OPTI 435/535 Homework #3 Due: October 3, 2011 Before Class

Undergrads do problems 1 through 3
Grads do all four problems

1. The mean wavefront error over a normalized pupil is given by

$$\overline{W} = \frac{1}{\pi}\int_0^{2\pi}\int_0^1 W(\rho,\theta)\rho d\rho d\theta$$

and the wavefront variance is given by

$$\sigma_W^2 = \frac{1}{\pi}\int_0^{2\pi}\int_0^1 \left(W(\rho,\theta) - \overline{W}\right)^2 \rho d\rho d\theta$$

where $W(\rho,\theta)$ is the wavefront error. For the following wavefront, show that the wavefront variance is just the sum of the squares of the Zernike expansion coefficients a_{nm}.

$$W(\rho,\theta) = a_{2,2}Z_2^2(\rho,\theta) + a_{3,1}Z_3^1(\rho,\theta)$$

2. The spot pattern from a Shack Hartmann wavefront sensor contracts with myopia. Suppose we have a lenslet array with lenslet spacing of 100 microns and our sensor can accurately separate spots that are spaced by 10 microns. What is the required focal length of the lenslets, if we wish to be able to measure up to 10 diopters of myopia?

3. A wavefront of the form $W = -0.002x^2$ is measured with a Shack Hartmann sensor for a 4 mm diameter pupil. Suppose the lenslets of the array have a focal length of 24 mm and a spacing of 1 mm.

   (a) What does the *unaberrated* Shack Hartmann pattern look like?
   (b) What are the focal spot shifts Δx and Δy for each spot?
   (c) What does the Shack Hartmann pattern look like for the wavefront W?

*********************************Grads Only**********************************

4. Write the wavefront from Problem 3 in terms of Zernike polynomials.