Image Processing

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I. Introduction

In this computer assignment, we were given data that consisted of six different images. Each image was different or translated so that when taking the Fourier Transform of each one, it was easy to compare the pictures against their Fourier Transforms. In the second part of the computer assignment, we were given a picture of a moon. This picture was then low then high pass filtered to compare to one another and to the first six images given.

II. Methods

The method to process these pictures were to first use the Image Processing Toolbox to see the pictures. Then using Dr. Obeid's special myFFT2 function to create a plot of the 2-dimensional FFT for an image. The resulting 3D image was plotted magnitude by frequency which can be translated to decibels simply by adding 'db' into the argument. After discovering that, we plotted the images and corresponding Fourier Transforms we compared them to the specified pictures in the instructions. In the second part of the computer assignment we low and high pass filtered a picture of a moon. We looked at the Fourier Transform of each and compared them.

III. Results

In the first part of this computer assignment we compared image one and two.

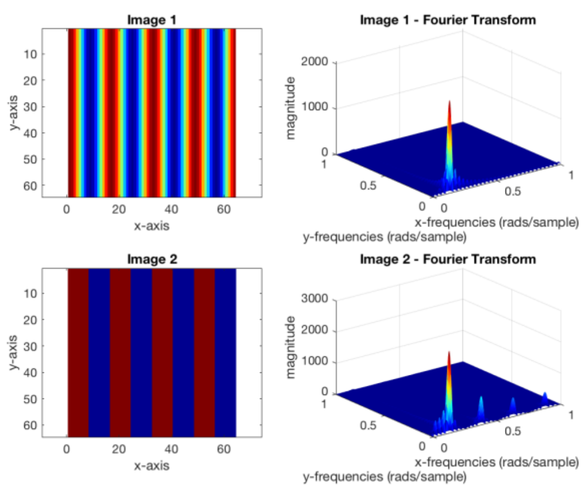

Figure 1: Image 1 and 2 with Fourier Transforms

In each case we plotted the pictures and corresponding Fourier Transforms in order to easily compare. Although the first and second image share the same frequency, from the Fourier Transformations we see that there is higher energy on the X axis in the second image. There is also more energy at lower frequencies. This tells us two things about the second image,
that first being that there are areas of the image that are a consistent color and there are very distinct divides in these areas of consistent color. The second image had a very consistent blend of color throughout the image giving us energy at what appears to be one frequency.

In the second case, we compare image two and three, which are the same image except three is rotated 90-degrees. This can be seen by the Fourier transformations because the 90-degree rotation of the image has a direct correlation in the Fourier Transformation. This is because image 2 only has very low energy when viewed from the Y axis, but has both high and low energy with respect to the X axis as discussed in question one. Once rotated at 90-degrees we see that that the energy concentrations at the various frequencies is now shown with respect to the Y axis demonstrating a direct correlation to degree of image rotation.

The third case we compared image one and four. They both have vertical stripes, but have different frequencies. When we view the Fourier Transformations we can see that the x-frequency has the most energy at .1272 rads/sec for the first image and .5029 rads/sec for the fourth. We can find the the frequency by looking orienting the view to X and Z, then placing a marker at the peak of the impulse. We know that this is the discrete-time frequency because the units are in rads/sample. By using the equation $f = \frac{\Omega * 16}{2\pi}$ we can find the frequency. Which is .3239Hz for the first image and 1.2806 Hz for the second image. This is under the assumption that both images were sampled at the same frequency which is 16 pixels per sample.

The fourth case was just a picture and the corresponding Fourier Transform. We can see something that looks like a 3d Sinc pulse is very close to centered at the origin because the image is the same with respect to both the X and Y axis while having energy at a very low frequency. We see that there is a sharp edge where the colors do not blend therefore we have some frequency.

The sixth image was a result of image 2 and 3 multiplied together. These images being multiplied together is an example of convolution, specifically that either one could be considered a crenel of convolution. Being that we are looking at the quadrant that is all positive, we can see that there is the same energy on the X axis that there is on the Y axis. If one were to change the limits to display all four quadrants for both image 1 and 2 where the Z is positive, then by inspection convolve the two signals we would be able to fully justify the why the Fourier transformation of image 6 looks the way it does. This has also removed a lot of the sharp edges of the image. That is why we see almost all the energy at a single location on the Fourier Transformation plot.

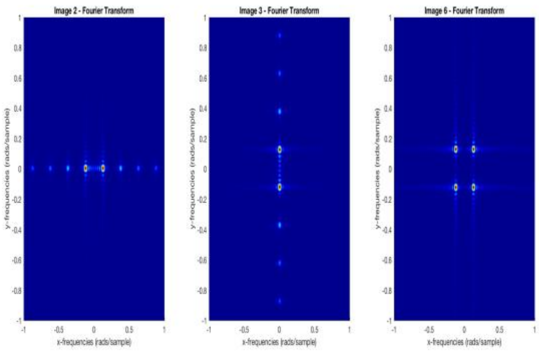

Figure 2: Convolution of Image 2 and 3

In the second part of the computer assignment we low and high pass filtered a picture of a moon.

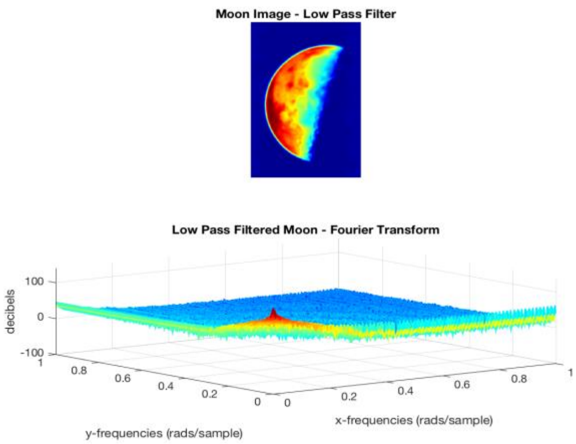

Figure 3: Low Pass Filter and the Fourier Transformation

The Fourier Transforms were only slightly different. The energy was in the same locations, but the magnitude was the variable that has changed the most. The image after being low pass filtered Removed the areas of high frequency (sharp edges) and left a blur that had energy at a lower frequency. The high pass filter removed the areas of low frequency and left only the areas of high frequency, which created an image that only showed the edges of the object in the picture.

IV. Discussion

This computer assignment demonstrates how the colors and patterns on any image relate to their Fourier Transforms. A basic electrical engineering principal such as filtering can be used in such complex image and audio processing as seen in the last two computer assignments. The real-world applications are limitless as pictures are filtered to be contrasted, blurred, or even smoothed every day. Not only is this used for photography, but these can be used for many medical assisted imaging. Not only is filtering a main function of this application, but manipulating these pictures with convolution we can see first had how the crenel algorithm for image processing works.