Computer Vision HW1 Report

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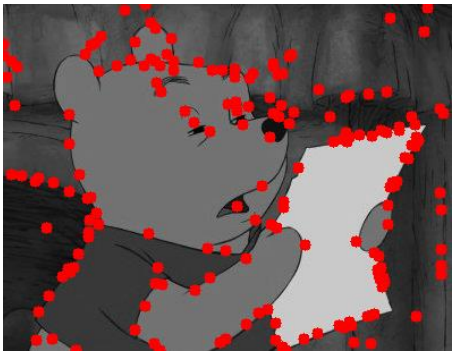
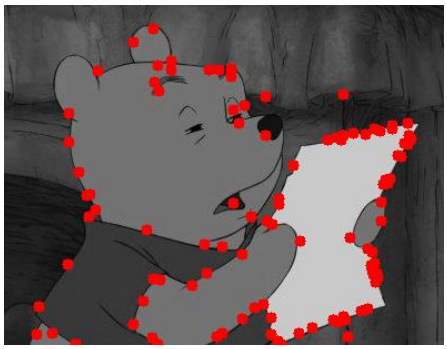
Part 1.

- **Visualize the DoG images of 1.png.**

	DoG Image (threshold = 3)		DoG Image (threshold = 3)
DoG1-1.png		DoG2-1.png	
DoG1-2.png		DoG2-2.png	
DoG1-3.png		DoG2-3.png	
DoG1-4.png		DoG2-4.png	

- **Use three thresholds (1,2,3) on 2.png and describe the difference.**

Threshold	Image with detected keypoints on 2.png
1	

2	
3	

(describe the difference)

The difference between the three PNG files is the number and quality of the keypoints detected. Lower threshold values will detect more keypoints, including those with low contrast and noise, while higher threshold values will detect only the most prominent keypoints with the highest contrast.

Part 2.

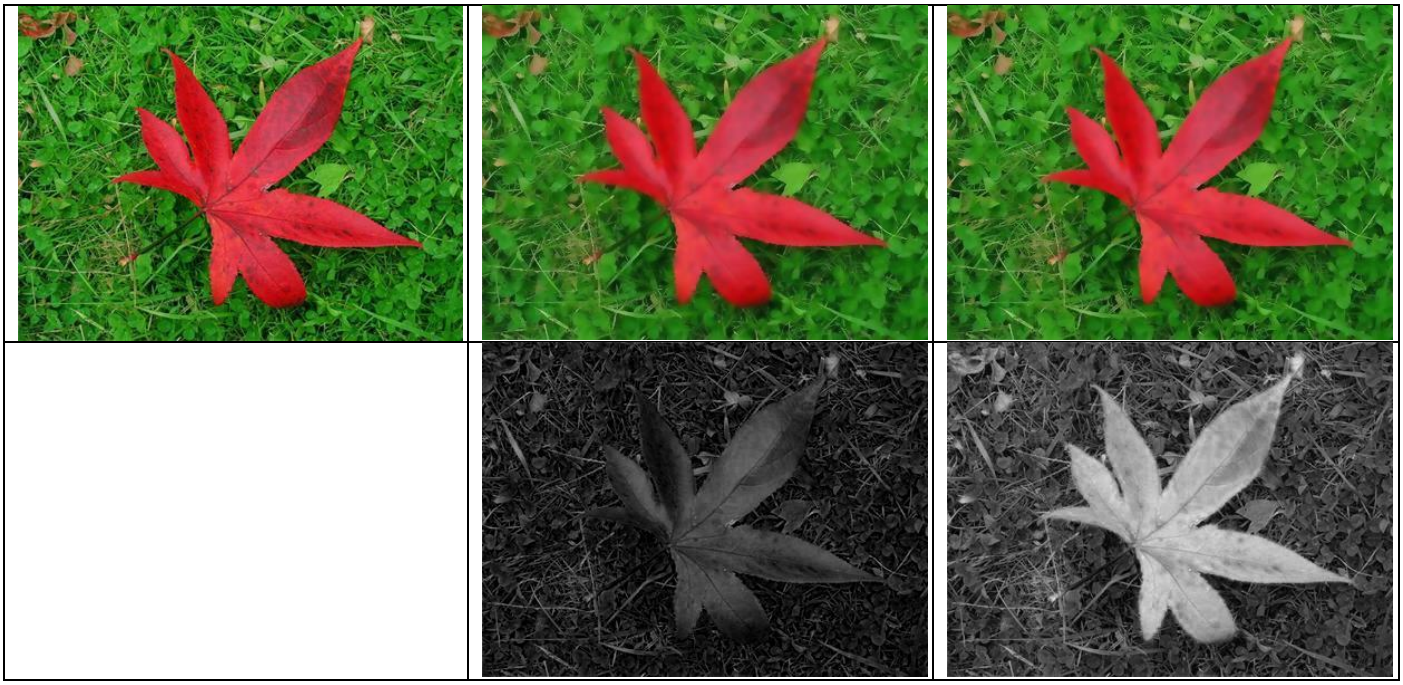
- **Report the cost for each filtered image.**

Gray Scale Setting	Cost (1.png)
cv2.COLOR_BGR2GRAY	1260668
R*0.0+G*0.0+B*1.0	1439568
R*0.0+G*1.0+B*0.0	1305961
R*0.1+G*0.0+B*0.9	1390952
R*0.1+G*0.4+B*0.5	1278834
R*0.8+G*0.2+B*0.0	1127294

Gray Scale Setting	Cost (2.png)
cv2.COLOR_BGR2GRAY	138911
R*0.1+G*0.0+B*0.9	77797
R*0.2+G*0.0+B*0.8	85864
R*0.2+G*0.8+B*0.0	188065
R*0.4+G*0.0+B*0.6	128150
R*1.0+G*0.0+B*0.0	110862

- **Show original RGB image / two filtered RGB images and two grayscale images with highest and lowest cost.**

Original RGB image (1.png)	Filtered RGB image and Grayscale image of Highest cost	Filtered RGB image and Grayscale image of Lowest cost

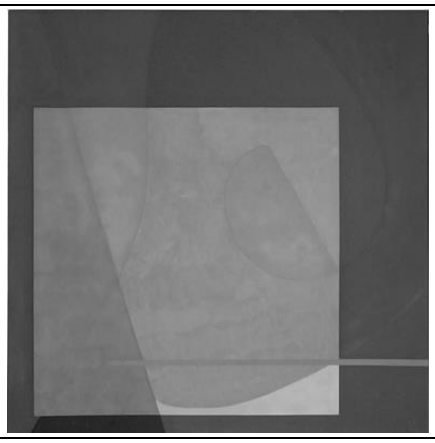
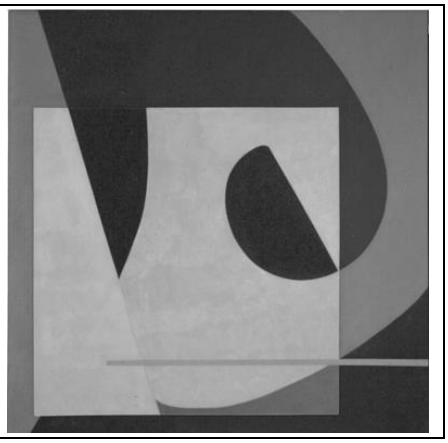


(Describe the difference between those two grayscale images)

The original image is mainly composed of green and red, which can explain why the grayscale setting of R0.0+G0.0+B1.0 has the highest L1-norm, as it uses a pure blue guidance image that is less similar to the input image. On the other hand, the grayscale setting of R0.8+G0.2+B0.0 has the lowest L1-norm, as it uses a guidance image with a strong red component that is more similar to the input image.

In general, joint bilateral filtering preserves edges better than bilateral filtering. That's why the grayscale image with the highest L1-norm has more strongly preserved edges compared to the one with the lowest L1-norm. But when using the two grayscale images as guidance to run a joint bilateral filter, the resulting RGB images don't show many differences.

Original RGB image (2.png)		Filtered RGB image and Grayscale image of Highest cost	Filtered RGB image and Grayscale image of Lowest cost
			

(Describe the difference between those two grayscale images)

For the grayscale image with the lowest L1-norm, the guidance image is created using weights that emphasize the blue color channel (0.1R + 0.9B), resulting in a grayscale image with better preserved in this image because the blue channel is emphasized, which contains more edge information. While the grayscale image with the highest L1-norm, the guidance image is created using weights that emphasize the green color channels (0.2R + 0.8G) which the original image doesn't have, so the resulting image appears lighter in color and has less defined edges.

- **Describe how to speed up the implementation of bilateral filter.**

I speed up by using the guidance image to only consider neighboring pixels with similar intensity values during the filtering process, instead of filtering all pixels in a window regardless of their intensity values. This reduces the number of computations required, making the filter faster. Additionally, the implementation optimizes the calculation of the constant matrix Gs and normalizes the guidance image before filtering. Finally, the implementation uses NumPy vectorization to perform the filtering operations efficiently and enhance its performance.