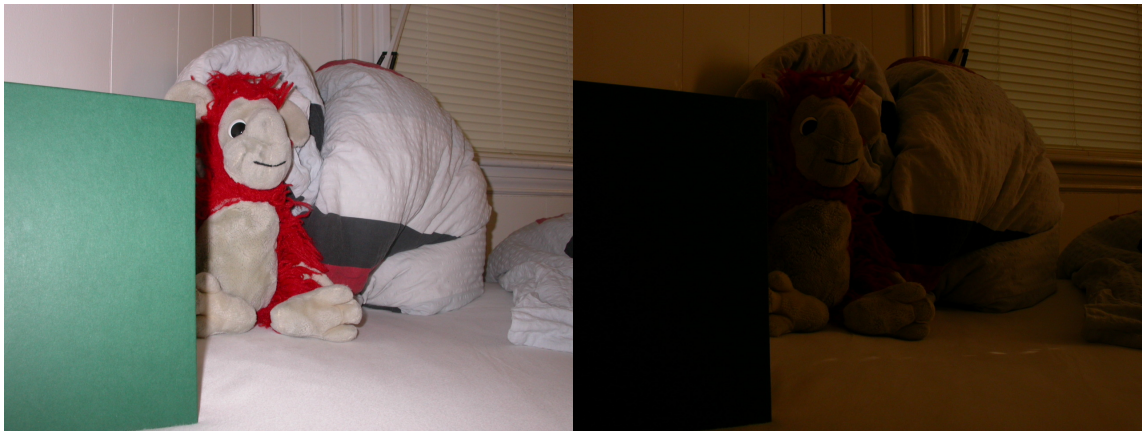
Bilateral Filter parameters and effects definition :

diameter(d) - size of neighbourhood for Gaussian filtering.
sigmaColor - Filter sigma in the color space. A larger value of the parameter means that farther colors within the pixel neighborhood will be mixed together.
sigmaSpace - Filter sigma in the coordinate space. A larger value of the parameter means that farther pixels will influence each other as long as their colors are close enough.

Sigma values: For simplicity, we can set the 2 sigma values to be the same. If they are small (<10), the filter will not have much effect, whereas if they are large (>150), they will have a very strong effect, making the image look "cartoonish".

Filter size: Large filters (d>5) are very slow, so it is recommended to use d=5 for real-time applications, and perhaps d=9 for offline applications that need heavy noise filtering.

3.6 Results in Different Images



inputs: flash - no flash image

grayscale - formula

lab - hsv

inputs: flash - no flash image

grayscale - formula

hsv - lab

inputs: flash - no flash image

grayscale - formula

lab - hsv

4 Conclusion

Results are successful, i did all the steps as specified. But in fact the resulting images are a little dark. In research paper they mention it and i tried to increase the contrast by doing histogram equalization of large scale layer but some results broken. So i left it as it is. In the end i learn many things about layers, bilateral filter, color spaces, intensities, image data types etc.

5 References

Eisemann, Elmar, and Fredo Durand. "Flash photography enhancement via intrinsic relighting." ACM transactions on graphics (TOG). Vol. 23. No. 3. ACM, 2004.

http://maverick.inria.fr/Publications/2004/ED04/