Project Ideas

Here are some possible project ideas. You are encouraged to develop your own ideas, based on your interests or on topics related to your research. Feel free to discuss your ideas with me.

1. Design a two–mirror scanner to be used in a laser–radar beam prior to a beam–expanding telescope. Assume that the laser radar will be used to visualize and identify vehicles at a distance of 1 kilometer. Specifically determine the scanner angles and locations and the intervening optics to provide the desired coverage.

2. Design a telescope for a focused laser radar, assuming a 30–cm aperture parabolic primary. Use a moving secondary lens to obtain focal distances that vary linearly from 15 meters to infinity. Evaluate the effect of spherical aberration on beam size as the focus is changed from maximum to minimum.

3. Analyze the effect of polarization on imaging in a high–NA focusing term. Specifically, start with the Maltese cross analysis in Chapter 6, and use Fourier transforms to determine the effect in the image plane. Consider an imaging problem that involves, for example, looking at birefringent biological material such as collagen, with a detection polarizer crossed with respect to the polarization of the incident light.

4. Design an all–optical peep–hole for an apartment door. Assume that the door must be at least 1 inch thick, the field of view must be sufficient to identify a visitor outside the door, and the pupil must provide sufficient eye relief.

5. Design a Littrow grating that will allow a dye laser to be tuned continuously from 450 to 650 nm. Specifically pick the grating pitch, blaze angle, and diameter. Design an appropriate curved output coupler. You may choose your beam parameters. Analyze the efficiency as a function of wavelength for different angles. In reality, several different dyes would be requred for such a laser; a single dye does not have gain over this bandwidth.

6. Model the aberrations we discussed in Chapter 5 using Fourier analysis between the pupil and image planes. In some cases you will want to consider different field positions.

7. Explore the use of infrared sensors around wavelengths of 5 and/or 10 micrometers for detecting plumes of gas using their spectral absorption and emission. This draws extensively on material from Chapter 12, and is rather ambitious unless you have some experience in the field.

8. Investigate different specifications of color, such as the C. I. E. (xyz) and color television (RGB) standards. Examine the transformations among the standards, and identify the important features of each, and why they are important; non–negativity, releationship to vision, ability to be produced, etc. Consider different graphical representations of the standards you choose and of the transformations among them. Develop a computer program which will accept a spectrum as input, and produce the three RGB values between 0 and 255 as output, to drive a color monitor.

9. Look through the literature to determine the principles behind the operation of Ballotini, the glass beads that are used in reflective paint. Construct a model that will predict the brightness of reflected light as seen by a driver.