

Image Processing Assignment 2

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[Task 1]

$$(a) H_2 = H_1$$

$$\Rightarrow (H_1 - 5 + 2P_H) + 1 = H_1$$

$$\Rightarrow P_H = 2$$

The height padding should be 2, the width padding should be 2.

$$(b) 504 = (512 - F_H) + 1 \Rightarrow F_H = 9; \quad 504 = (512 - F_W) + 1 \Rightarrow F_W = 9$$

The kernel size is 9×9 .

$$(c) H_2 = W_2 = (504 - 2) / 2 + 1 = 252$$

The output size is 252×252 .

$$(d) H_3 = W_3 = (252 - 3) / 1 + 1 = 250$$

The output size is 252×252 .

$$(e) 1^{\text{st}} \text{ Conv: } F_H \times F_W \times C_1 \times C_2 + C_2 = 5 \times 5 \times 1 \times 32 + 32 = 832$$

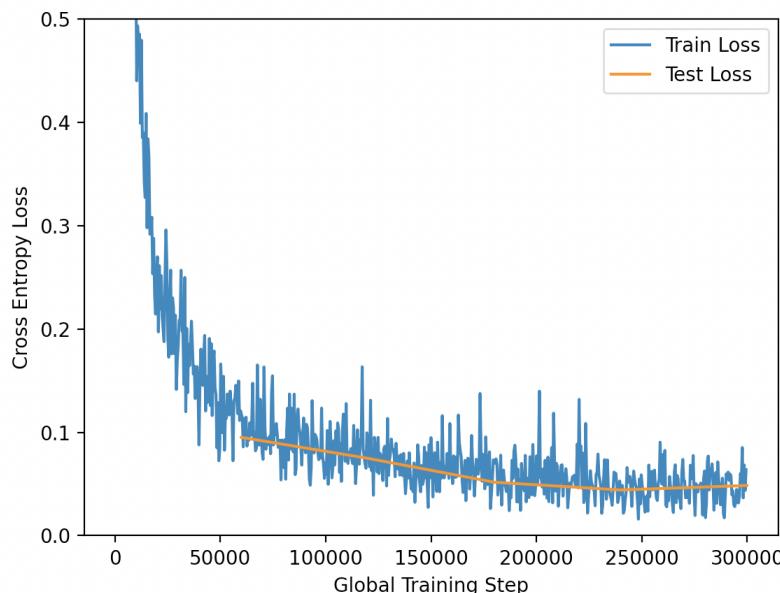
$$2^{\text{nd}} \text{ Conv: } F_H \times F_W \times C_1 \times C_2 + C_2 = 3 \times 3 \times 1 \times 64 + 64 = 640$$

$$3^{\text{rd}} \text{ Conv: } F_H \times F_W \times C_1 \times C_2 + C_2 = 3 \times 3 \times 1 \times 128 + 128 = 1280$$

$$\text{Total} = 832 + 640 + 1280 = 2752$$

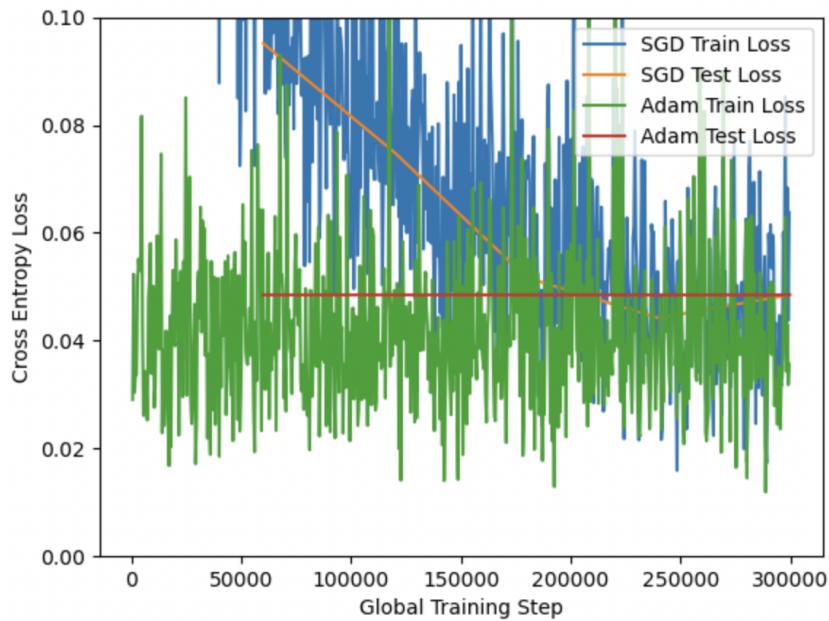
[Task 2]

(a) Training epoch 41/100
Final Test loss: 0.04851137533230384. Final Test accuracy: 0.9828

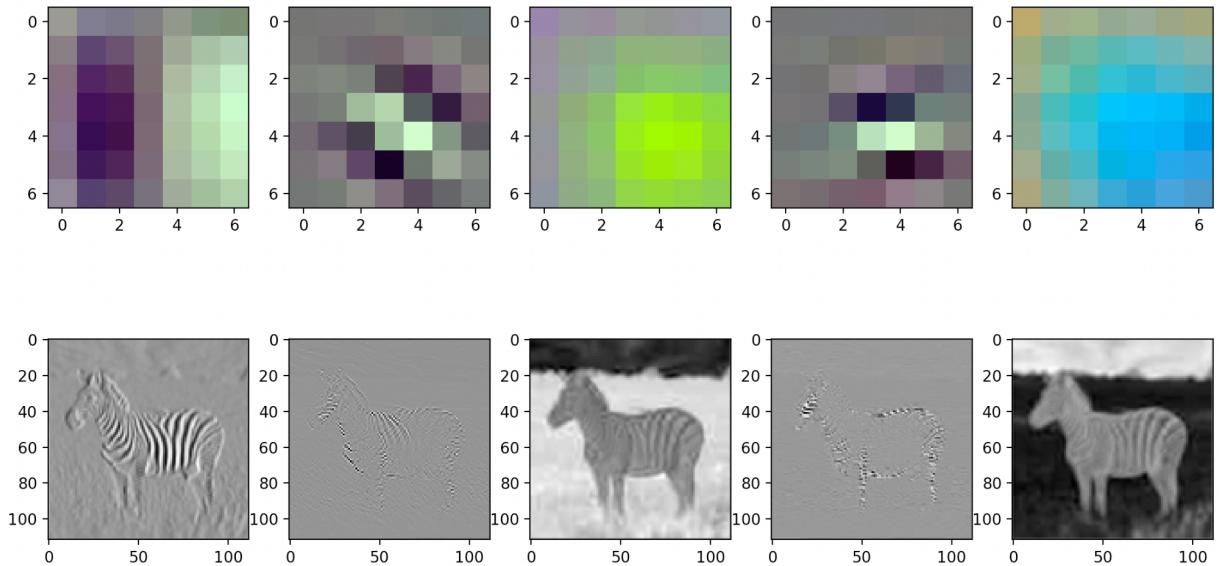


I don't think the model is overfitting because the loss of the validation set is in general lower than the loss of the training set.

(b)



(c)



(d) The first filter extracts the dark stripes of the zebra. Because only dark colors are amplified.

The second and fourth filters extract the shape/border of the zebra. Only the lines shaping the zebra are visible. The two kernels are similar.

The third filter returns the original greyscale of the image, while the fifth filter takes the inverse of the original greyscale.

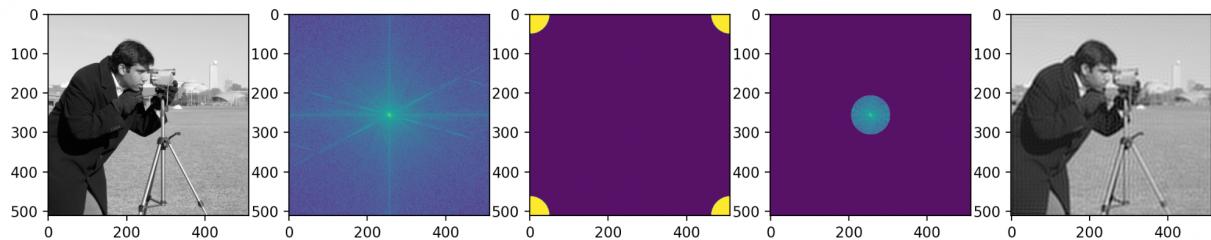
[Task 3]

- (a) 1a - 2e: vertical, narrowest spacing means vertical, loosest dots
1b - 2c: vertical, narrower spacing means vertical, looser dots
1c - 2f: vertical, widest spacing means vertical, closest dots
1d - 2b: horizontal, widest spacing means horizontal, closest dots
1e - 2d: horizontal, narrowest spacing means horizontal, loosest dots
1f - 2a: horizontal, narrower spacing means horizontal, looser dots
- (b) A high-pass filter sharpens the image by keeping the high frequencies and filtering out the low frequencies
A low-pass filter smooths the image by keeping the low frequencies and filtering out the high frequencies
- (c) The first image represents a high-pass filter because the center, where the low-frequency is removed (multiplied by 0), while the outer area, where the high-frequency is kept (multiplied by 1)
The second image is a low-pass filter, the reasoning is the exact opposite of the first image.

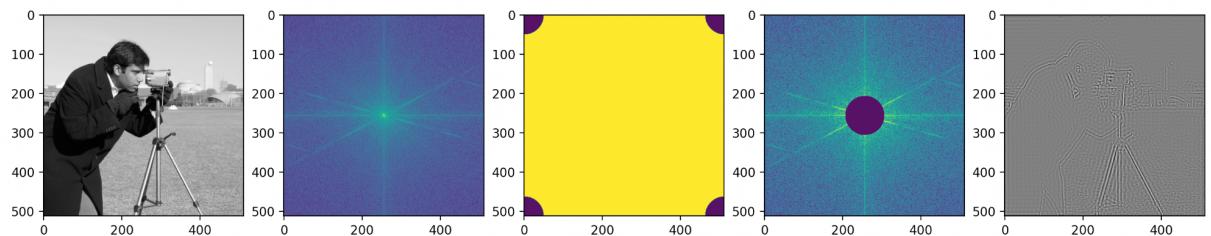
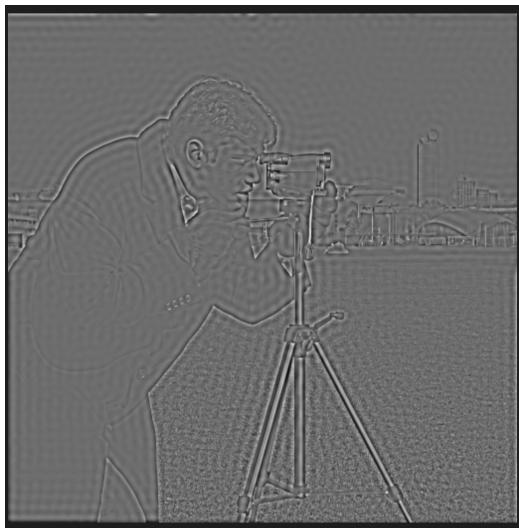
[Task 4]

(a)

Low-pass:

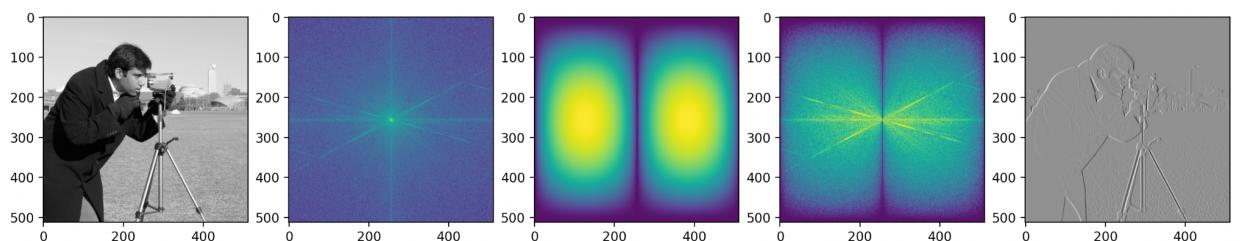


High-pass:

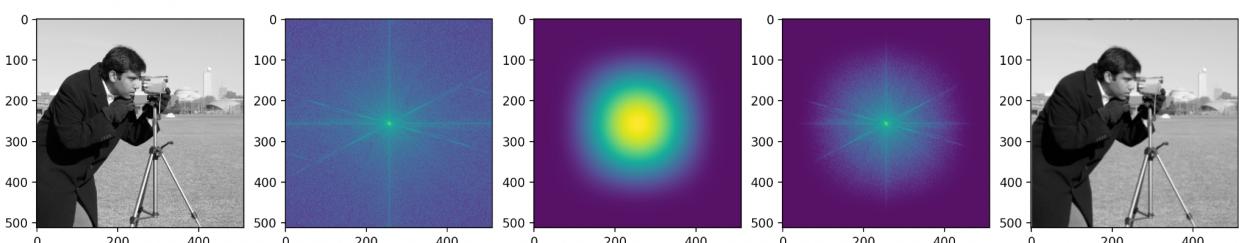


The ringing effect is due to the acute transition of frequency around the edges of the objects in the images,

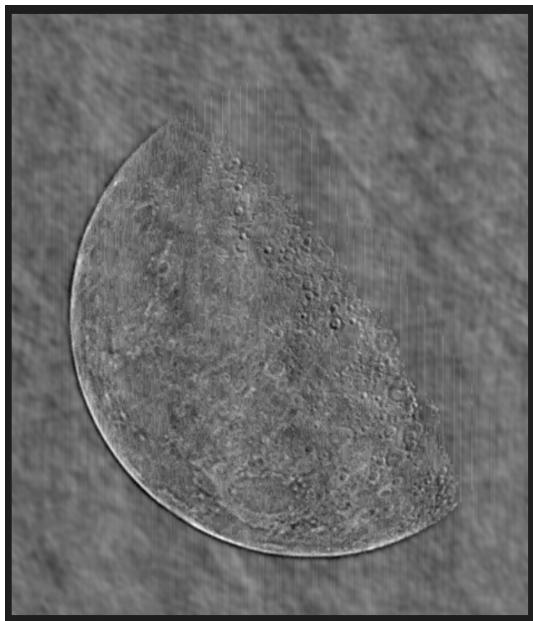
(b) Sobel:



Gaussian:



(c)



(d)

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Found angle: -21.81
Found angle: 90.00
Found angle: -44.87
Found angle: 44.87
Found angle: -67.94
Found angle: -89.50
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