Assignment 3 Report
Image Processing - EEL715
Group No 15

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***Abstract*—This report covers the ELL715 Image Processing Assignment 3 solution**

I. Question 1

Q. Given a 256256 grayscale image salesman.bin with 8-bit pixels. In this problem you will use three different methods to apply a 77 linear low-pass average filter to the image. The resulting filtered images should be exactly the same in all three cases. The filter impulse response is a 77 square where each pixel is equal to 1/49. The filter window is SQUARE(49). The reference point is located in the center, so that the output image is not shifted relative to the input image. Note: this is a linear translation invariant (LTI) filter. The output is linear convolution, not circular convolution.

A. Part A

Q. Implement the 77 linear average filter using image domain convolution. Set each pixel in the output image equal to the average of the pixels in a 77 neighborhood about the corresponding pixel in the input image. Handle edge effects by zero padding (i.e., use a value of zero for pixels where the window hangs over the edges of the input image). Show the input and output images with full scale contrast.

Ans. Spatial Convolution was implemented after padding with 3 pixels on each side. The following output was obtained.

Fig. 1. Input Image.

Fig. 2. Output of Spatial Domain Convolution.

B. Part B

Q. Implement the same filter by pointwise multiplication of DFTs. In this case, your impulse response image H will be of size 128×128 and will have all pixels equal to zero except for a 7×7 square of pixels in the center that will all be equal to 1/49. As in Example 3, we have (p0,q0) = (64,64), which is Matlab (row,col) = (r,s) =(65,65). Show the following images with full scale contrast:

1) The original input image.
2) The zero padded original image
3) The zero padded impulse response image.
4) The centered DFT log-magnitude spectrum of the zero padded input image
5) The centered DFT log-magnitude spectrum of the zero padded impulse response image.
6) The centered DFT log-magnitude spectrum of the zero padded output image.
7) The zero padded output image.
8) The final 256 256 output image.

Verify that the output image is the same as the one in part (a). In Matlab, if the output image from part (a) is in the array

Y1a and the output image from this part is in the array Y1b, then you can do this using the Matlab statement

Ans Frequency Domain Convolution was implemented as listed above and the following images were obtained. The output image is identical with those obtained through spatial domain convolution.

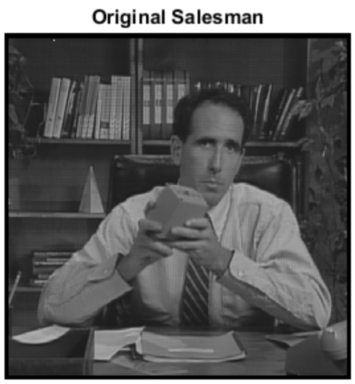

Fig. 3. Original Image

Fig. 4. Zero padded original image.

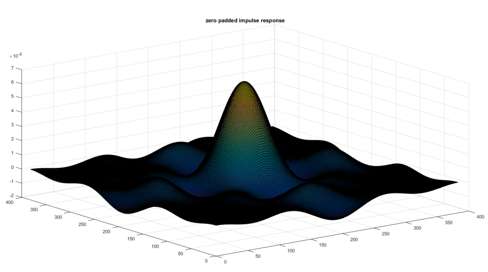

Fig. 5. Zero padded impulse response image.

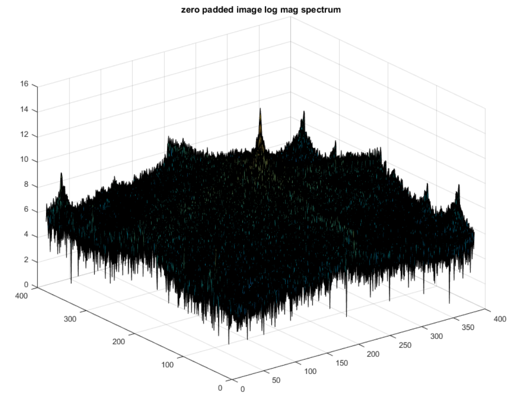

Fig. 6. Centered DFT log-magnitude spectrum of the zero padded input image.

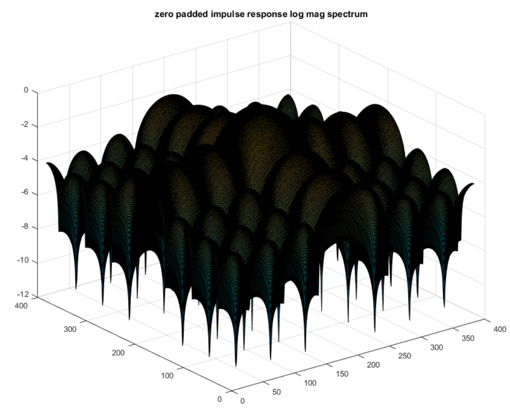

Fig. 7. Centered DFT log-magnitude spectrum of the zero padded impulse response image.

C. Part C

Q Implement the same filter again using the zero phase impulse response and DFT. Use a size of 256 256 for the impulse response image H. To do this in Matlab, initialize the original non-zero phase impulse responseto all zeros and then set elements (126:132,126:132) equal to 1/49. This will give you a 7 7 square of pixels with value 1/49 centered at (p0,q0) = (128,128), which is Matlab (row,col) = (r,s) = (129,129). Obtain the zero phase impulse response image. Show the following images with full scale contrast:

1) The original input image.
2) The 256 256 zero phase impulse response image (this is h2 in Example 5).
3) The 512 512 zero padded zero phase impulse response image (this is h2ZP in Example 5).
4) The final 256 256 output image.

Verify that the output image is the same as the one in part (a).

Ans Frequency Domain Convolution was implemented as

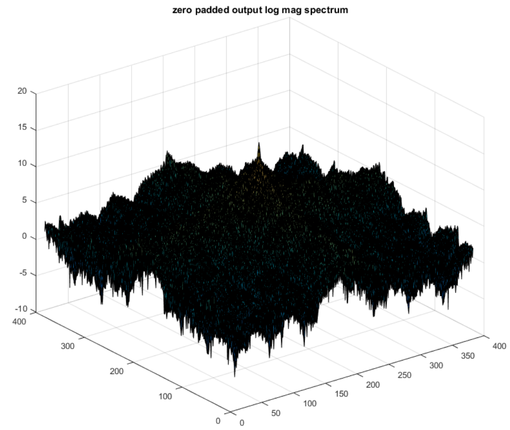

Fig. 8. The centered DFT log-magnitude spectrum of the zero padded output image.

Fig. 9. The zero padded output image..

listed above and the following images were obtained. The output image is identical with those obtained through spatial domain convolution.

II. Question 2

Q Obtain the images girl2.bin, girl2Noise32Hi.bin, and girl2Noise32.bin from the course web site. All three are 256 256 grayscale images with 8-bit pixels.

1) girl2.bin is the original image, also known as Tiffany.
2) girl2Noise32Hi.bin has hi-pass Gaussian white noise added. The DFT of the noise is nonzero for $u2+v2 > 64$ cpi and zero for $u2 + v2 \leq 64$.
3) girl2Noise32.bin has broadband Gaussian white noise added.

Fig. 10. The zero padded output image after removal of padding.

Fig. 11. The zero padded output image after removal of padding.

A. Part A

Q Read and display all three images. Compute the MSE of girl2Noise32Hi and girl2Noise32 relative to girl2.

Ans

MSE and SNR w.r.t Original Image

	MSE	SNR
Broadband Noise	744.46	34.37
High Pass Noise	692.50	35.09

B. Part B : Ideal Low Pass Filter

Q Apply an isotropic ideal low-pass filter with Ucutoff = 64 cpi to all three images. Since the cutoff frequency of the hi-pass noise is known exactly in this case, it is best to implement the filter using circular convolution.

Ans

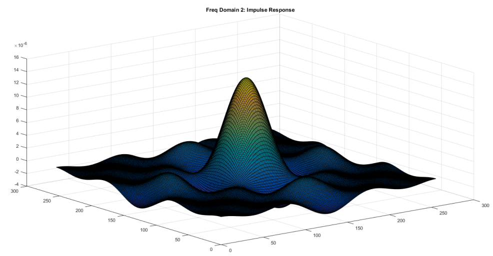

Fig. 12. The 256 256 zero phase impulse response image.

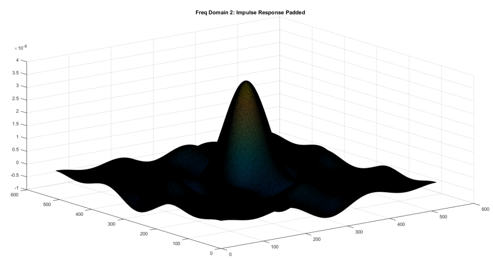

Fig. 13. The 512 512 zero padded zero phase impulse response image.

Fig. 14. The final 256 256 output image.

Mean Square error, SNR and ISNR for Ideal LP filter

	MSE	SNR	ISNR
Original Image	127.74	34.37	-
Broadband Noise	550.87	34.37	3.01
High Pass Noise	398.99	40.60	5.51

C. Part C : Gaussian Filter with cutoff 64

MSE, SNR and ISNR for Gaussian with cutoff 64

	MSE	SNR	ISNR
Original Image	21.96	69.60	-
Broadband Noise	555.07	37.30	2.93
High Pass Noise	442.45	39.57	4.48

D. Part D

MSE, SNR and ISNR for Gaussian with cutoff 34

	MSE	SNR	ISNR
Original Image	102.34	54.21	-
Broadband Noise	539.73	37.58	3.21
High Pass Noise	422.11	40.04	4.95

III. Conclusion

Salient Object Selection and Tracing of Contour Works reasonable well with the current Algorithm. It was tested with all test-images supplied and finds reasonable contours of primary foreground objects in the image. The contour detection may possibly be further refined using texture and colour data.

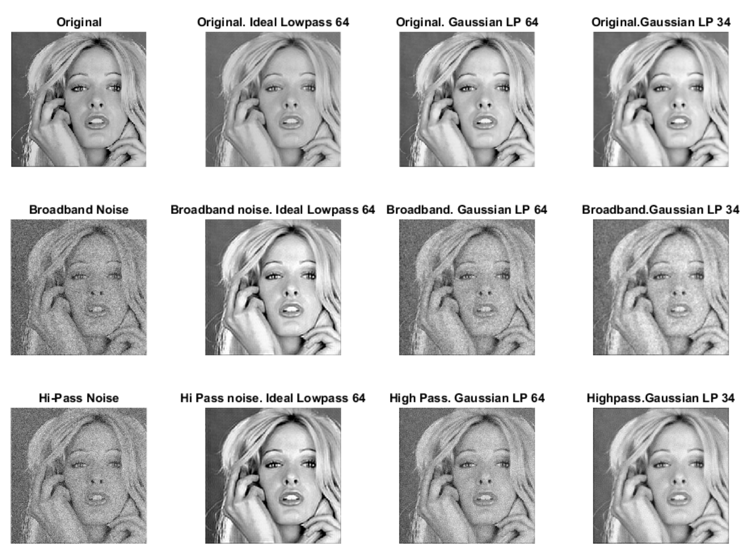

Fig. 15. The final results across different filters.

References

[1] http://www.mathworks.com/