

Assignment 3: CS 663, Fall 2021

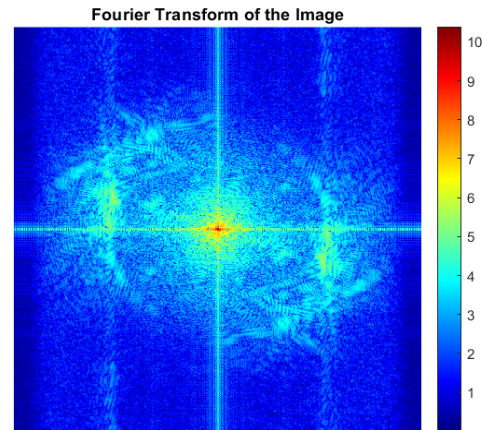
Question 2

- Consider the barbara256.png image from the homework folder. Implement the following in MATLAB: (a) an ideal low pass filter with cutoff frequency $D \in \{40, 80\}$, (b) a Gaussian low pass filter with $\sigma \in \{40, 80\}$. Show the effect of these on the image, and display all filtered images in your report. Display the frequency response (in log absolute Fourier format) of all filters in your report as well. Comment on the differences in the outputs. Also display the log absolute Fourier transform of the original and filtered images. Comment on the differences in the outputs. Make sure you perform appropriate zero-padding while doing the filtering! [20 points]

Answer: Note: All the displayed Fourier transforms of the images are in the log absolute format.



Barbara original image



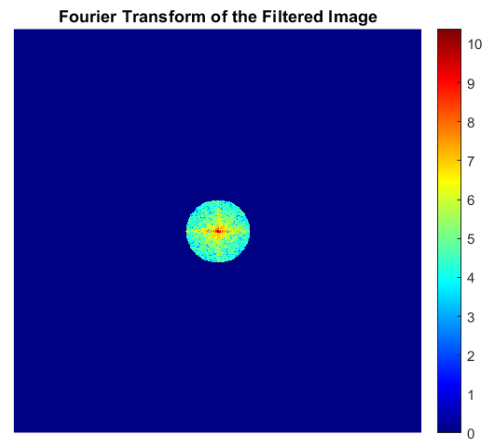
Barbara Fourier transform

- (a) An ideal low pass filter with cutoff frequency $D \in \{40, 80\}$
We show the results for cutoff frequencies 40, 60 and 80. The resulting images after ideal low pass filtering are as shown below:

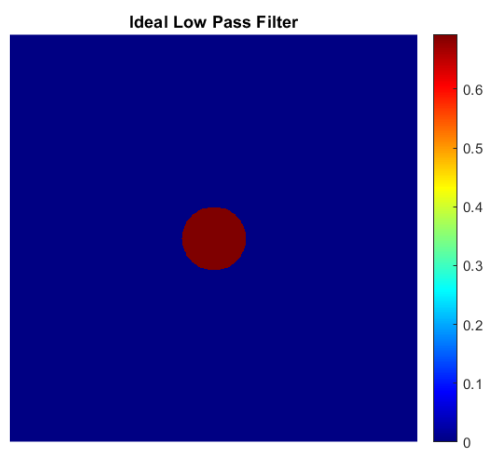
* Cutoff Frequency = 40



Filtered Image



Fourier transform of the Filtered Image

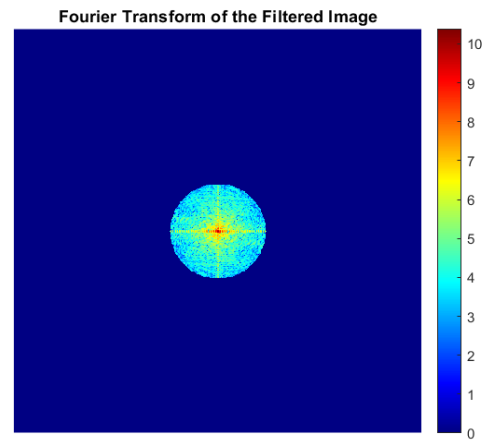


Frequency Response of ideal low pass filter

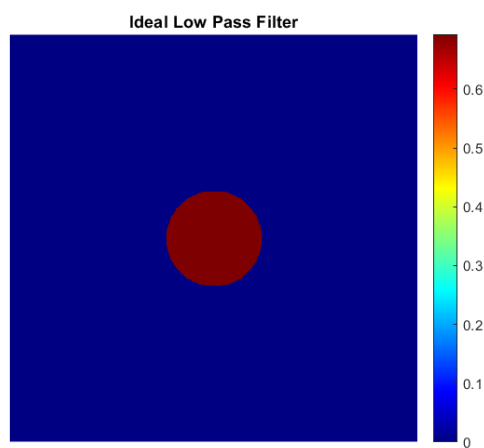
* Cutoff Frequency = 60



Filtered Image



Fourier transform of the Filtered Image

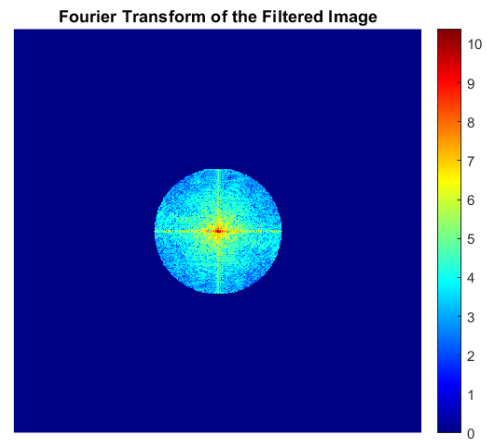


Frequency Response of ideal low pass filter

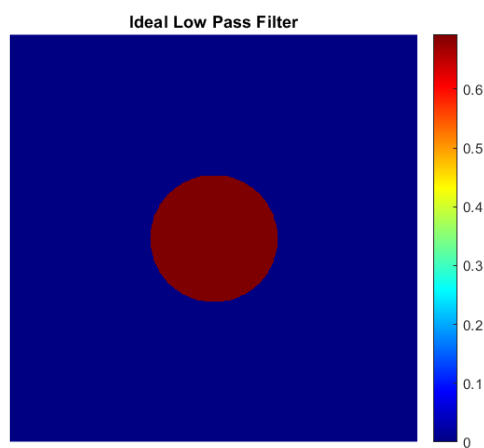
* Cutoff Frequency = 80



Filtered Image



Fourier transform of the Filtered Image



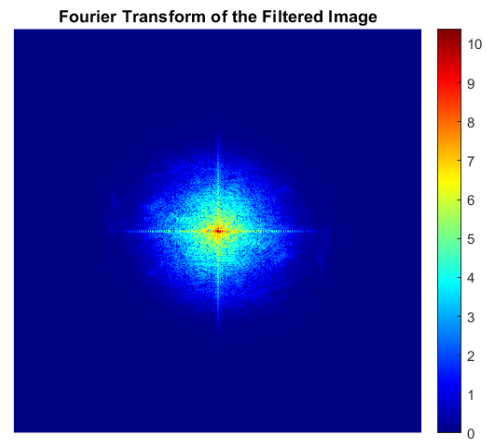
Frequency Response of ideal low pass filter

- (b) a Gaussian low pass filter with $\sigma \in \{40, 80\}$. We show the results for cutoff frequencies 40, 60 and 80. The resulting images after ideal low pass filtering are as shown below:

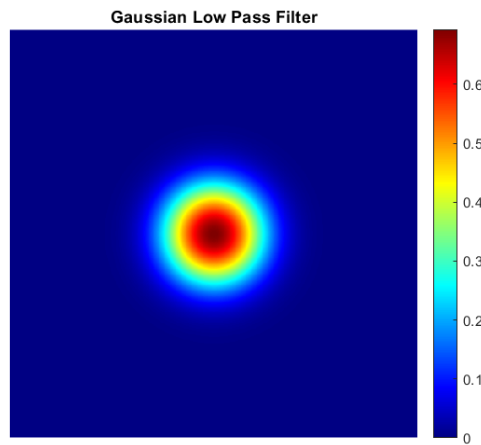
– Cutoff Frequency = 40



Filtered Image



Fourier transform of the Filtered Image

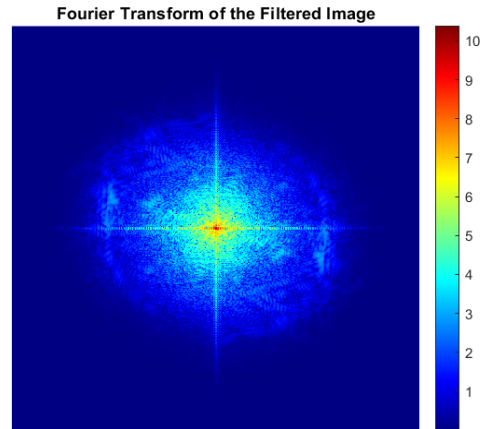


Frequency Response of ideal low pass filter

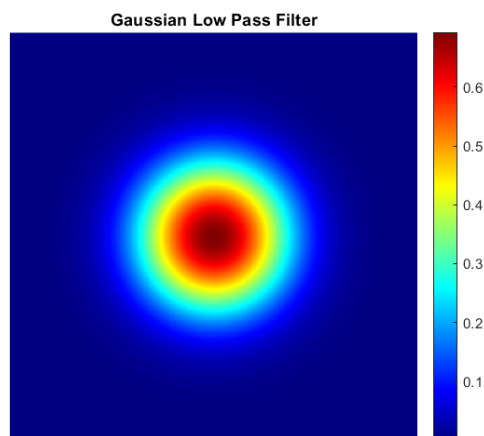
– Cutoff Frequency = 60



Filtered Image



Fourier transform of the Filtered Image

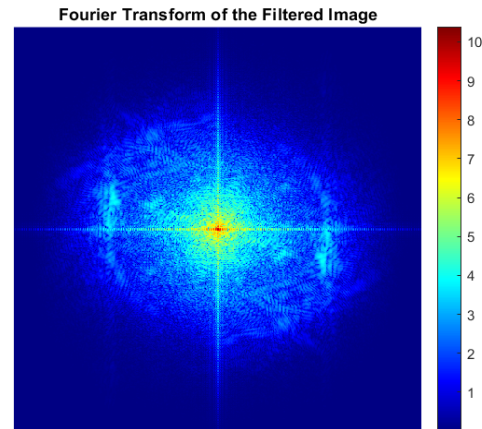


Frequency Response of ideal low pass filter

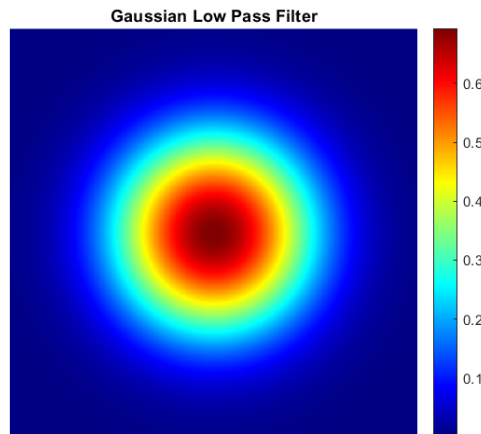
– Cutoff Frequency = 80



Filtered Image



Fourier transform of the Filtered Image



Frequency Response of ideal low pass filter

• Observations

- From the obtained results we can easily see that as the cut-off frequency (for ideal low pass filter) / sigma (for Gaussian low pass filter) is increased, the higher frequency components which correspond to finer details in the image start becoming clearly visible.
- Also we can see that for ideal low pass filter there is a presence of ringing artifacts that appear as spurious signals near sharp transitions in the images. These ringing artifacts are quite undesirable and are a result of the complete elimination of high frequencies higher than the cut-off frequency by the ideal low pass filter.
- When a Gaussian low pass filter is used these ringing artifacts are absent. This is because the Gaussian low pass filter does not completely eliminate the higher frequencies and rather weakens them.