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Band-stop (notch) filter

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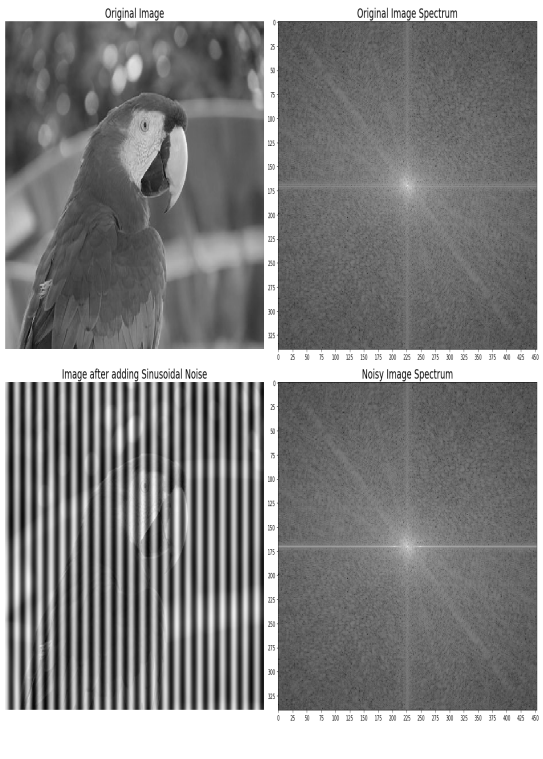
Image restoration

Using a notch filter to remove periodic noise from images

In this example, we will first add some periodic (sinusoidal) noise to the parrot image to create a noisy parrot image (this can happen because of **interference** with some electrical signal) and then observe the effect of the noise in the frequency domain of the image using the following code block:

```
from scipy import fftpack
pylab.figure(figsize=(15,10))
im = np.mean(imread("../images/parrot.png"), axis=2) / 255
print(im.shape)
pylab.subplot(2,2,1), pylab.imshow(im, cmap='gray'), pylab.axis('
pylab.title('Original Image')
F1 = fftpack.fft2((im).astype(float))
F2 = fftpack.fftshift( F1 )
pylab.subplot(2,2,2), pylab.imshow( (20*np.log10( 0.1 + F2)).asty
pylab.xticks(np.arange(0, im.shape[1], 25))
pylab.yticks(np.arange(0, im.shape[0], 25))
pylab.title('Original Image Spectrum')
# add periodic noise to the image
for n in range(im.shape[1]):
    im[:, n] += np.cos(0.1*np.pi*n)
pylab.subplot(2,2,3), pylab.imshow(im, cmap='gray'), pylab.axis('
pylab.title('Image after adding Sinusoidal Noise')
F1 = fftpack.fft2((im).astype(float)) # noisy spectrum
F2 = fftpack.fftshift( F1 )
pylab.subplot(2,2,4), pylab.imshow( (20*np.log10( 0.1 + F2)).asty
pylab.xticks(np.arange(0, im.shape[1], 25))
pylab.yticks(np.arange(0, im.shape[0], 25))
pylab.title('Noisy Image Spectrum')
pylab.tight_layout()
pylab.show()
```

The following screenshot shows the output of the preceding code block. As can be seen, the periodic noise there on the horizontal line became more prominent in the frequency spectrum around u = 175:



Now let's design a band-stop/band-reject (notch) filter to eliminate the frequencies that are responsible for noise by setting the corresponding frequency components to zero in the next code block:

```
F2[170:176,:220] = F2[170:176,230:] = 0 # eliminate the frequenci
im1 = fftpack.ifft2(fftpack.ifftshift( F2 )).real
pylab.axis('off'), pylab.imshow(im1, cmap='gray'), pylab.show()
```

The following screenshot shows the output of the preceding code block, the restored image by applying the notch filter. As can be seen, the original image looks sharper than the restored one, since some true frequencies from the original image are also rejected by the band-reject filter along with the noise: