[SLM01] Pixelated Structure of SLM

1.Objectives：

To investigate how the basic structure of the SLM affects the behaviors of the light such as diffraction.

2. Introduction：

An SLM can be used to modulate the amplitude and phase of light. Its internal structure is similar to an ordinary LCD (liquid crystal display), which is a matrix structure consisting of many grid-like pixels. When voltage is applied, the liquid crystal in each pixel will deflect at a different angle according to the magnitude of the voltage, thereby producing a different refractive index and achieving the effect of modulation. The basic structure of an SLM, even without being given an electrical signal, can affect the behaviors of light, including its maximum diffraction angle, diffraction efficiency, and the polarization state. By using these characteristics, we can verifiy the SLM's various basic parameters, such as its pixel size, aperture ratio, and alignment angle.

If d represents SLM pixel size, m represents diffraction order of reflected light. Grating Equation is

$$d\sin\theta_m=m\lambda \quad (1)$$

Under the condition of paraxial approximation, the diffraction angle will increase proportionally. Thus, using the above equation, we can calculate the pixel period d by, first, measuring the diffraction angle, then, substituting it with the wavelength of the light. Under the condition of a fixed wavelength, a larger diffraction angle requires a smaller pixel period. This is why SLMs need to be made smaller with their dimensions made closer to the wavelength of the light.

3. Materials：

Laser、Mirror、Spatial filter、Lens、Beam splitter、Spatial Light Modulator (SLM)、Target、Polarizer、Screen.

4. Procedure：

(1) Calibration

1. Setup instruments as shown in Figure 1. Make sure that the light emitted by the laser runs parallel to the surface of the table. Also make sure that the light beam passes through the center of each component and it enters each component perpendicularly.
2. Place the block between the mirror and the beam splitter.
2. Place the cross target in front of the screen.
3. Adjust 2 screws behind SLM until the dark cross is in the center of the rectangle as shown in Figure 2.

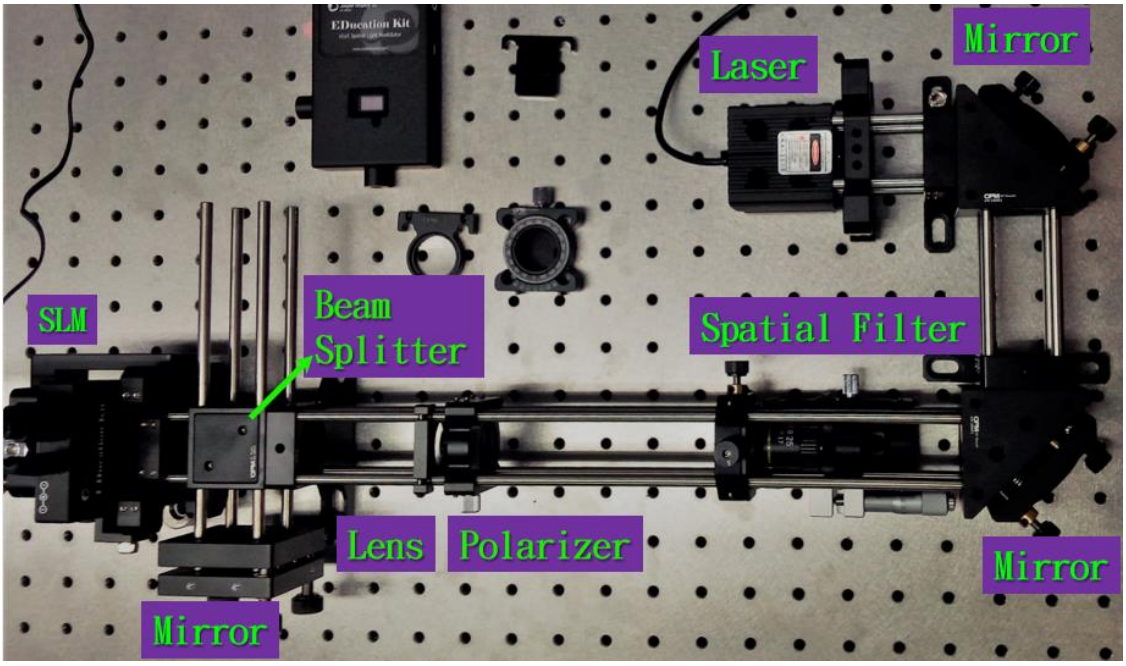

Figure 1

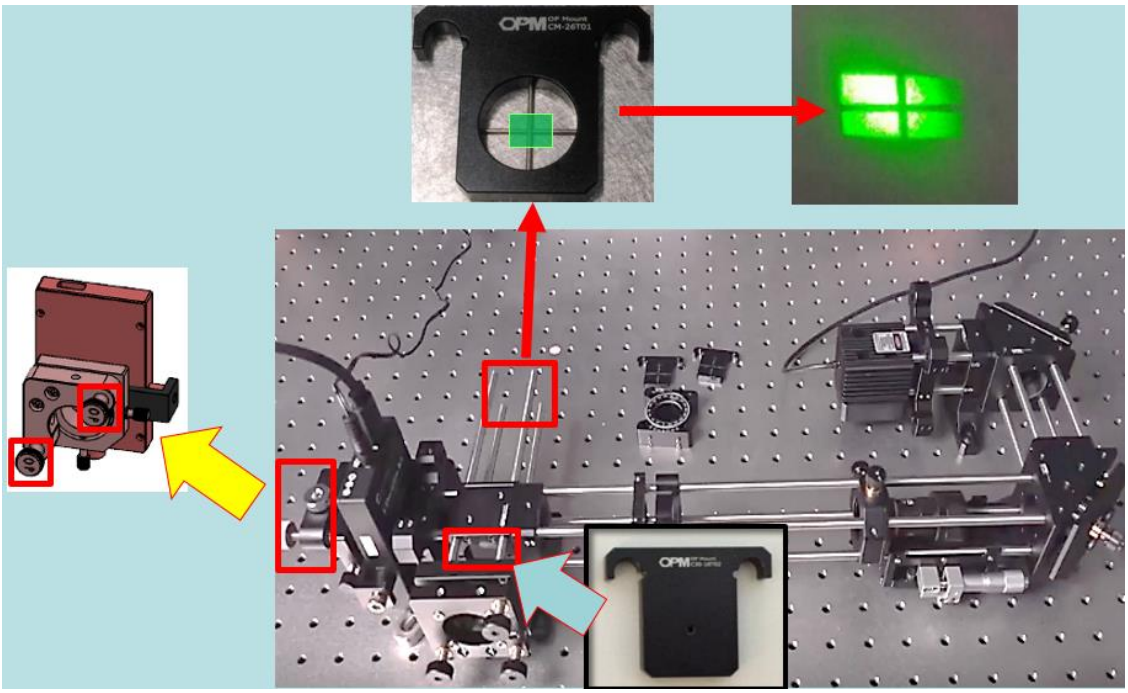

Figure 2

(2) Setup

1. Remove the cross target and install the analyzer as shown in Figure 3.

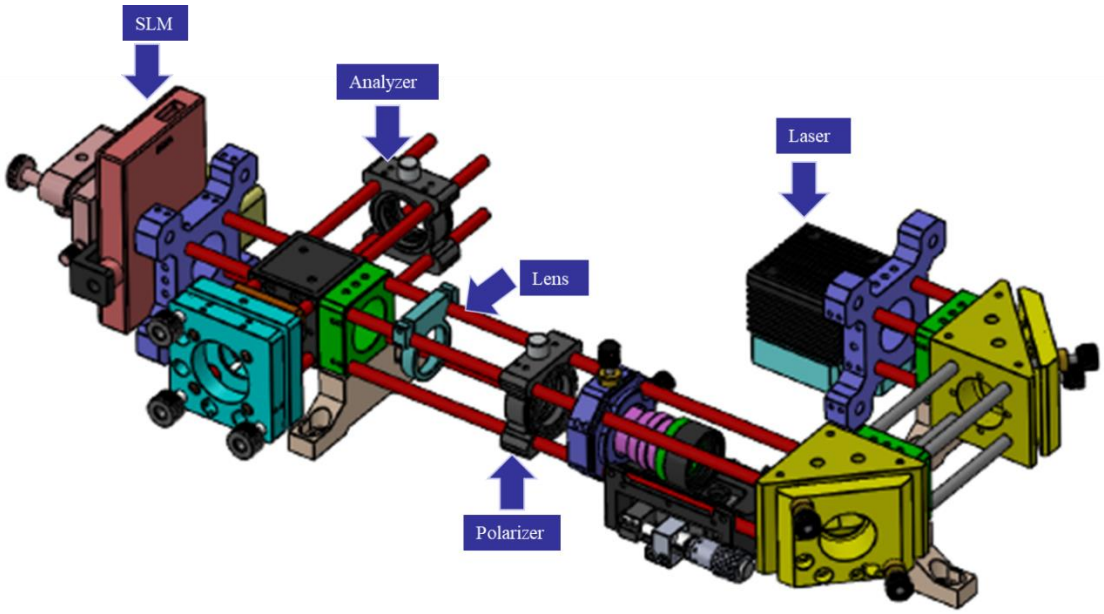

Figure 3

2. Open the EDK software. Select 1 for the Monitor Index in the upper right corner. Select experiment to 2. Amplitude Modulation. Select the Image Input tab, then select the file to import, and press the Generate button, you can see the result shown in Figure 4. Then press the Send to

LCOS button to transfer the image to the SLM.

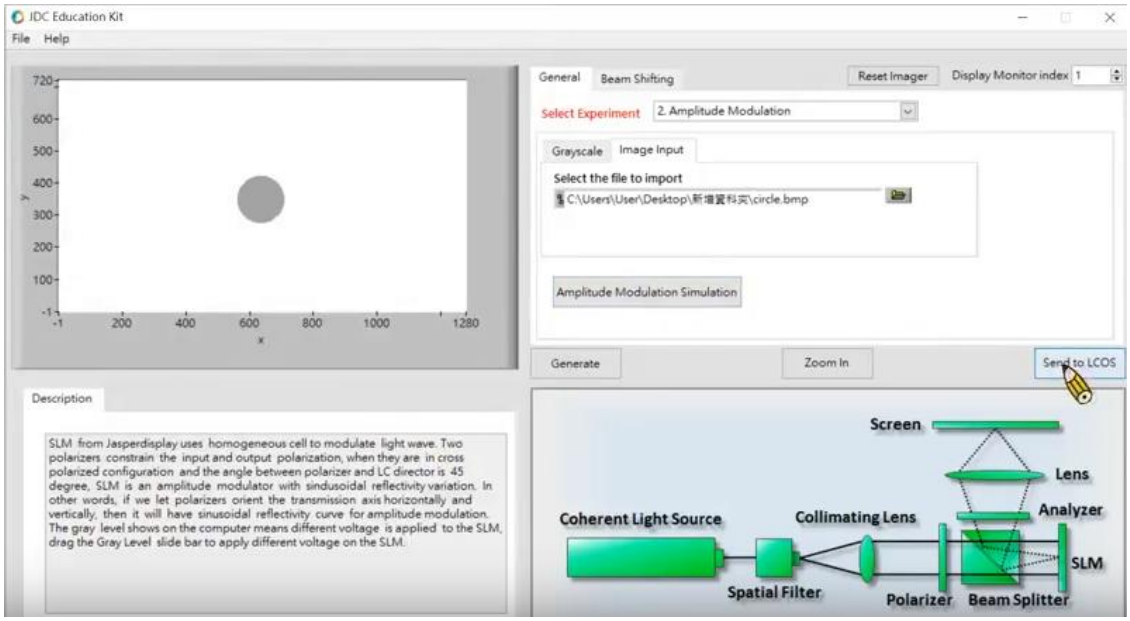

Figure 4

3. Rotate the polarizer to 0˚ and analyzer to 90˚.
4. The spatial light modulator can produce diffracted light beams of several different orders even when it is not powered, as shown in Figure 5. Measure the distance Δy between the central bright spot and the bright spot of first order.

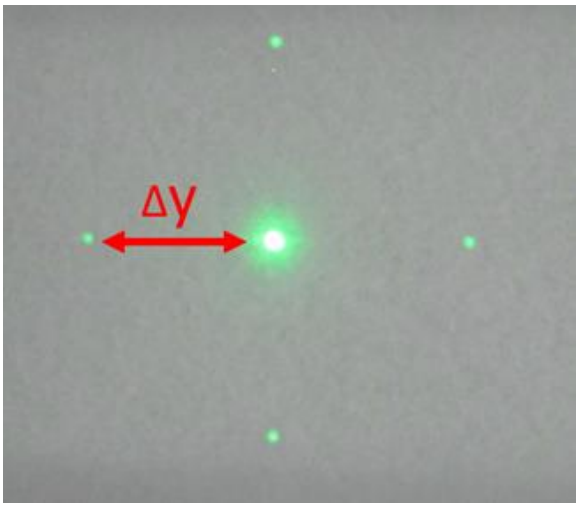

Figure 5

5. Measure the distance L between the SLM and the screen. Use the formula θ =tan-1(Δy/L) to calculate the diffraction angle θ.
6. Use grating equation $d\sin\theta_m=m\lambda$ to calculate SLM pixel size d.

5. Questions：

(1) If we change the distance L between the SLM and the screen, what is the change of the the diffraction angle θ? What is the change of the distance Δy between the central bright spot and the bright spot of first order?

(2) If the green laser is changed to the red laser, how does the SLM pixel size change?