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

2. Design an optical cloaking system and explore the fundamental limits on field of view and angle.

3. Read the literature on focusing by small high–index spheres, and construct a simple ray–tracing program to determine their imaging behavior.

4. Design a schlieren imaging system with a field of view of 1cm, using an LED source. Determine the expected signal from a camera, and the minimum gradient OPL that can be measured.

5. Consider the absorption of light in a Gaussian beam by a glass window, using available data on the complex index of refraction. Determine the increase in temperature of the glass with time, the resulting change in thickness and index of refraction, and the effect on image quality.

6. 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.

7. When a short pulse of light passes through glass, the pulse length is increased because of dispersion in the index of refraction across the bandwidth of the pulse. Compute the increased length of the pulse for at least two different types of glass; one crown and one flint. Design a "pre–chirp" system using gratings that will compensate for this broadening. You will find quite a bit of information on this in the literature.

8. 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.

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.