Lab 5
Image Restoration and Filtering

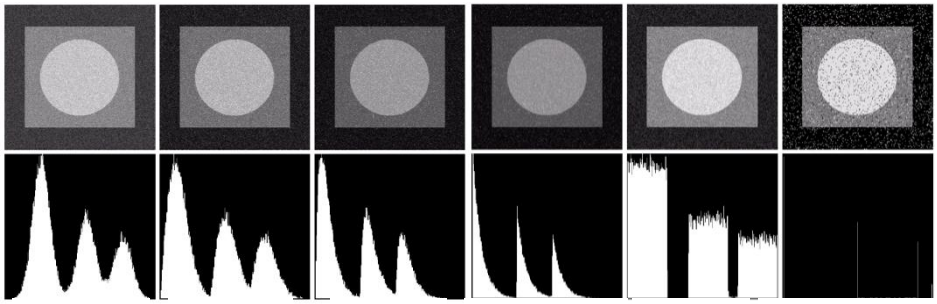
Please provide a brief explanation of each step.

1. Use the following commands for estimating the noise model from degraded images.

```
g = imread('noisy_1.tif');
B = roipoly(g);                  % Generate the binary mask image by specifying a
                                   polygonal ROI interactively
p = imhist(g(B));                % Compute the histogram of the pixels in the ROI
figure, bar(p, 1);
```

Image	Noise Model
noisy_1.tif	
noisy_2.tif	
noisy_3.tif	
noisy_4.tif	

Examples of noise models



2. Use the following spatial filtering functions for suppressing the noises in the above images.

```
B = imfilter(A,h,option1,option2,...)
B = medfilt2(A,[m n])
```

3. Evaluate the denoised images using mean square error (MSE).

$$MSE(f,\bar{f}) = E[\left(f(x,y) - \bar{f}(x,y)\right)^2]$$

This method measures the "distance" between the original (f) and denoised image ($\bar{f}$) (the smaller the better). If MSE = 0, the image is "perfectly" denoised.

The denoised images should have $\boldsymbol{MSE}$ **less than** the specified values:

Image	MSE must less than the specified value	MSE	Filtering method and its parameter values
noisy_1.tif	33.00		
noisy_2.tif	31.00		
noisy_3.tif	26.00		
noisy_4.tif	35.00		

4. Use an *ideal inverse filter* to restore the image degraded by motion blur (*missing_motion.tif*) using the following function

```
J = deconvwnr(I,PSF,0);
```

An ideal inverse function is defined as $\hat{F}(u,v) = \frac{G(u,v)}{H(u,v)}$

A degradation model (`PSF`) is *PSF_missing_motion.mat*

5. Use the *Wiener filter* to restore the image degraded by motion blur using the following function

```
J = deconvwnr(I,PSF,NSR);
```

`PSF` is the point-spread function with which image `I` was convolved.
`NSR` is the noise-to-signal power ratio of the additive noise. Recall that the Fourier transform of the Wiener filter (H_w) is defined as

$$H_w(u,v) = \frac{H*(u,v)}{|H(u,v)|^2 + [S_{vv}(u,v)/S_{ff}(u,v)]}$$

where H is the transform function of the degradation,
$H*(u, v)$ denote complex conjugate of $H(u, v)$,
$S_{vv} = |N(u,v)|^2$ is the power spectrum of the noise,
$S_{ff} = |F(u,v)|^2$ is the power spectrum of the undegraded image.
`NSR` = S_{vv}/S_{ff}

5.1 Use the *Wiener filter* to restore the degraded image (*missing_motion.tif*) with known noise distribution (*missing_noise.tif*). The error (MSE) of the result should less than 23.20

5.2 Estimate the S_{vv} and S_{ff} using the noise estimation technique done in 1-3. The error (MSE) of the result should less than 23.50

- Use function

```
v = statmoment(p,n)
```

to compute the variance of the noise distribution (`p`). The function outputs a vector `v` with `v(1)` = mean, `v(2)` = variance of the noise distribution.

- Use function

```
J = imnoise(I,'gaussian',mean,variance)
```

to generate the noise image used to compute S_{vv}

- Use a smoothing filter to estimate S_{ff}.

6. Use the method in 5.2 to restore the degraded image (*bonus.jpg*) using the degradation function (*PSF_bonus_motion.mat*).

NOTE

- You should convert an input image to type `double` before proceed a restoration process using the function:

```
f = im2double(I);
```

- You can convert the resulting image back to type `uint8` before computing MSE using the function:

```
I = im2uint8(f);
```