H2_Chia
Exercise 4

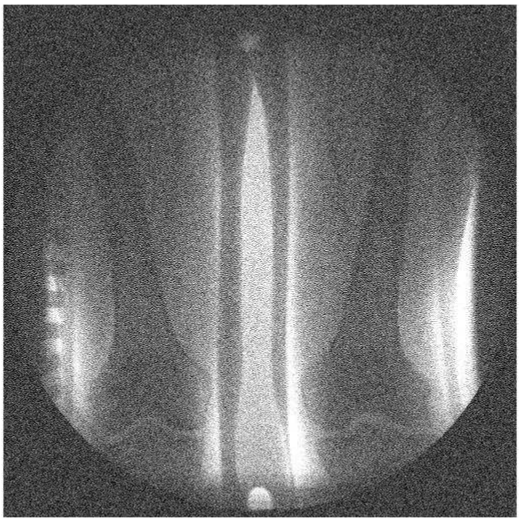
First of all, we need to load the .mat file and visualize the images on it. To do it, we just need to run the following lines:

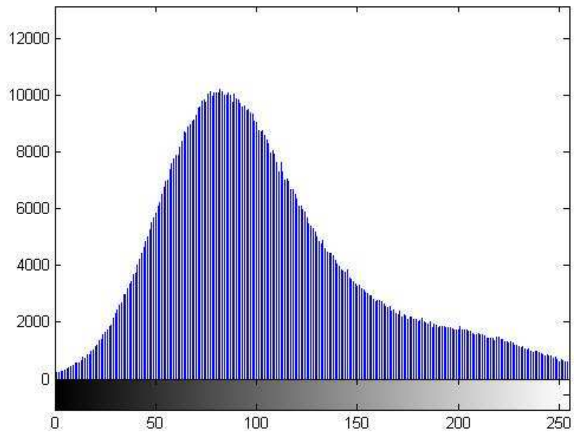
```
load h2_noisy_images.mat
figure, imshow(img1,[ ])
figure, imshow(img2,[ ])
figure, imshow(img3,[ ])
figure, imshow(img4,[ ])
```

As we see, we have the same base image with different kind of noises.

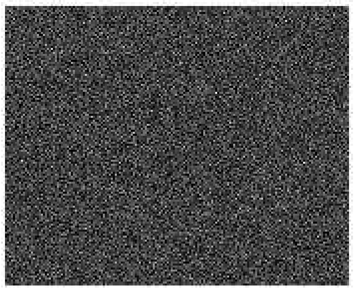
Image 1

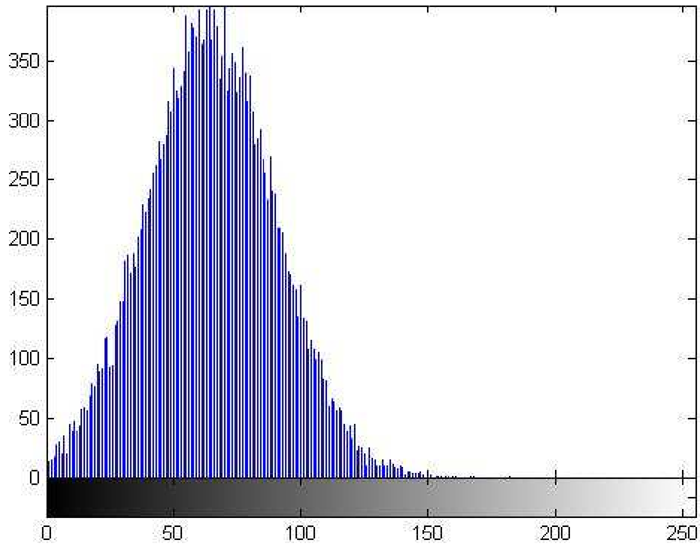
To determine which noise is affecting this image, we have to analyze the histogram. However, it will be more useful if instead of analyzing the complete image, we just consider a portion of the background.





If we crop a small portion (with the function *imcrop*), like the following one, and we obtain its histogram, we'll see more clear the kind of noise that was added.

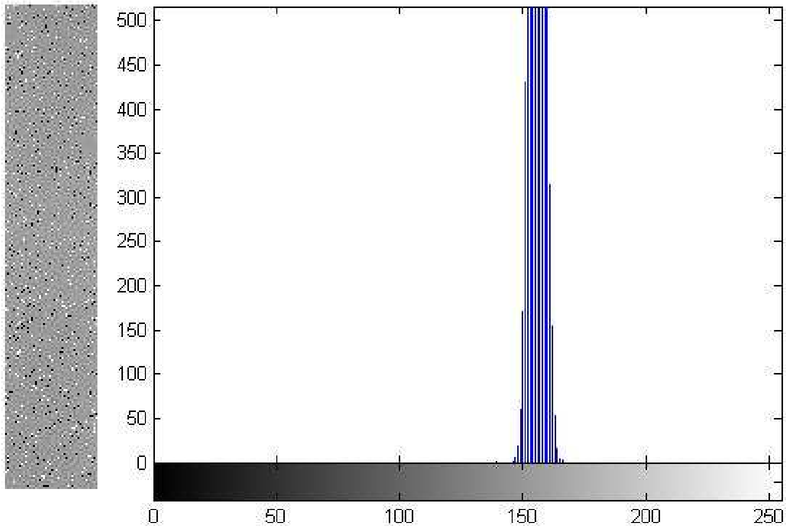




So, as we see, this noise is Gaussian, with mean 60, and standard deviation approximately of (150-60)/3=30. This is because the Gaussian function contains the 99.7% of the information between [center-3·std dev, center+3·std dev]. Also, we have to consider, that if we work with *double* images, we need to divide these parameters by 255.

Image 2

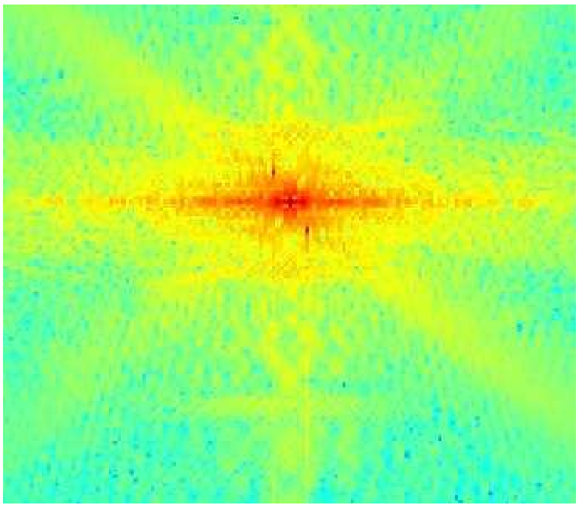
For the second image, we clearly see that the noise is salt&pepper. Since the background is black, if we crop a portion of it, we'll see only the white component of this kind of noise, so in this case it's better to pick a grey zone, where we'll be able to see the black and the white components more enhanced. To do this, I chose the grey part that it's in the middle of the image.



On this image, composed by 11224 pixels, we find 346 black pixels (corresponding to intensity value 0) and 326 white pixels (intensity 255). If we consider the average between this two, i.e. 336, it corresponds to the 2.99% of the total amount of pixels. And since the salt&pepper substitute d/2 % of pixels with white and d/2 % pixels with black, we can conclude that the value of the density d is 6.

Image 3

The third image has a different kind of noise. As we can see, it's sinusoidal. To examine the frequency we can perform a Fourier transform of the image. If we look closer to the center, we'll see the two red spots of the noise:



This two dots correspond to the points (520,517) and (506,509), being the center (513,513). This means that the module of the vector from the center to each one of this points is 8, so the frequency of the noise is 8/1024 cycles/sample.

Also, it's possible to obtain the tilting, calculating the phase of this vector:

atan((520-506)/(517-509))*180/pi=60º

For the amplitude, I cropped a small part of the background, which was supposed to be black, to check the value of the pixels with higher intensity. On the histogram of this cropped part, the highest value of intensity was 103, which means that the intensity is 103/255.

Image 4

On the fourth image, we can see two kinds of noise: salt&pepper and sinusoidal. First, I cropped a small part of the background, and I obtained the histogram. This background was black in the beginning, and since the amplitude of the sinusoidal noise is not 1, all the white dots belong to the salt&pepper noise. On this histogram I could see that 226 out of 24708 pixels where white, i.e the 0.91%. So in this case the density is 1.8.

To analyze the sinusoidal noise, I used the upper stripe. It's in the black background; wide enough to have a considerable amount of pixels, and it also contains the sinusoidal noise.

Doing the Fourier transform of this stripe, we can see the sine components, with distance to the center 4, and frequency 4/1024 cycles/sample. In this case, we can prove that this is true, because the complete image has 4 cycles of the sine, which means that the period is 1024/4 sample/cycle.

The tilting is 0, since the components of the Fourier transform are on the horizontal-axis.

The amplitude of the sinusoidal noise is 53/1024=0.0518. This value can be easily obtained doing the histogram to the upper stripe, obviously without considering the white dots that belong to the salt&pepper noise