ECE 5256

Project 3: Correlation and Convolution in the Spatial Domain

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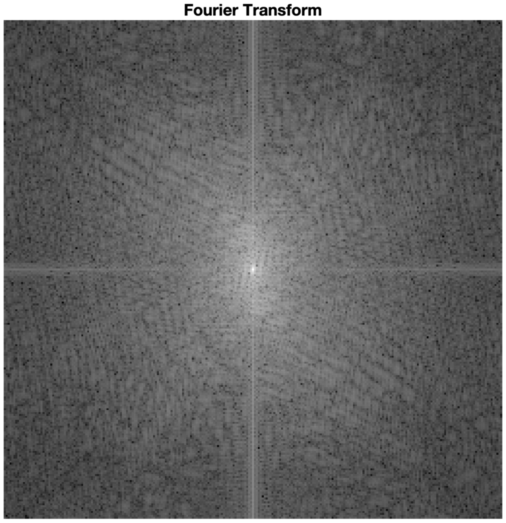

Figure 1: The shifted Fourier transform of the image used.

Low Pass

The first part of this project investigated Low pass filtering the the frequency domain. I did this by multiplying the Fourier transform (Fig. 1) of an image by a circle (Fig. 2). I created the circle by square adding a meshgrid and the taking the square root of this. That maxtrix is the distance from the center. I can then find the values that are lower then a certain value. For the low pass filter I identified values less than $\frac{1}{8}$ the width of the original image. This is $\frac{1}{4}$ the width of the original image. After I multiplied the two I took the inverse Fourier transformation to get the resulting filtered image (Fig. 3)

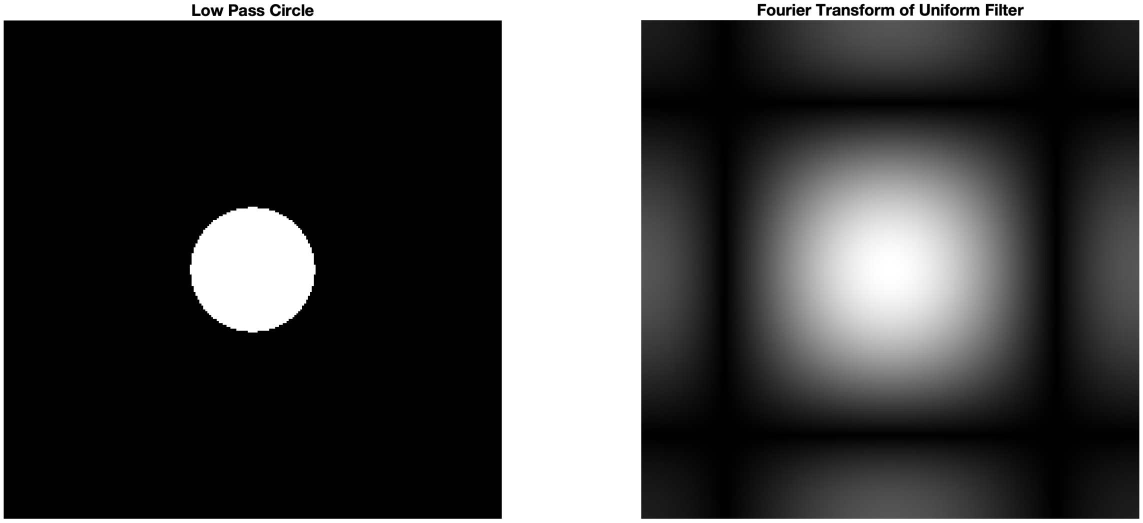

Figure 2: Low Pass filter in the frequency domain (Left) Uniform filter in frequency domain (right). These appear similar however the uniforms response does appear to repeat as seen in the edge. The edge is also not as abrupt with the uniform filter. The abruptness of the ideal filter causes the ringing present in Fig. 3

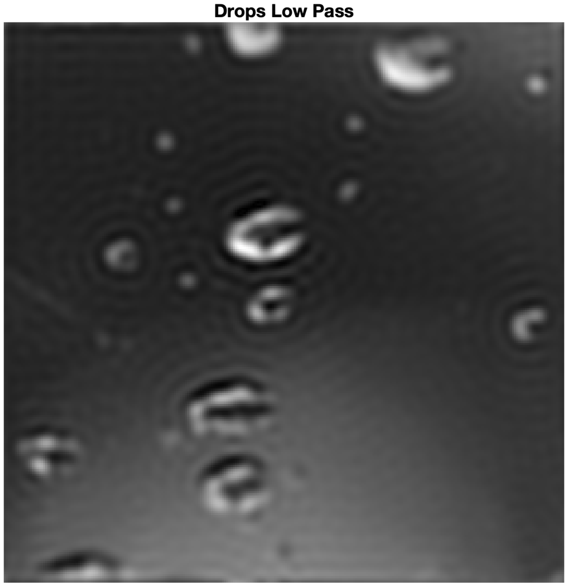

Figure 3: Caption

High Pass

This part of the lab deals with high ass filtering in the frequency domain. Similarly to the first part of the project I used a mesh grid and a radius but for this section I took the values greater than $\frac{1}{4}$ of the width of the image; this is a diameter of $\frac{1}{2}$ the image (Left: Fig. 4). I then multiplied Fig. 1 by this and then took the inverse transform to get Fig. 5.

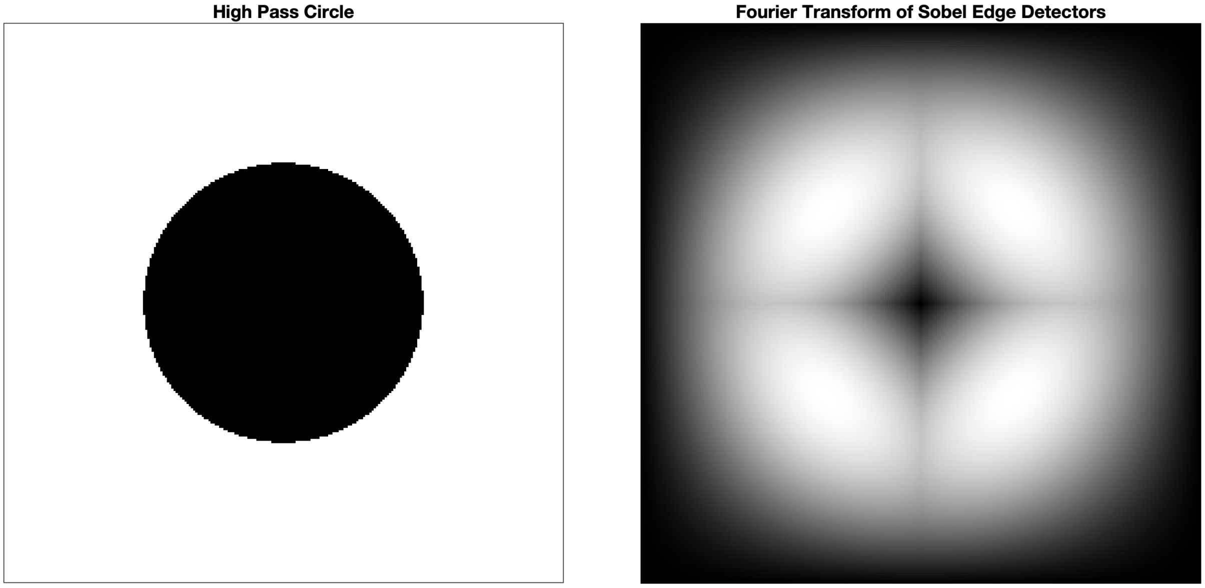

Figure 4: The ideal high pass filter and the added sobel filters. They do appear similar however with the sobel filter we still pass the DC resulting in more detail in the output image. The edges the sobel frequency aren't as abrupt as the ideal filter. This makes the the combine sobel filter appear more like a butter worth

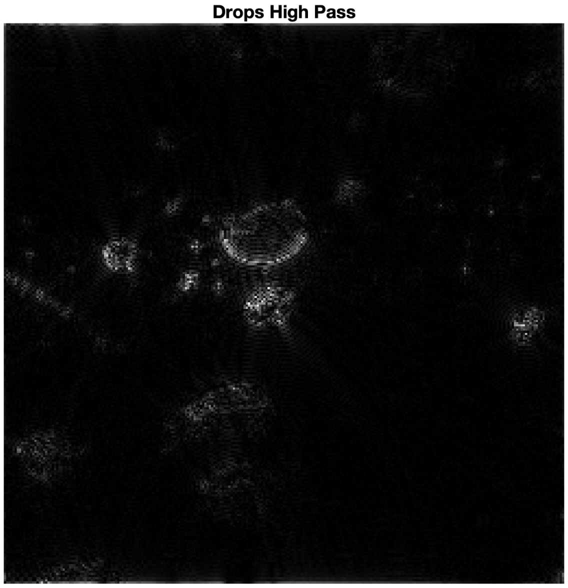

Figure 5: Resultant image after the idea high pass. Since the abrupt edge of the filter there is ringing present.

A MATLAB Code

This is the code used for the coding portions of this project.

```
%Housekeeping commands
clear all
close all

Drops=imread('Drops.jpeg'); %reading in image
Drops=im2gray(Drops); %converting to grayscale
FDrops=fft2(Drops); %proforming the Fourier transfrom
%Displaying the Freq response and shiting it
imagesc(log10(abs(fftshift(FDrops))))
colormap('gray') %use gray colormap
axis off image %axis opperations
title('Fourier Transform') %Title
exportgraphics(gcf,'FFTDrops.png','Resolution',300)% saving image

%Creating an array with 0 in the center that is the width of the image
x=-(length(Drops)-1)/2 :(length(Drops)-1)/2;

[X,Y]=meshgrid(x);% meshgrid to make 2 2d arrays to multiple

R=sqrt(X.^2 + Y.^2); %getting distance from the center point
%Finding there the disnace is less then 1/8 radius (1/4 diameter)
circlow=cast(R<length(Drops)/8,'double');

%Displaying mask
figure
imagesc(circlow)
colormap('gray')
axis off image
title('Low Pass Circle')
exportgraphics(gcf,'LowPassMask.png','Resolution',300)
%applying filter to FFT
FDropsLow=fftshift(FDrops).*circlow;
```

```
DropsLow=abs(ifft2(FDropsLow));% inverse Fourier transfrom
%displaying inverse Fourier transfrom
figure
imagesc(DropsLow)
colormap('gray')
axis off image
title('Drops Low Pass')
exportgraphics(gcf,'DropsLowPass.png','Resolution',300)

%creating unifrom filter
NormFilter=ones(3); %memory allocation
NormFilter=1/sum(NormFilter,'all').*NormFilter;%making normalization kernal

%padding array on all sides to fit image
PadNorm=padarray(NormFilter,[(length(Drops)-1)/2 (length(Drops) -1)/2],0);
FPadNorm=fft2(PadNorm);%Fourier transfrom
%displaing Fourier transfrom
figure
imagesc(abs(fftshift(FPadNorm)))
colormap('gray')
title('Fourier Transform of Uniform Filter')
colormap('gray')
axis off image
exportgraphics(gcf,'FUniform.png','Resolution',300)

%Finding values greater than 1/2 the width of the image (1/4 radius)
circhigh=cast(R>length(Drops)/4,'double');
%displaying Figure
figure
imagesc(circhigh)
colormap('gray')
%some werid stuff i had to do cause it was cropping on export
box on
set(gca,'xtick',[])
set(gca,'xticklabel',[])
set(gca,'ytick',[])
set(gca,'yticklabel',[])
axis image
title('High Pass Circle')
exportgraphics(gcf,'HighPassMask.png','Resolution',300)
%applying mask
FDropsHigh=fftshift(FDrops).*circhigh;

DropsHigh=abs(ifft2(FDropsHigh)); %inverse Fourier transfrom
figure
imagesc(DropsHigh)
colormap('gray')
axis off image
box on
title('Drops High Pass')
exportgraphics(gcf,'DropsHighPass.png','Resolution',300)

sobx=[1 0 -1;2 0 -2;1 0 -1]; %Creating Sobel opperator
PadSobx=padarray(sobx,[(length(Drops)-1)/2 (length(Drops)-1)/2],0);
FSobx=fft2(PadSobx); %Fourier transfrom
soby=sobx'; %Creating Sobel opperator
PadSoby=padarray(soby,[(length(Drops)-1)/2 (length(Drops)-1)/2],0);
FSoby=fft2(PadSoby);Fourier transfrom
figure
imagesc(abs(fftshift(FSoby))+abs(fftshift(FSobx)));% adding and dispalying
title('Fourier Transform of Sobel Edge Detectors')
colormap('gray')
axis off image
exportgraphics(gcf,'FSobel.png','Resolution',300)
```