Computational Physics : Assignment 3

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Question 7.2: Detecting Periodicity :

(a) We can clearly see the periodic nature of the sunspots and we can estimate the length of this periodic cycle to be around 130 months

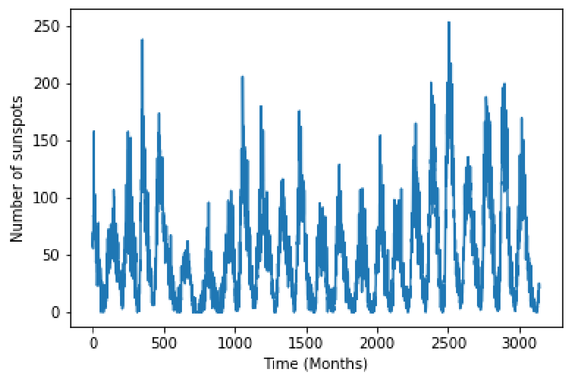

Figure 1: Number of Recorded Sunspots Since January 1974

(b) Figure (2) is the result of Fourier-transforming the data and plotting $|c_k|^2$ against K. As we can clearly see, there is a dominant peak at a non zero value of K which agrees with the periodic nature of our data that we have plotted in the previous part.

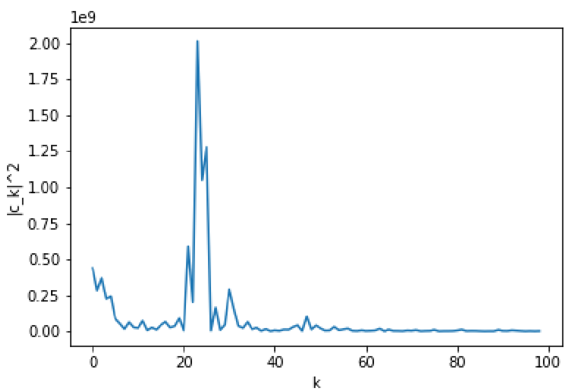

Figure 2: Power Spectrum of the Sunspot Signal

(c) The peak corresponds to a value of K around 22 or 23 and the associated period of oscillation equals to

$$\frac{N}{k} = \frac{3143}{23} = 136$$

months which agrees roughly with what we estimated earlier in part (a)

Question 7.9: Image Deconvolution:

(a) Density plot of an array of the grid values:

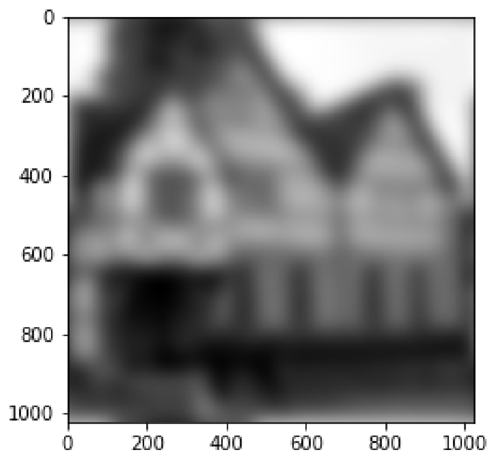

Figure 3: Blurred Photo prior to the Deconvolution Process

(b) Density plot of the point spread function. Due to the periodic nature of the point spread function, we get to see those bright patches in each of the four corners as the values for negative x and y are repeated at the end of each interval.

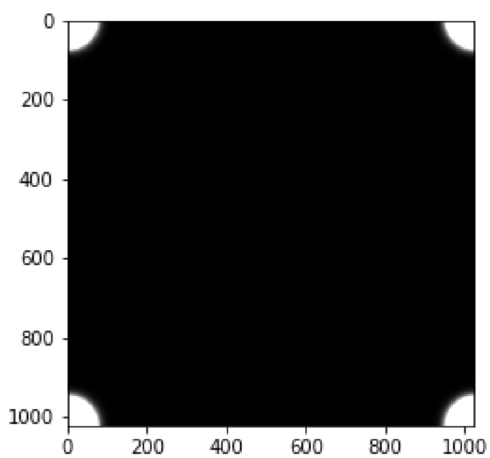

Figure 4: Density Plot of the Gaussian Point Spread Function

(c) The figure below is the result of applying the deconvolution process following the series of steps mentioned in the book involving calculating the point spread function, fourier transforming the data and the point spread function, and performing an inverse fourier transform to get the unblurred image.

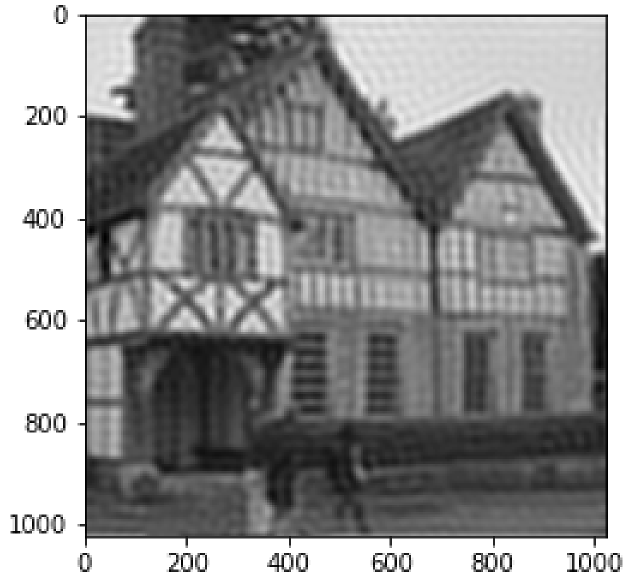

Figure 5: Unblurred Photo

(d) The main point limiting our abilities to perfectly deblur a photo is mathematical in nature. In the process of getting an unblurred photo, we have to divide by the fourier transform of our point spread function. If that happens to be zero or very close to zero, we will get an error which would affect the entire process. The only solution around this is defining a tolerance parameter and we just don't divide by the transformed point spread function if its value is less than this particular parameter. Though this might solve the mathematical problem we will face, it results in loss of data which affects how good or sharp the image is.