AN020

Calibration of Spatial Light Modulators

Author: Kavita Chand and Justin Mansell
Revision: 10/05/10

A calibration of Spatial Light Modulator (SLM) is an experimental determination of the relationship between the grey levels of the entrance signal and the resulting phase change appearing in every pixel of the device. The wavefront compensation application requires that the devices have a linear phase response. Because the SLM devices do not have a linear phase response using gray values that linearly increase from 0 to 255 (for an 8 bitsystem), the device must be calibrated.

We are presenting the data for calibration of a Boulder Nonlinear Systems (BNS) liquid crystal spatial light modulator (LC SLM). The square array of LC phase modulators has 512 pixels on a side with 15µm pitch. Using a Michelson interferometer as shown in Figure 1, the image of the LC was placed onto a camera using a singlet imaging lens. As the X, Y, or XY tilt is added multiple fringes across the aperture can be seen and an image of the fringe pattern created by the SLM is captured using a frame grabber. The top half of the LC was not modulated, but the lower half was given a piston phase shift by writing a fixed grey scale value to all the pixels. Thus the unmodulated top halves of the image acts as the reference, and have an incrementing grayscale value on the bottom half of the image. Figure 2a shows a typical image with a phase shift applied. The piston phase shift causes the fringes in the lower half to move relative to the upper half. The amount of motion is directly proportional to the phase shift. The intensity ratio above and below the LC SLM is also related to the phase shift.

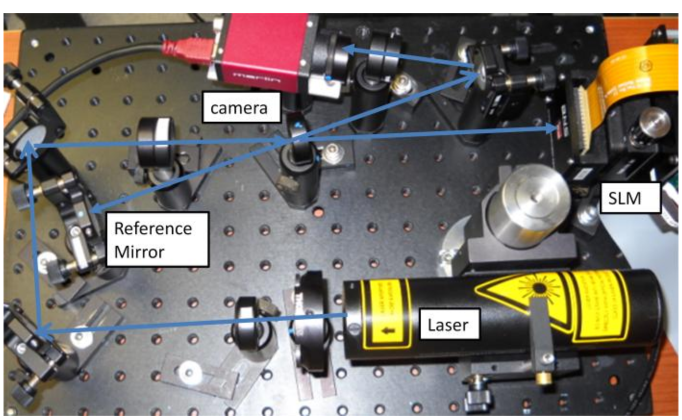
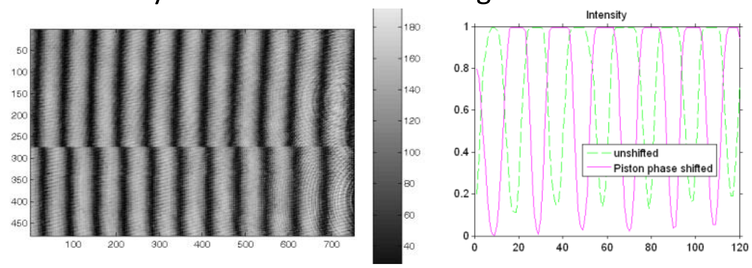


Figure 1 - Lab setup of Michelson Interferometer

The calibration was done using the intensity on the CCD directly above and below the phase shift. Five lines of the CCD above and below the phase discontinuity were averaged to minimize noise effects and establish an intensity cross section shown in Figure 2b.



(a) (b)

Figure 2- (a) Piston Phase shifted Intensity on SLM and (b) example measurement of the fringes for a given DAC voltage

Now these averaged intensities were Fourier transformed and the phase (ϕ_1), corresponding to the frequency for the maximum intensity of the unmodulated fringe pattern was calculated after filtering out the dc terms. At this frequency, the corresponding phase at the lower half with the phase shift was calculated (ϕ_2). The differences of these phases were plotted with the counts. The phase shift ($\Delta\phi$) is given by

$$\Delta\phi = \phi_2 - \phi_1$$

This phase shift was plotted with the counts (Figure 3).

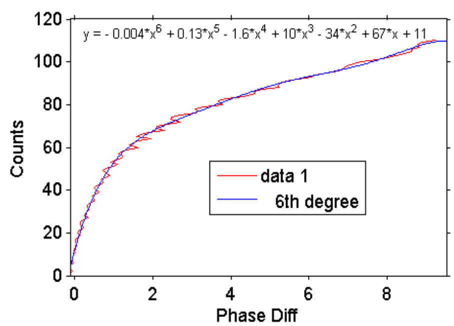


Figure 3- Measured Relationship between phase shift and DAC output

To test the SLM calibration, Kolmogorov spectrum turbulence phase screens were placed on the SLM. The output of the interferometer was recorded and compared with a modeled interferogram to verify calibration. The theoretical and the measured phase screens were nearly identical.

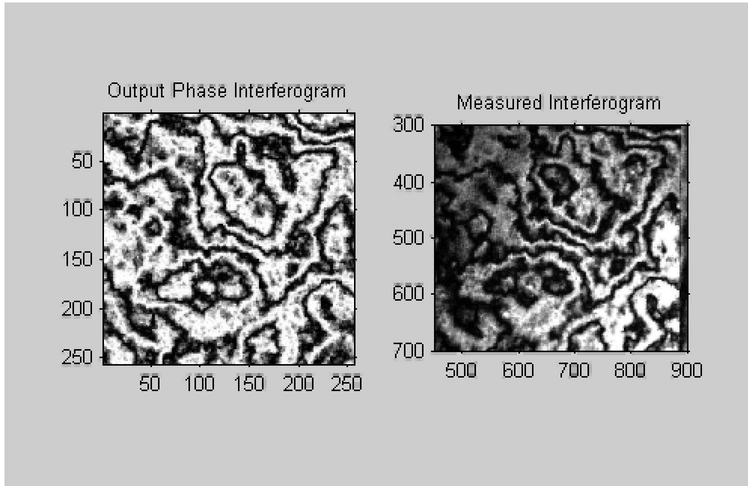


Figure 4- Phase Screens on SLM (a) modeled and (b) measured