# EE475 HW 4

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## I. 1. Unsharp Masking and High-Boost Filtering

*A.*

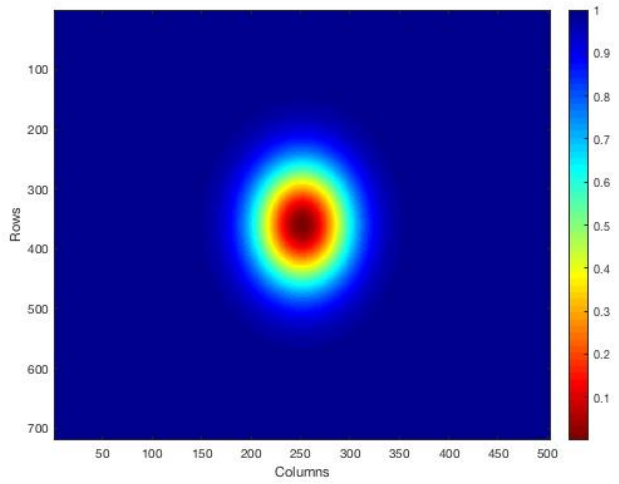



Fig. 1: Gaussian High Pass Filter Mask as a heat map

*B.*

Fig. 2: result of filtering with a Gaussian high-pass filter

After filtering I used *imshow(I,[LOW HIGH])* function to visualize the output better. My range is [0 25]. The output can be visualised differently if one choses an another range.

*C.*

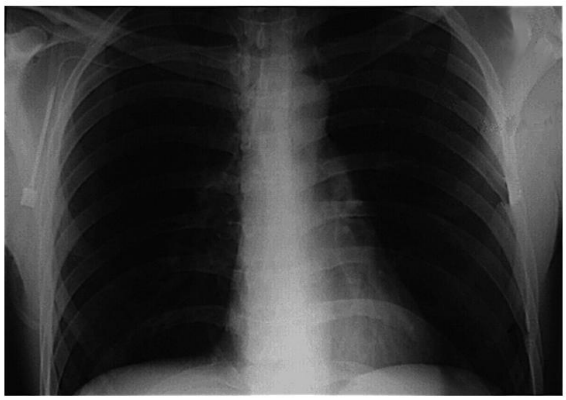
*D.*

## II. 2. Moiré Noise Removal

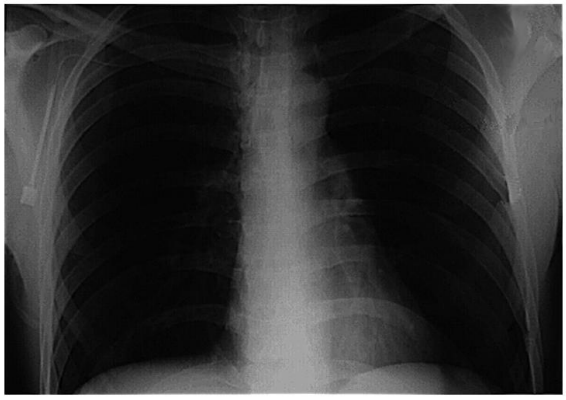
*A.*

*B.*

First I looked at the 2D magnitude spectrum of the given image and marked the points where the magnitude spectrum on log scale larger than 130(Fig. 6.a). This plot gave an idea to me where should I look at to find spectral peaks. From Figure 6.a and 6.b I concluded that there are 8 spectral peaks on this



(a) high-boost filtering for k = 1



(b) high-boost filtering for k = 1.6

Fig. 3: High-boost filtering

image's magnitude spectrum. To find where these points are located exactly I investigated the magnitude spectrum array called *car_magnitude_spectrum*. The spectral peaks and the corresponding diameters are the following based on my observations.

| Column | Row | Diameter |
|---|---|---|
| 56 | 86 | 2 |
| 112 | 82 | 2 |
| 58 | 166 | 2 |
| 116 | 161 | 2 |
| 56 | 45 | 1 |
| 112 | 41 | 1 |
| 58 | 207 | 1 |
| 114 | 203 | 1 |

TABLE I: Locations and corresponding diameters of spectral peaks

*C.*

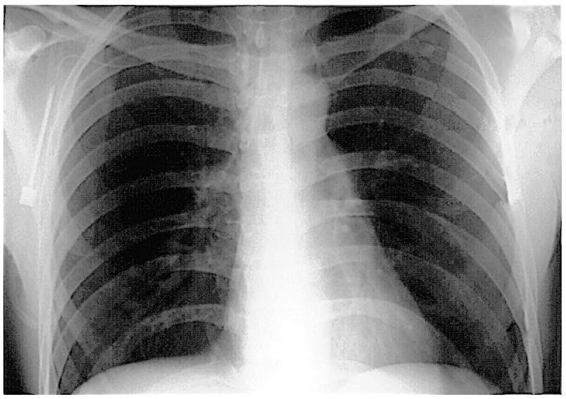
*D.*

## III. 3 Deblurring

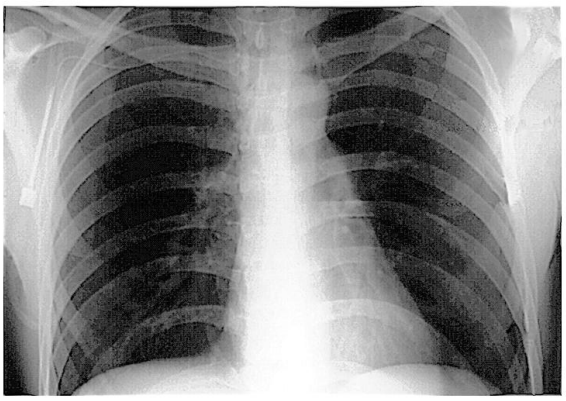
*A.*

*B.*

The blurred and noisy version of book-cover image is a grainy image. The low pass filters are good at smoothing the graininess



(a) Histogram equalized high-boost filtering for k = 1



(b) Histogram equalized high-boost filtering for k = 1.6

Fig. 4: Histogram equalized results

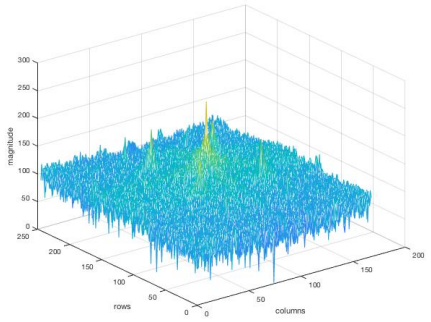



Fig. 5: magnitude spectrum

of an image. But we receive a slightly blurry image in exchange. Looking at figure 10.b one can claim that our blurred and noisy image is definitely a grainy image.

*C.*

*D.*

*E.*

## IV. 4. Importance of the Phase

*A.*

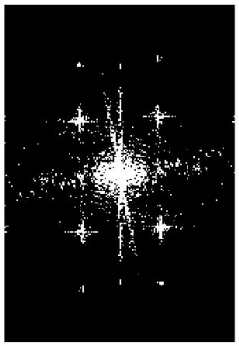
*B.*

*C.*

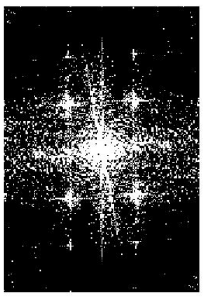
*D.*

*E.*

Clearly the phase information is far more important than the magnitude information in preserving key aspects of individual

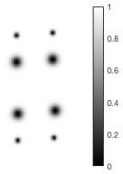


(a) The locations where the magnitude spectrum of the given image larger than 130 on log scale

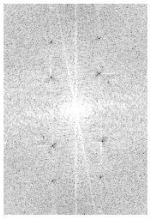


(b) The locations where the magnitude spectrum of the given image larger than 120 on log scale

Fig. 6: 2D visualization of magnitude spectrum



(a) notchfilter scaled [0 1]



(b) magnitude spectrum of output of notch filter (on log scale)

Fig. 7: Notch filter

images. The phase information seems to retain a lot of information about image edges and image orientations. The phase-only reconstruction preserve features because of the principle of phase congruency. At the location of edges and lines, most of the sinusoid components have the same phase. This properly alone can be used to detect lines and edges without regard to magnitude. Figure 16 and Figure 17 confirms this statement. Although we tried to reconstruct Erdogan image from his own magnitude spectrum, we failed to get Erdogan image. On the other hand we get Trump's image although we used Erdogan's magnitude spectrum.

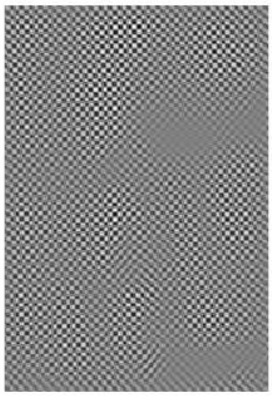
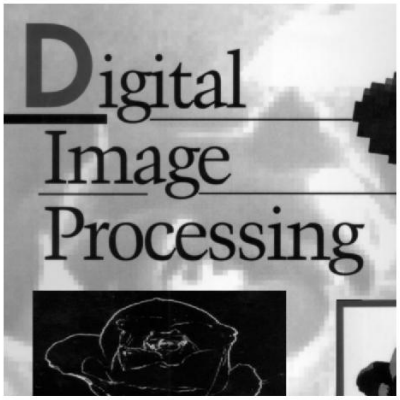
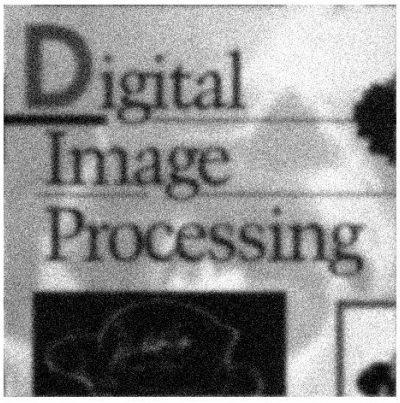


Fig. 8: extracted moiré pattern




(a) original image

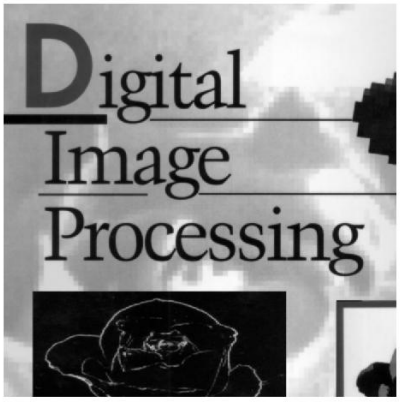



(b) the blurred & noisy version of the book-cover image

Fig. 10: b

Fig. 9: moiré pattern removed

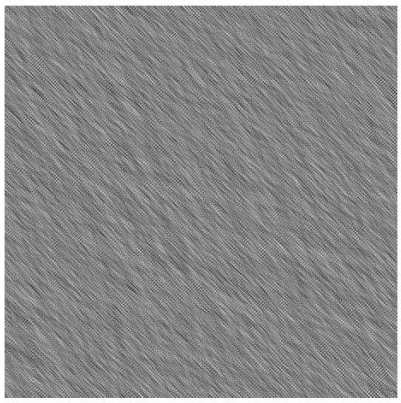

Fig. 11: result of applying the inverse filter and a butterworth low pass filter




(a) original book cover image

(b) linear camera motion distorted image

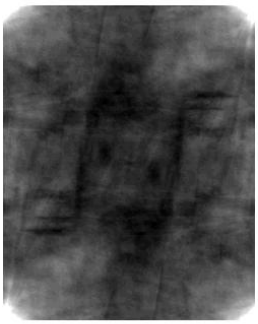
Fig. 12: d



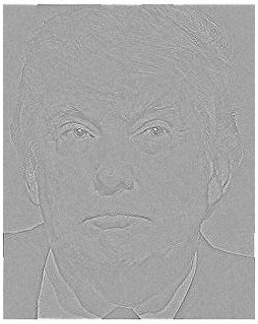
(a) restored by direct inverse filtering

(b) restored by Wiener filter

Fig. 13: restored images

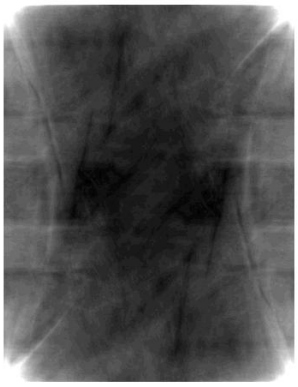


(a) Trump reconstructed from magnitude-only spectrum, imshow range [0 30]

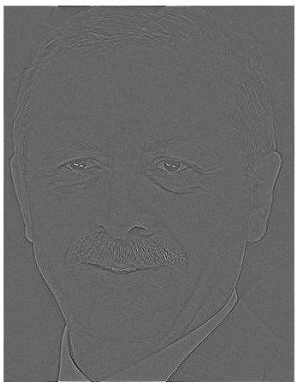


(b) Trump reconstructed from phase-only spectrum , imshow range [50 200]

Fig. 14: reconstructed Trump from his own phase and magnitude (ranges are determined empirically)



(a) Erdogan reconstructed from magnitude-only spectrum, imshow range [0 30]



(b) Erdogan reconstructed from phase-only spectrum , imshow range [50 200]

Fig. 15: reconstructed Erdogan from his own phase and magnitude (ranges are determined empirically)

Fig. 16: Trump reconstructed from his own magnitude spectrum and Erdogan's phase spectrum, imshow range [60 150]

Fig. 17: Erdogan reconstructed from his own magnitude spectrum and Trump's phase spectrum, imshow range [60 150]