

Fourier Filtering and Deblurring

**Mathematical Models and Methods for Image
Processing**

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The blur model

$$s = h * y$$

- y is the original image
- h is the blur kernel ($h \geq 0$)
- s is the corrupted image

Blur may have several causes

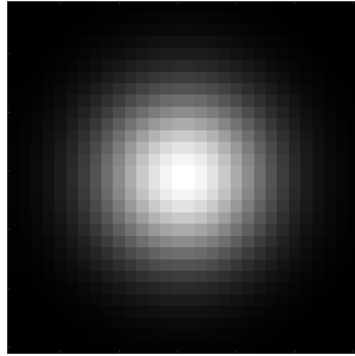
Out of focus

s



=

h

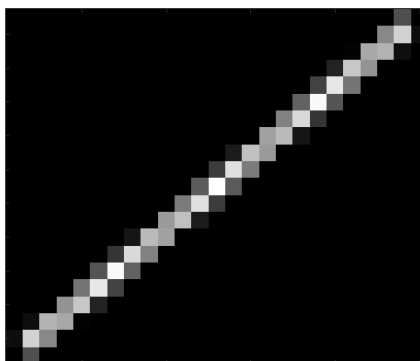


*

y



Motion blur

 s  $=$ h $*$  y 

The deblurring problem

$$s = h * y$$

Estimate y given the corrupted image s

The blur kernel h is assumed to be **known** (it can be estimated)

Phase is more significant than absolute value

$$\mathcal{F}(y_{ob}) = \rho_{ob} e^{i\theta_{ob}}$$



$$\mathcal{F}(y) = \rho e^{i\theta}$$

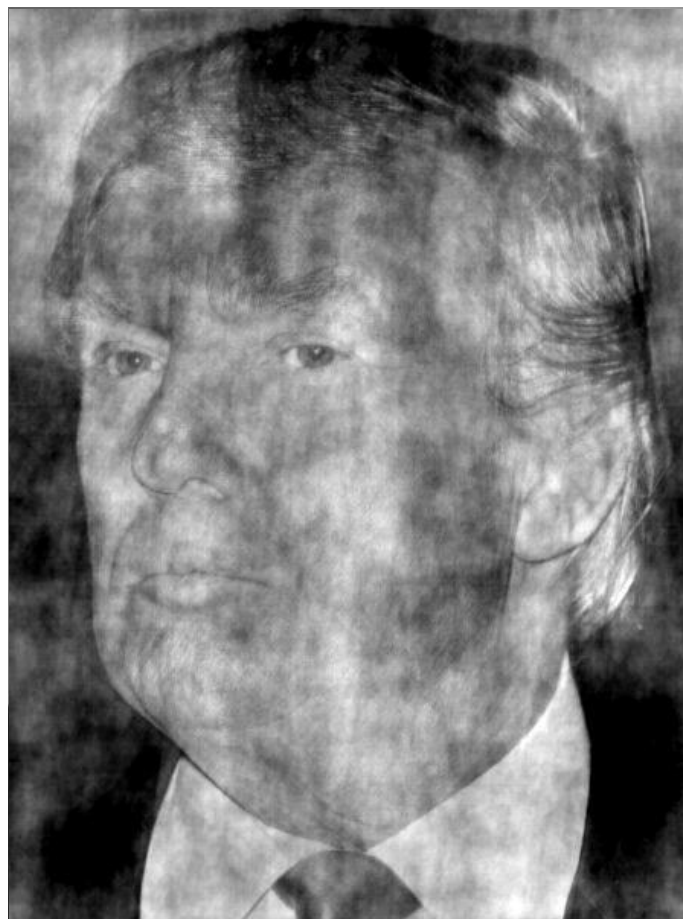
$$\mathcal{F}(y_{tr}) = \rho_{tr} e^{i\theta_{tr}}$$



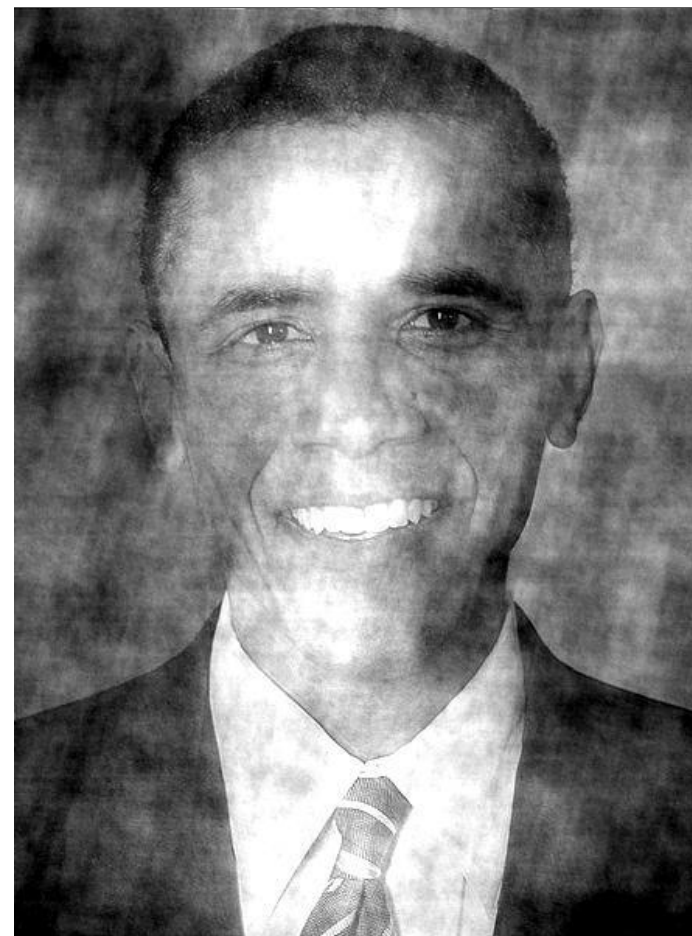
Phase is more significant than absolute value

$$\mathcal{F}(y) = \rho e^{i\theta}$$

$$\rho_{ob} e^{i\theta_{tr}}$$



$$\rho_{tr} e^{i\theta_{ob}}$$



Assignments



Blur inversion

- Corrupt the image with a motion blur (no noise at first!)
- Compute the (padded) Fourier transform of the corrupted image and the noise
- Estimate the image performing the blur inversion
- Try to add a small amount of noise
- Estimate the image using the blur inversion and the regularized inverse



Wiener Filtering

- Corrupt the Lena image with a motion blur and noise
- Compute the (padded) Fourier transform of the corrupted image and the noise
- Estimate the image using the ideal Wiener filter (best linear filter in terms of PSNR)
- Try using the Cameraman image to estimate the PSD of the Lena image, and perform the Wiener filtering
- Iterate the Wiener Filter using the previous estimate to compute the PSD

