COSE490 Digital Image Processing (Fall 2020)
Instructor: Prof. Won-Ki Jeong
Due date: Nov 8, 2020, 11:59 pm.

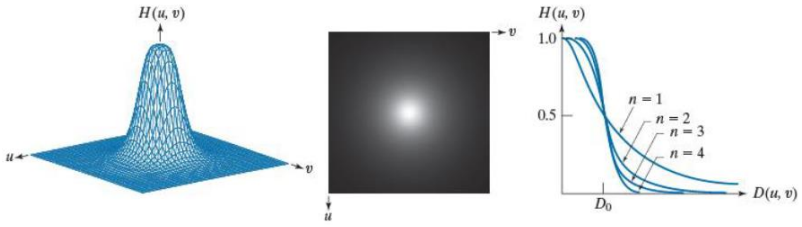
Assignment 2: Frequency domain filters (100 pts)

In this assignment, you will implement frequency domain filters as described below. Each my***.m includes the skeleton code for frequency domain filter (e.g., padding and cropping, shifting, Fourier transform). You only need to design and implement frequency filter marked as "ToDo" in `myLPF.m`, `myHBF.m`, and `myNotch.m`. You should implement each function on your own without using MATLAB-provided functions.

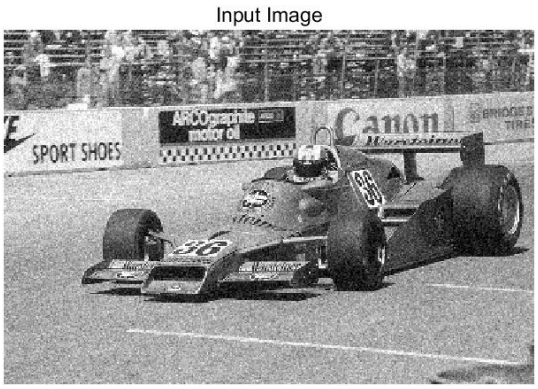
1. myLPF.m : Low-pass Filter (30 pts)

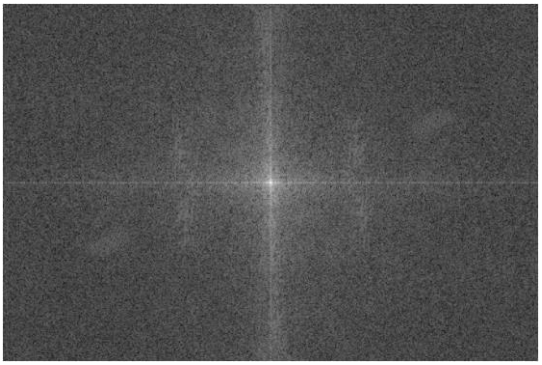
For the low-pass filter, you should implement Butterworth filter as follows:

$$H(u,v) = \frac{1}{1 + [D(u,v)/D_0]^{2n}}$$

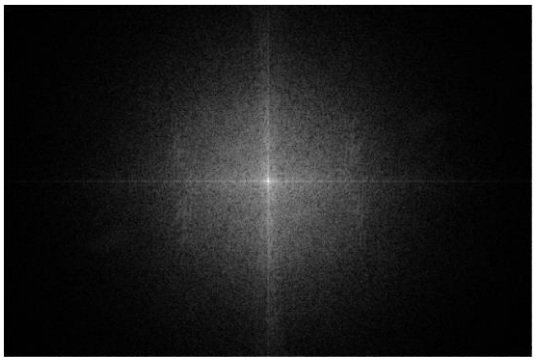


Input image and its Fourier spectrum





Result image using Butterworth frequency filter and its Fourier spectrum



Test with various cut-off frequency and degrees, and discuss the results.

2. myHBF().m : High-boost Filter (20 pts)

Once you implemented LPF, then High-boost filter can be implemented as follows:

$$g(x,y) = \Im^{-1}\left\{\left[1+k*\left[1-H_{LP}(u,v)\right]\right]F(u,v)\right\}$$
$$= \Im^{-1}\left\{\left[1+k*H_{HP}(u,v)\right]F(u,v)\right\}$$

Use the Butterworth filter you implemented above. Test with various parameters for cutoff frequency, degrees, and boosting weight (k).

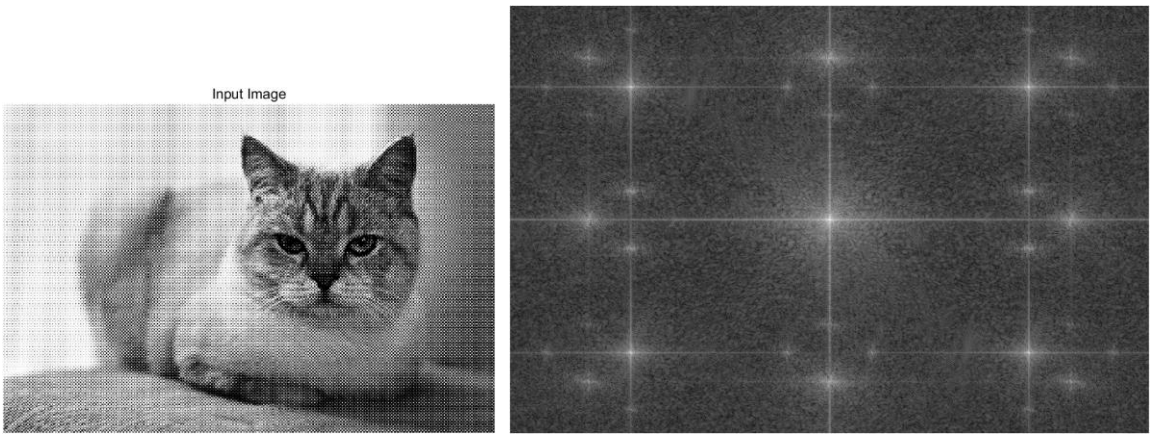
3. myNotch.m Notch filter (50 pts)

Notch filter can be used to remove periodic background noise. The given cat-halftone.png image also contains periodic artifacts caused by halftoning, which can be removed using a notch filter.

频域中亮点的位置

You should identify locations of bright spots in the frequency domain, and apply high-pass filter on each location using the low pass filter developed above:

$$H_{HP}(u,v) = 1 - H_{LP}(u,v)$$



Input image with periodic background artifact and its Fourier spectrum.

4. Submission

You need to write a short report explaining the results. Submit the report (pdf) along with `myLPF.m`, `myHBF.m`, and `my Notch.m` files via blackboard.

Good luck and have fun!