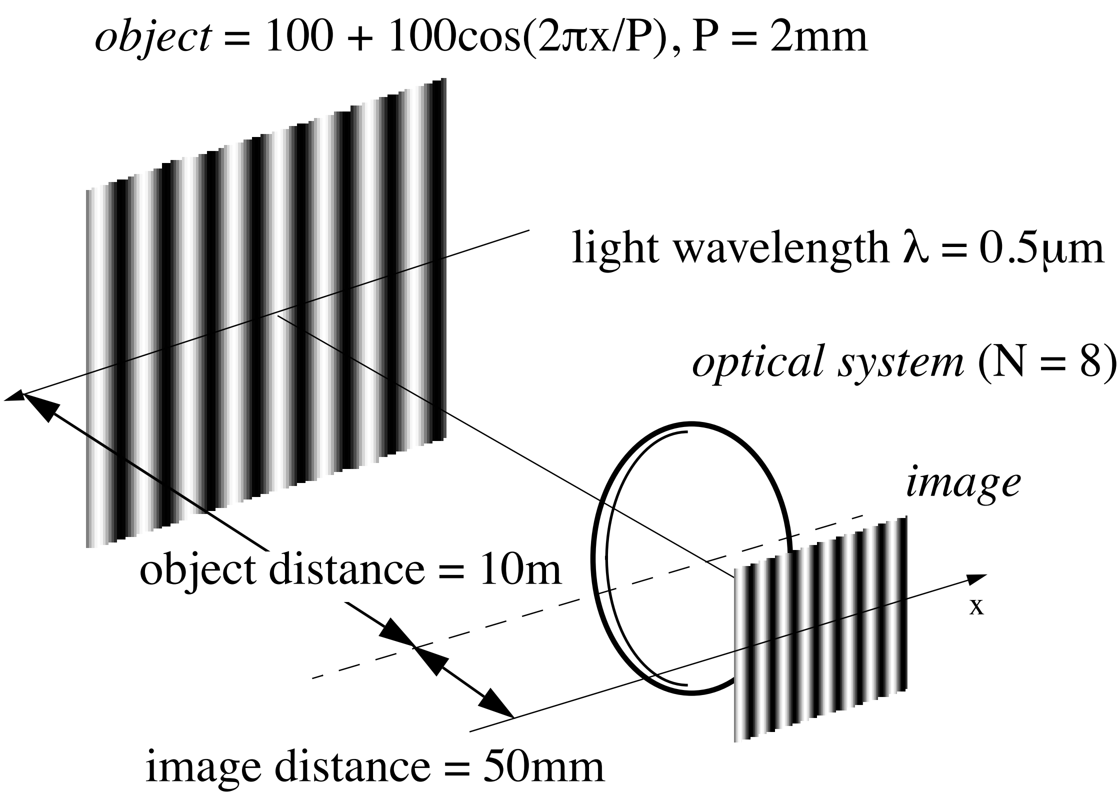
ECE/OPTI 533 Digital Image Processing Spring Semester, 2003

Homework 2

Due **in-class, February 6, 2003**

1. A 2-D target is imaged by a camera, with the following specifications:



The optical system is diffraction-limited with a circular aperture.

Assuming the lens is a linear system in light intensity, find the modulation of the image (assume infinte extent for both the object and image). (50%)

magnification m = 50mm/10m = 0.005

period of pattern (image space) = m*P = 0.005*2mm = 0.01mm

frequency of pattern (image space) = 1/0.01 = 100cy-mm^{-1}

cutoff frequency of optics (image space) = 1/λN = 1/0.5*8 = 250cy-mm^{-1}

$$\text{MTF}(100/250) = \frac{2}{\pi}\left[\text{acos}\left(\frac{100}{250}\right) - \frac{100}{250}\sqrt{1-\frac{100}{250}^2}\right] = 0.505$$

modulation (image) = MTF(100/250)*modulation (object) = 0.505

2.Suppose the image in problem 1 is scanned in the x-direction with a square detector, width = 7μm. What is the modulation of the output signal? Assume continuous, instantaneous scanning, with no sampling or electronic filtering of the signal. (30%)

modulation (scanned image) = MTF(detector)*modulation (image)
$= |\text{sinc}(100*0.007| * 0.505 = 0.186$

3. What is the maximum detector size for scanning in problem 2 that would preserve at least 80% of the input image modulation? (20%)

MTF (detector) $= |\text{sinc}(100w)| = |\sin(\pi 100w)/(\pi 100w)| > 0.8 \Rightarrow w = 0.0036\text{mm} = 3.6\mu\text{m}$