Hyper Spectral Imaging - Homework 1

May 27, 2015

Problem 1. - Basic Geometric Optics

Valparaso is the seaport located about 110 Km ($\approx$ 70 miles) northwest of Santiago. One of the beauties of the city is colorful houses (as seen in Figure 1).

Figure 1: Valparaiso - Chile

Assume that we want to take a similar picture of the view ($\approx 100m \times 75m$) with a CCD camera (1280×960 pixels - $Area_{pixel} = 10\mu m \times 10\mu m$).

a) what is the magnification of the imaging system?

b) If you want to use a thin lens with $f = 20mm$, find the distance between the image (the CCD) and the lens? What is the distance to the object (landscape)? What do you think about these results?

c) What is the smallest resolvable distance on the image?

Now assume that we want to zoom in optically so that we can get the picture of the pink building.

d) Based on your solution to parts a-c, estimate the size of the building. (You may need to do a little bit process in Matlab, but you don't need to be accurate)

e) What is the magnification of the system to take the picture of the pink building?

f) Repeat part "b" for taking the new picture.

g) Repeat part "c" for the new picture.

Problem 2. - Matlab & Reading assignment

Save the pskypeicture of Valparaiso (it is also uploaded on the website and attached to the email) on the current folder of Matlab. Use function *imread* to load the data from the image to a matrix in Matlab (You can type in "help imread" in Matlab, to read about the function).

a) What is the size of the matrix? Based on the size, what do you think this matrix contains? You can test this on single color images to give you a better understanding.

b) Read about *"Bayer filter"*. Now imagine that the image is the field of view we want to take a picture with Bayer filter applied to it. Reconstruct the image in Matlab.

Problem 3. - Refraction from a prism

Assume that we shine white light (shown yellow in the figure!) to a prism as shown in Figure 2. The material of the prism is *"Barium dense flint glass"*. You can find index of refraction of the material for different wavelengths in website: *http://refractiveindex.info*. We have a detector

located at a distance d to the detector. There is a pinhole in front of the detector that allows the light pass to the detector from a specific angle and will reject light coming from other angles.

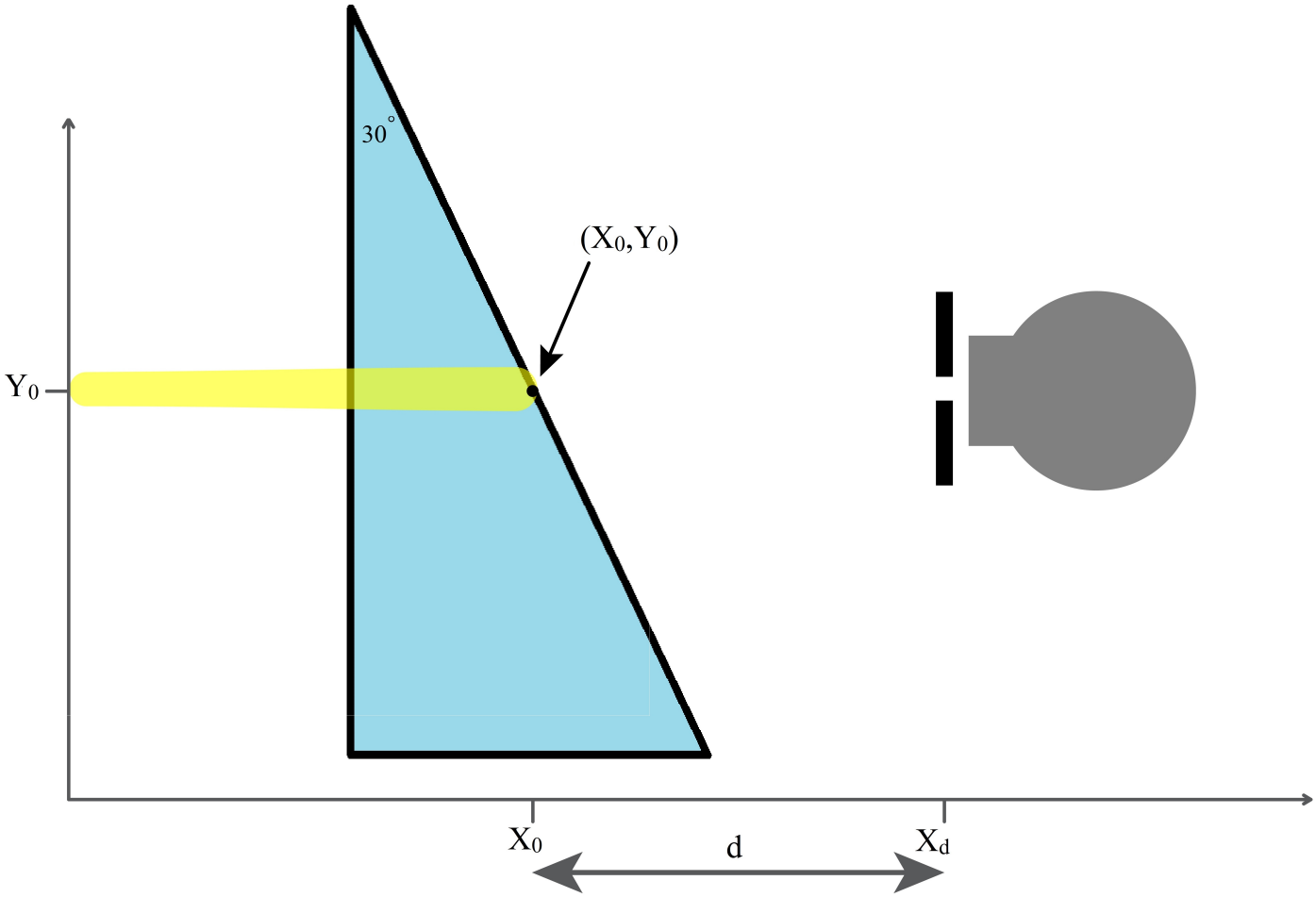

Figure 2: Problem 3, Light goes through a prism with index of refraction $n_p = 1.5$ and the detector is placed at a distance d to the prism.

a) What happens to the light coming out of the prism?

b) Where should we put the detector to detect red light?

c) Where should we put the detector to detect blue light?

d) What is going to happen if we start scanning the detector in y direction? (Moving the detector step by step in the y direction and record the output of the detector)