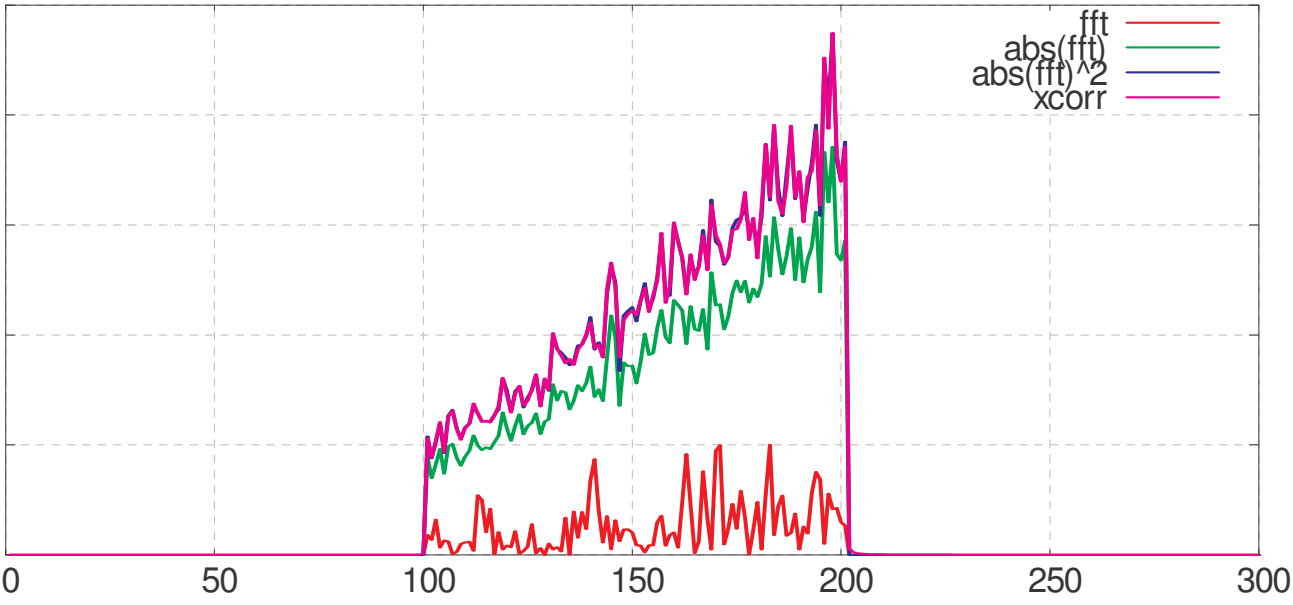
Stochastic Noise Power Spectrum

The power spectrum of a deterministic signal is: $S(\omega_x, \omega_y) = \|F(\omega_x, \omega_y)\|^2$

It would be nice to use this approach directly with stochastic signals. However, we can't do this directly. We can't take a set of samples of a random signal, average the fft's and get the power spectrum.

The following code illustrates this

```
sum_fft=     zeros(1,1000);      sum_abs_fft= zeros(1,1000);
sum_sqr_fft= zeros(1,1000);      sum_cor_fft= zeros(1,1999);
mask=100:200;  filt= zeros(1,1000);
filt(1+mask)=    mask;
filt(1001-mask)= mask;
nsamples=100;
for i=1:nsamples
   rand_sig= real( ifft(fft( randn(1, 1000)) .*filt));
   fft_rand= fft(rand_sig);
   sum_fft = sum_fft + fft_rand;
   sum_abs_fft = sum_abs_fft + abs(fft_rand);
   sum_sqr_fft = sum_sqr_fft + abs(fft_rand).^2;
   sum_cor_fft = sum_cor_fft + fft( ifftshift(xcorr(rand_sig)));
end
sum_fft     = abs( sum_fft/nsamples );
sum_abs_fft = sum_abs_fft/nsamples;
sum_sqr_fft = sum_sqr_fft/nsamples;
sum_cor_fft = abs( sum_cor_fft(1:2:1999)/nsamples );
plot([sum_fft.^2; sum_abs_fft.^2; sum_sqr_fft; sum_cor_fft]')
```



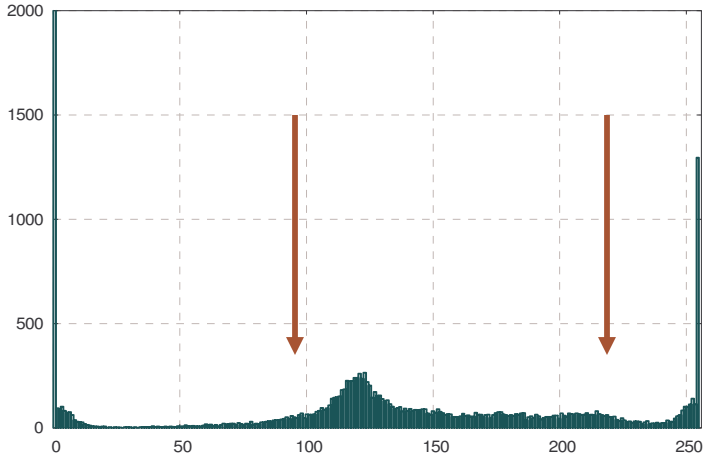
Valid noise power estimators:

- The average of cross-correlations
- The average of sample spectral power

Invalid noise power estimators:

- Average of abs (spectrum)
- Average of spectrum

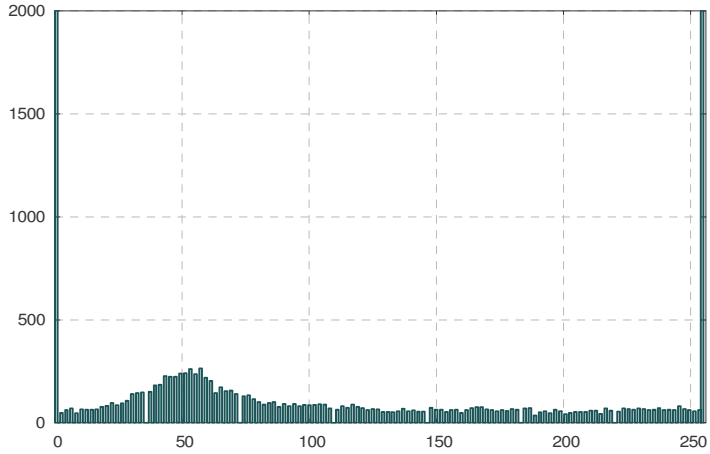
Histogram normalization



Histogram using: `hist( im(:), 256 )`

Now, stretch histogram in the range 95 to 220:

```
im=(im-95)*256/(220-95); im=im.*(im>0 & im<256) + 255*(im>255);
```



Now, perform histogram normalization over the entire range

```
imagesc(reshape(im1,135,135));
hv=hist(im0(:),256);
map= cumsum(hv); map=map-min(map); map=map/max(map);
im1=reshape(   map(im0+1),  size(im0) );
```

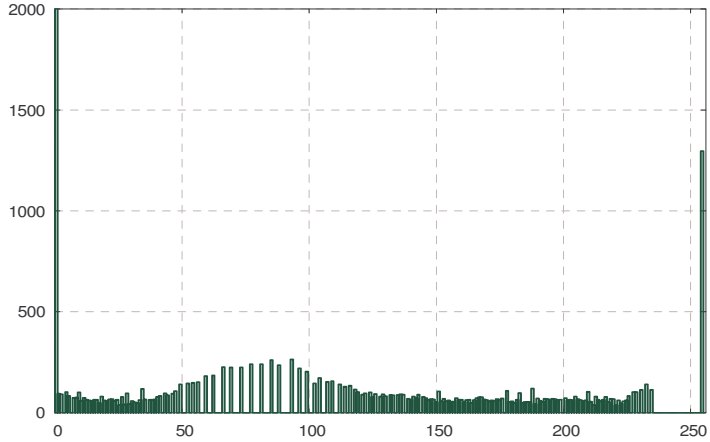
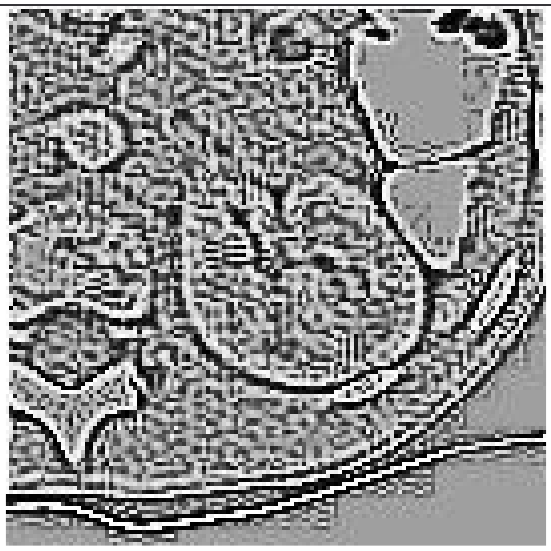


Image Enhancement (Spatial Domain)

1. Normal Resolution
2. Smoothed LPF
3. Unsharp Mask= *Image1 – Image2*
4. Mask applied to Image 1 = *Image1* + λ*Image3*

Code:

```
for lambda = 0:.1:1;
  m=[0,0,0;0,1,0;0,0,0] + lambda*[-.1,-.1,-.1;-.1,.8,-.1;-.1,-.1,-.1];
  im=conv2(im0,m,'sa e');
  jpgwrite(sprintf('imusm-%3.1f.jpg',lambda),histnorm(im));
end
```



λ = 100

λ = 10

λ = 5

λ = 2