4 PsiOptik Image Processing System Engineering Design Specifications

{4-1} Optical Column Specifications

Figure 4.1 enumerates the 16 elements of the optical column, including the Helium Neon laser *S* and power supply *S**, the 11 lenses *L*1 – *L*9 used for beam expansion and image transformation, polarizers *P*1 and *P*2 used to attenuate the laser beam, and the 3 computer interface I/O elements *I*1 - *I*3. Elements are implemented on a standard optical bench or "breadboard" of length 70" with an element peg spacing of 1". The laser beam was aligned to pass through the center of each lens and LCD SLM. Elements were installed either directly into the bench or into translating micropositioners. Table 1 details the physical characteristics and bench positions (measured from the laser stand) of each element installed. Manufacturer's part numbers are given for the Melles Griot laser and lenses. Part numbers and detailed specifications of the interactive I/O elements *I*1 - *I*3 are given below in *{4-2}*.

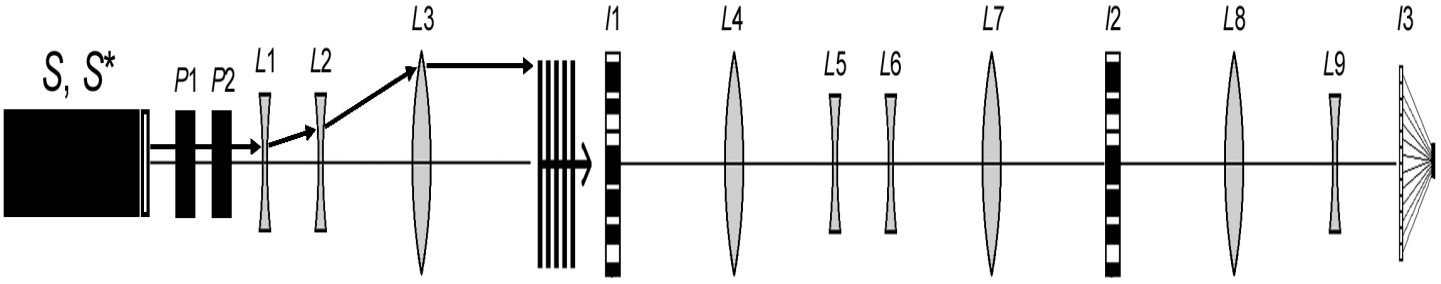
Lenses *L*1, *L*2, and *L*3 form the laser beam expander of the system. The calculated expansion ratio is 21.8×, so that the expanded beam has diameter of 21.8× (1.00 mm) = 2.18 cm. Lenses *L*4-*L*7 form the magnifying Fourier transform stage, while *L*8 and *L*9 form the inverse transform stage. The relationship between the spatial extent of the transform plane optical field and the input image Fourier transform is given by equation (1.18), $|x_2| = (B\,\lambda)/T_x$, where *B* is the effective focal length of the magnifying Fourier transform stage, T_x is the period of a spatial frequency ω_x appearing in the input image, and $|x_2|$ is the deflection of the transform plane field from the optical axis due to the presence of T_x. The effective focal length of the magnifying Fourier transform stage is $B = 5.015$ m.

Crossing polarizers *P*1 and *P*2 allows the input laser beam to be continuously attenuated. In PsiOptik's image processing system, it was found that a low intensity plane wave source recovered the best image for reasons discussed in section *{2-2}*.

Table 1: Optical Column Elements: Physical Characteristics and Positions

Element(s)	*Melles Griot Part #*	*Description*	*Position(s)*
S	05-LHR –151	15 mW 632.8 nm Helium Neon laser. Beam diameter: 1.00 mm. Power supply: 6.5 mA at 2290 V.	0"
*S**	05-LPL-902-065	Helium Neon laser power supply.	0"
*P*1, *P*2	03-FPG-019	Dichroic Sheet polarizers.	3”, 5”
*L*1, *L5*, *L*6, *L*9	05-LDK-007	-20 mm focal length divergent lens. Lens diameter: 20 mm.	7", 26.61", 29.35", 48.43"
*L*2	01-LDK-017	-40 mm focal length divergent lens. Lens diameter: 22.4 mm.	9.20"
*L*3	01-LDX-205	150 mm focal length convergent lens. Lens diameter: 50 mm.	14.08"
*L*4, *L*7, *L*8	01-LDX-189	127 mm (5") focal length convergent lens. Lens diameter: 50.8mm.	22", 34", 44"
*I*1	N/A	Earth Computing Technologies LCD: *SLM* 1.	17"
*I*2	N/A	Earth Computing Technologies LCD: *SLM* 2.	39"
*I*3	N/A	Matco Inc. CCD camera.	52.8"

Figure 4.1: Optical Column Elements: Physical Characteristics and Positions



{4-2} PC INTERFACE SPECIFICATIONS

LCDs and LCD Controller Cards

Two LCDs from Earth Computer Technologies are used to generate the input image ($I1$) and the filter pattern ($I2$). The image (filter) plane is a 6" (9.5")-diagonal flat panel with a .21 mm (.3 mm) pitch size, capable of 640x480 resolution with 16 gray levels. Each display requires interfacing with a separate Earth ISA controller board which each require a separate PC. The LCDs and controller boards were purchased as kits (SK-1001R SuperKits).

CCD and Video Capture Card

The optical system measures the resultant output image using the CNP-101 1/3" CCD board camera from Matco Inc. Images from the CCD are transferred to a PC using the ATI TV Wonder video capture card. Processed images are captured with the ATI Video Player GUI.

{4-3} SYSTEM PERFORMANCE SPECIFICATIONS

The performance characteristics of the PsiOptik system can be derived from the kinematic transform properties of the optical column implemented and from the device characteristics of the specific LCD and LCD controllers and of the CCD and video capture board installed. The PsiOptik system can process monochromatic images represented in 16 gray levels, with a maximum image resolution of 100×100. Lowpass and highpass rectangular and circular filters are implemented. Noise and dynamic range attributes have yet to be determined as of this writing.