The Catholic University of America

ENGR-652: Digital Image Processing- Due OCT 17-2014

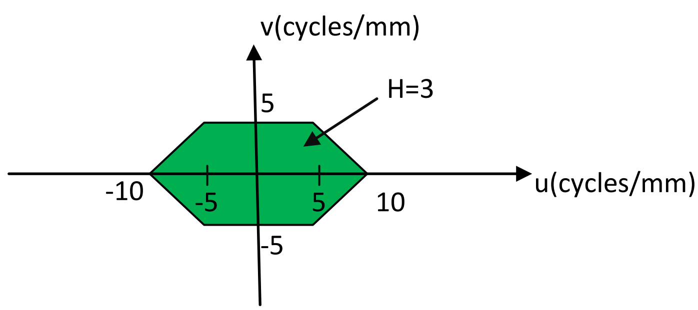
Assignment 4:

1. A Cohu 4910 visible-wavelength charge-coupled-device (CCD) camera has a focal plane array of size 6.4mm (H) x 4.8mm (V) with 768 (H) x 494 (V) pixels, respectively.
    - Determine the sampling rate of the camera in the horizontal and vertical directions.
    - Determine the smallest diffraction limited *f#* optics that can be used to guarantee no aliasing for an arbitrary scene (assume a circular exit pupil).

    Recall that *f#* =focal length divided by aperture. A small *f#* generally yields a nice wide field of view. But with that wide field of view comes a price (you need a dense array to sample that wide field of view, which is projected onto the focal plane, at the Nyquist rate).

2. An image $f(x,y) = 4\cos(4\pi x)\cos(6\pi y)$ is sampled with $\Delta x = \Delta y = 0.5$ and separately with $\Delta x = \Delta y = 0.2$. The reconstruction is done with an ideal reconstruction filter in each case. What is the expression for each of the two reconstructed images? You can write the code in matlab to verify your results.

3. For a continuous image with the continuous-space Fourier transform, $F(u,v)$ shown below, accurately sketch $F_s(u,v)$ (cyc/mm), $F(f_1,f_2)$ (cycles/sample), and $F(\omega_1,\omega_2)$(radians/sample). Assume the signal was sampled at the Nyquist rate.



4. An image with 10 stripes per meter is viewed from a distance of 10 meters, what is the fundamental frequency of the pattern in (cycles/degree) and in (cycles/rad).

5. A set of samples is obtained ideally (no blur, no aliasing) with a sampling rate $\Delta x = \Delta y = 0.5$. The discrete-space Fourier transform is computed from those samples at one point and we find that

$$F(\omega_1,\omega_2)\Big|_{\omega_1=\omega_2=\pi/4} = 5.$$

    What can we say about the original signal's continuous-space Fourier transform, $F(u,v)$?