Due: Tuesday 14:00pm, Nov. 28, 2017

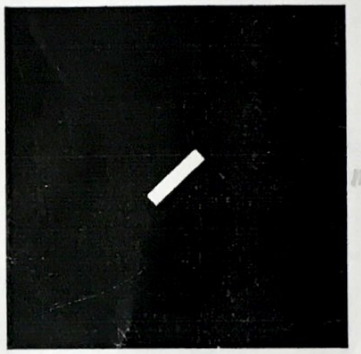
NOTE: For all of the homework in this course, do not use the problem-related OpenCV API (neither built-in nor library) to solve your problem.

NOTE: You **should** use **contrast enhancement** technique when showing your output in the report.

1. 2D-DFT (50%) (C/C++)

   (a) Write your own **DFT** subroutine (with origin shifted) and test on *blackwhite256.raw and blackwhite256_rotate.raw*. Show the output of both magnitude and phase spectra. Discuss the difference of each result image. (Figure, 10%; Discussion, 10%)

blackwhite256.raw

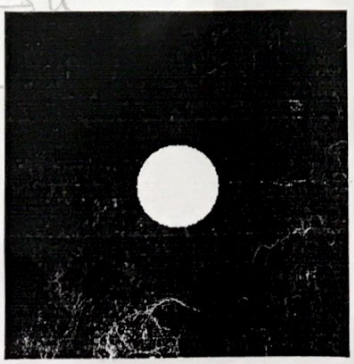


blackwhite256_rotate.raw

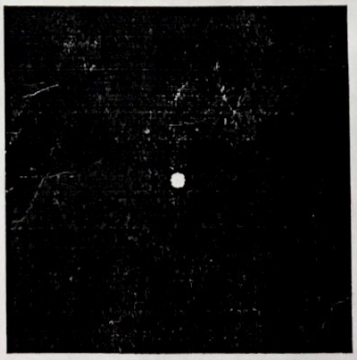
   (b) Write your own **IDFT** subroutine and test on DFT output from (a). Show the result images. (Figure, 5%)

   (c) Compare the output from (a) with the output using OpenCV built-in **DFT** function. Discuss the difference in execution time and result images. Explain the difference between each other. (Figure, 10%; Discussion, 5%)

   (d) Perform **IDFT** (either using your own **IDFT** or OpenCV built-in **IDFT** function) on both *circle256_1 raw and circle256_2.raw* respectively. Show the output images. Discuss your observation between two output images. Explain it. (Figure, 5%; Discussion, 5%)



circle256_1.raw



circle256_2.raw

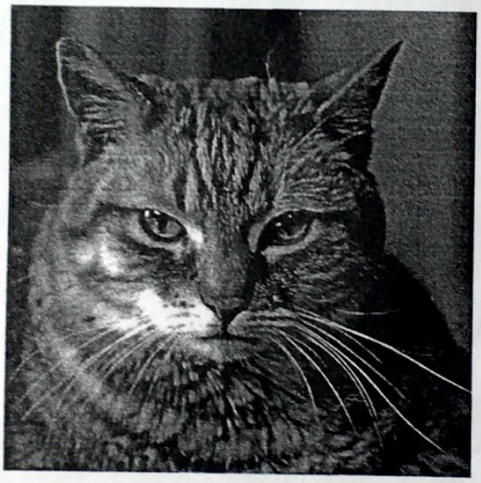
2. Filter in Frequency domain (50%)

Note: OpenCV built-in **DFT** and **IDFT** functions are allowed in this problem.

(a) Using **ideal LPF** and **ideal HPF** with $D_0 = 3, 15, 50$ respectively to filter *cat512.raw* in frequency domain. Show the result of magnitude spectra, and the output images by IDFT. Discuss the visual difference between each result image. (Figure 10%; Discussion 10%)

(b) Using **Gaussian LPF** and **Gaussian HPF** with $D_0 = 3, 15, 50$ respectively to filter *cat512.raw* in frequency domain. Show the result of magnitude spectra, and the output images by IDFT. Discuss the visual difference between each result image. Compare and discuss the results with (a). (Figure 10%; Discussion 10%)

(c) Using **Butterworth LPF** and **Butterworth HPF** with, $D_0 = 3, 15, 50$ where $n = 1,2,4$ to filter *cat512.raw* in frequency domain. Show the result of magnitude spectra, and the output images by IDFT. Discuss the visual difference between each result image, and also compare with the results of (a) & (b).
(Figure 5%; Discussion 5%)



Cat512.raw