

ENSC 376 Lab 1

V1.2(Feb. 27, 2008)

Introduction:

Lab 1 is designed to give students basic experience in optics and to see how a zoom lens works. In the lab you will set up lenses on an optical table, with a screen pattern as the object, and a digital camera system to take the images. Then you will use the images to calculate magnification, orientation, and aberrations in the system. There are two parts, first a single lens, and then a combination of positive and negative lenses.

1 Single Lens

In this experiment you will start by mounting a lens in a lens holder, and a post, and place this in an optical mount on a positing rail. You also place the object screen on a post centered on the axis of the lens (ie same elevation). The lens you will use is a $f=+5$ cm convex lens. Make certain to align the lens so its optic axis is along the optical rail, and is centered on the axis of the camera. The camera will be stationary so do all measurements relative to the camera position (note the sensor is located behind the front of the camera. Please see attached appendix for using the camera software.

Starting with the object screen about 8 cm from the lens image find set the lens/object so the image is focused at the camera. Suggest that you calculate the distances then make the adjustments yourself. Before putting the camera in place use a card to view the image and check the location. Then move the object to about 10 cm, 12 cm and 14 cm from the lens, also taking pictures. Measure the object and image distances (object to lens distance do not need to be exact numbers, as long as both object and image distances are accurately measured). Suggest you use the formulas to estimate the locations when doing this. Remember to adjust all distances so the image is in focus at the centre of the camera.

2 Zoom Lens

In this experiment we use a two lens system with $f_1=+5$ cm and $f_2 = -10$ cm. Start with object 10cm from the positive lens, and the convex lens 9 cm from the positive lens. Again image the object the camera (use a card to establish the focus distance before setting up the camera, lens combination. Now change the spacing between the positive and negative lenses from 9 cm in 1cm increments down to 3 cm. Again use approximate distances for setup but measure the exact distance you use.

Analysis

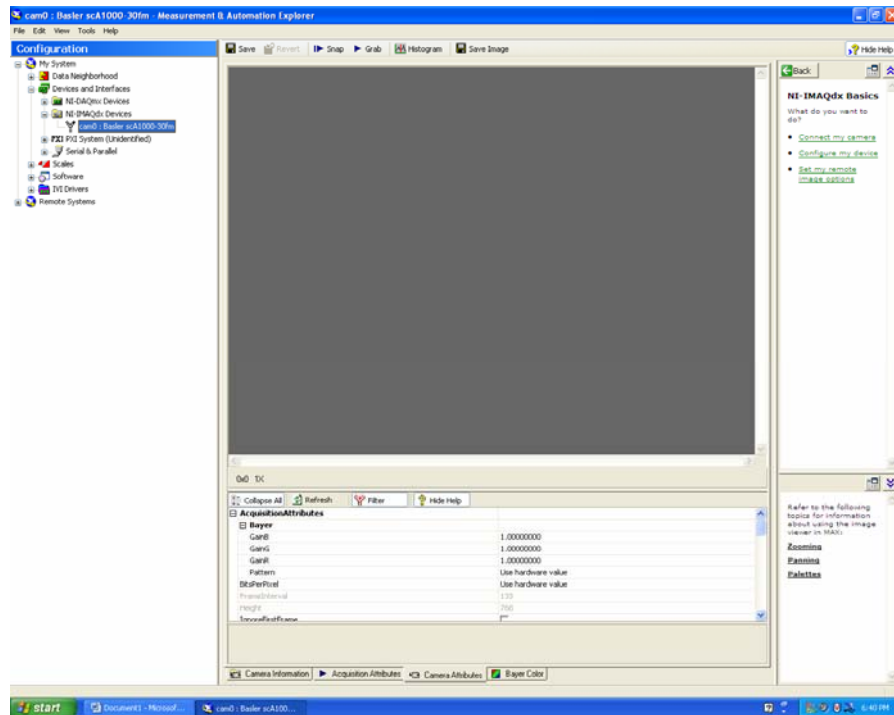
In both systems and for all positions:

- (1) Compare the object, image distance with what you expect from the calculations (for the zoom lens section use the matrix method for calculations).
- (2) From the captured image calculate the image magnification and orientation
- (3) Check the images for aberrations. For example compare the spacing of the lines horizontally and vertically at the center of the image, at the top and bottom, and at the diagonal corners. What is the focus like at the corners.

ENSC 376 Lab 1 – Appendix 1

Snapshot Capture Software Instructions

1. Power up the PC computer and select Windows XP Professional on start-up.
2. Login using with the user name **ensc376**, password **glenn**
3. Once finished booting, double-click the National Instruments “Measurement & Automation” shortcut on the desktop.
4. Expand and select Devices and Interfaces → NI-IMAQdx Devices → cam0 : Basler scA1000-30fm.
5. The main window should display an interface for controlling the CCD camera attached to the computer.



At the bottom of the interface there are tabs for adjusting the properties of the image acquisition and camera. These settings include the video mode and frame rate, as well as the brightness and exposure of the image. At the top from left to right are the following functions:

Save: saves the current settings of the camera

Restore: loads previously saved settings

Snap: Take a single image with the camera.

Grab: Start or stop taking continuous images

Histogram: Displays the color distribution for the current image

Save Image: saves a snapshot of the current image to a file

Right-clicking the image gives you options for changing the information that is displayed and gives options for switching between the pan and zoom functions. When zooming, simply click on the image to zoom in and hold the shift key while clicking to zoom out. When panning, simply click and drag the image to the desired position.

6. To close the program, simply close the window and select **No** when it asks if you wish to save the camera's settings. Remember to also shutdown the computer once you are done.