# ECE 457/557 Digital Image Processing
## Fall 2018
## Project #3
## Due Thursday 18 October 2018

## Filtering

You will explore filtering from both the spatial domain and the frequency domain perspectives.

1) Load the images `lena` and `crowd` from homework #1 into your workspace. Crop each to 256x256. Use these cropped images for the studies in this project. Also create an image with a 'perfect' circle with diameter 200 pixels on a background of 256 pixels. It should have a solid interior to use in the edge detection portion.

2) **Spatial Domain**:
   <u>Averaging filters</u>
   Explore averaging filters in the spatial domain. Try using
   - constant weighting filters of different dimensions (3x3, etc.),
   - weighted average filters of different dimensions and different standard deviations.

   Filter each image using each of these filters (`conv2` function).
   Compare how changes in the size of the filter and in the weight distribution affects your resulting image. Calculate the standard deviation of each weighted averaging filter.
   <u>Edge Detection Filters</u>
   You have seen several different edge detection filters (Sobel, Prewitt, Laplacian, plus a discussion in the text section 3.7 …). Create multiple edge detection filters and use these to filter your image and produce an image showing the edges. Be conscious of how you display the results! Describe the process you used and compare how the different filters affect your image.

3) **Frequency Domain**:
   Take the `lena` and `crowd` images and calculate and display the frequency spectrum for each. Create filters and apply each to the image. Convert the images back to the spatial domain (`fft2`, `fftshift`, `ifft2`, `meshgrid`, and multiplication with a "`.*`" should be of help).
   Try using:
   - ideal and non-ideal filters.
   - different categories of filters (LPF, HPF, BPF, SBF…)
   - different cut-off frequencies.

   Describe the images that are produced, how each filter and the cutoff frequency affects the image. Compare the filtering in the Frequency domain to filtering in the spatial domain. Be conscious of how you display the results!

Display your results in a well formatted report. Work on grammar and presentation, as these will contribute to your grade (the writing center is in the Liberal Arts building, room 200, and writing rules are in BlackBoard). Your grade will be significantly determined by the depth of your investigation, and the insight exhibited in your comments. This is expected to be greater for graduate students, although undergraduates should remember this is a 400 level course and there are no exams. Submit code you're your report through Blackboard.

<u>ECE 557</u>: These filters are spatially invariant filters. Another class of filters is adaptive filters. Either (1) Read some text book like sources and write a 1 page report giving an overview of what adaptive filters are, and how they work, or (2) find a journal or conference article that uses adaptive filters and summarize the article also explaining why an adaptive filter was needed instead of one of the filters explored in this project. Cite your sources. Prepare some PPT slides to present your results to the class.

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**Grading Rubric**

**Filtering**

_____     Investigation of constant weighting filters of different sizes

_____     Investigation of weighted average filters of different sizes. Standard

deviation calculated and reported

_____     Discussion of averaging filters

_____     Investigation of edge detection filters (Prewitt, Sobel, Laplacian,

Vertical, horizontal, diagonal)

_____     Correct display of edge detection output

_____     Discussion of edge detection filters

_____     Experiments with different categories of frequency domain filters.(LPF,

BPF, HPF)

_____     Experiments with different shaped filters (ideal vs. non-ideal)

_____     Experiments with different cutoff frequencies

_____     Discussion of frequency domain filtering

_____     Well formatted report (intro/body/conclusion, subsections, figures w/

labels)

_____     Good presentation (sentence structure, flow of thoughts, referencing of

figures and equations).

_____     Good grammar,

_____     Suitable depth of investigation

_____     Suitable insight exhibited in comments.

**ECE 557:**

_____     Adaptive Filters report & slides with proper citation.


_____     **Grade**