3.8 Pseudo-color Encoding, Theta Modulation and Color Composition

Objective:

Understand the concept of optical spatial filtering, familiarize with methods for pseudo-color encoding and color composition.

Experimental Setup

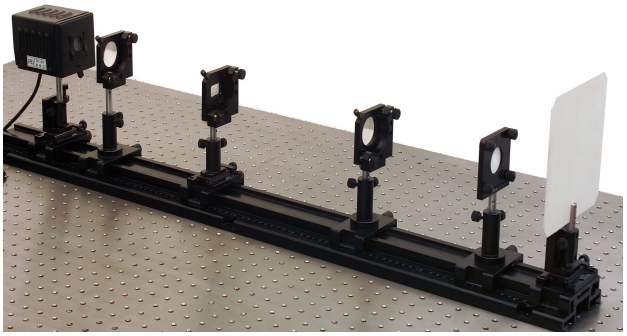

Figure 8-1 Photo of experimental setup

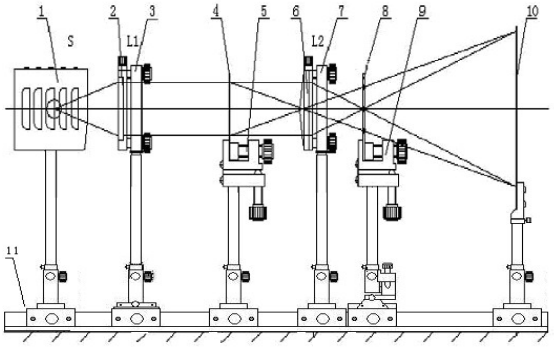

Figure 8-2 Configuration of components

1: Bromine Tungsten Lamp *S* (LLC-3)
2: Collimating Lens L_1 (f = 190 mm)
3: Two-Axis Mirror Holder (SZ-07)
4: Theta (θ) Modulation Plate
5: Plate Holder A (SZ-12)
6: Fourier Transform Lens L_2 (f = 150 mm)
7: Two-Axis Mirror Holder (SZ-07)
8: Plain White Paper (used as a filter)
9: Paper Clip (SZ-50)
10: White Screen (SZ-13)
11: Optical Rail with Carriers

Principal

Theta modulation is an application of Abbe imaging, so the theory of theta modulation is almost the same as Abbe imaging (refer to 3.7). The object is a special grating composed of three groups of grating reticles with an angle of 120° between them. They represent sky, wall and ground, respectively. Fourier spectrum of such a grating is shown in the middle of Figure 8-3. When using it as an object, we can see the light spots distribute on the spectral plane (Fourier Plane).

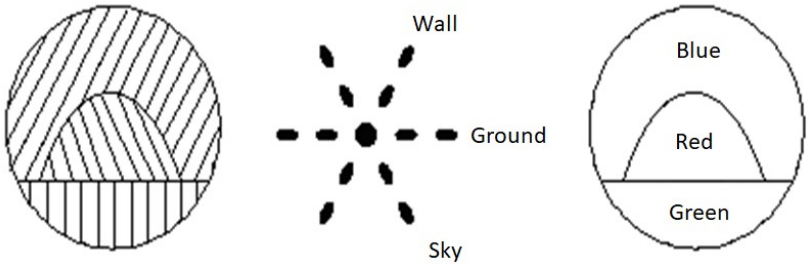

Figure 8-3 Theta modulation

We can use the filter to select the spectra we want. We can get 'blue sky', 'red wall' and 'green ground'. It is the so called pseudo-color encoding.

Experimental Procedures:

1) Refer to Figure 8-2, align all components in same height along the rail;
2) Place the Bromine-Tungsten lamp at the front focal point of lens L_1 to generate a collimated beam and illuminate onto a theta-modulation plate. Remove the frosted glass as the source and use the filament as the source;
3) Place screen P about 0.7~0.8 m away from the theta-modulation plate, place the transform lens L_2 between the theta plate and the screen, then move L_2 back and forth to form a clear theta-modulation plate image on the screen. Slide the frosted glass over to help determine a clear image. Once a clear image is found, remove frosted glass again.
4) Insert the paper clip (SZ-50) with a filter in place (can be made by a plain white paper) at the back focal plane of L_2 (Fourier plane). An image similar to the middle image in Figure 8-3 should be observed, otherwise move slightly to bring into focus.
5) Using a very sharp pin to pierce holes in the filter only using the first order spectrum (zeroth order will produce the complete image). As each hole is made, observe the associated image on the screen. Once the Fourier spectrum with the corresponding images is determined, replace the filter with a new one.
6) Using the pin more carefully to pierce the holes at the relevant places on the tiny spectrums, i.e. filtering single colors through to observe the sky as blue, the wall as red, and the ground as green (or your own selection of colors).

   Note: this experiment should be conducted in a dim environment.