Computer Vision HW1 Report

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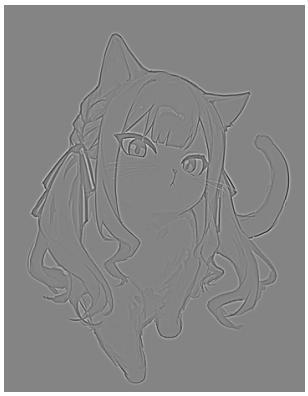
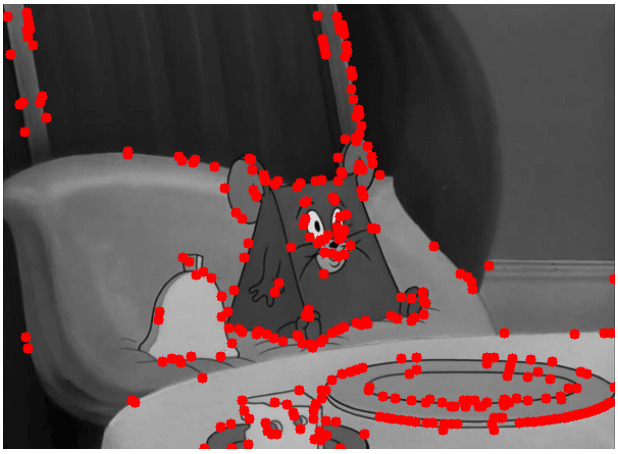
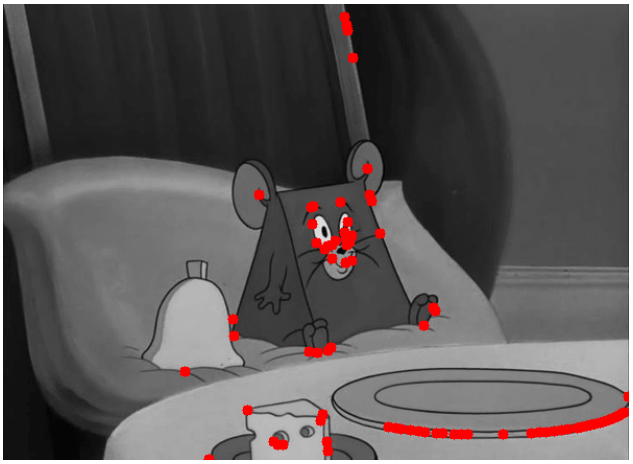
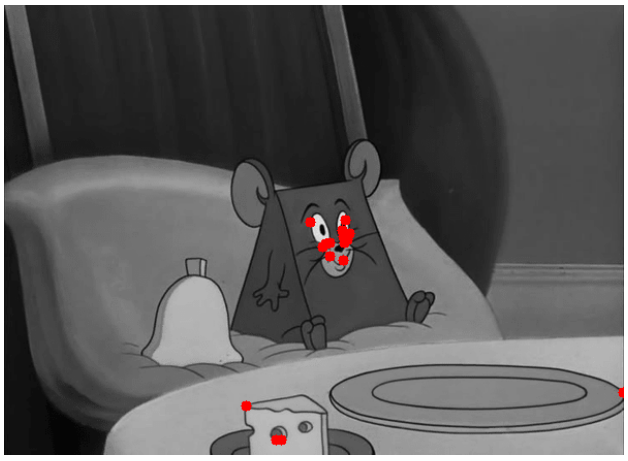
Part 1.

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

	DoG Image (threshold = 5)		DoG Image (threshold = 5)
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
2	
5	
7	

(describe the difference)

The difference among the three images lies in the number and clarity of detected keypoints. A lower threshold identifies a greater number of keypoints, including those with lower contrast and potential noise. In contrast, a higher threshold detects fewer but more prominent keypoints, focusing on areas with stronger contrast.

Part 2.

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

Gray Scale Setting	Cost (1.png)
cv2.COLOR_BGR2GRAY	1207799
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	1393620
R*0.1+G*0.4+B*0.5	1279697
R*0.8+G*0.2+B*0.0	1127913

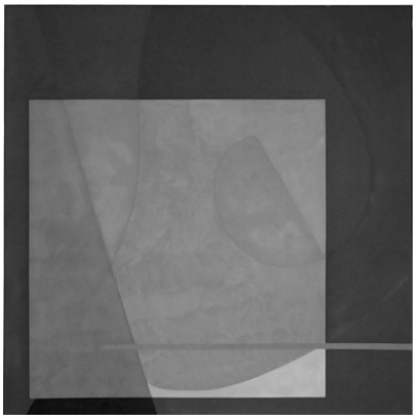
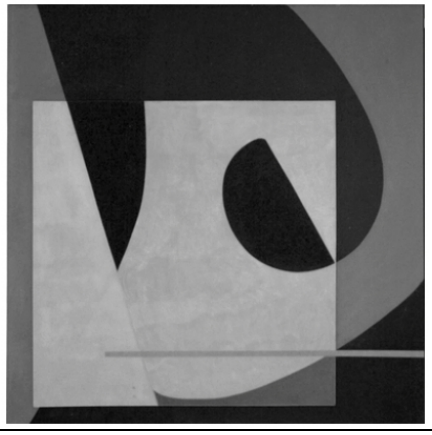
Gray Scale Setting	Cost (2.png)
cv2.COLOR_BGR2GRAY	183850
R*0.1+G*0.0+B*0.9	77884
R*0.2+G*0.0+B*0.8	86023
R*0.2+G*0.8+B*0.0	188019
R*0.4+G*0.0+B*0.6	128341
R*1.0+G*0.0+B*0.0	110862

- **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 difference between the images lies in the grayscale guidance images used for joint bilateral filtering. The grayscale image with the highest L1-norm (pure blue guidance) is less like the original image, leading to stronger edge preservation in the filtered RGB image. In contrast, the grayscale image with the lowest L1-norm (strong red component guidance) is more like the original, resulting in less pronounced edge preservation. Despite these differences, the final filtered RGB images do not show significant variations.

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)

The difference between the two grayscale images lies in how they are generated based on different color channel weightings. The grayscale image with the lowest L1-norm emphasizes the blue channel (0.1R + 0.9B), which helps preserve more edge details because the blue channel contains more edge information. In contrast, the grayscale image with the highest L1-norm is based on green-dominant weighting (0.2R + 0.8G), which does not align well with the original image's color distribution, resulting in a lighter appearance with less defined edges. Despite these differences, the final filtered RGB images show only minimal variation.

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

  I implemented several optimization techniques:

  1. Vectorize operations: Replace the nested loops with NumPy vectorized operations
  2. Pre-compute spatial kernel
  3. Use broadcasting for range kernel computation instead of loops