APPLICATIONS OF A SPATIAL LIGHT MODULATOR IN THE UNDERGRADUATE OPTICS LABORATORY

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Spatial light modulators (SLMs) are optoelectronic devices that enable dynamic modulation of the amplitude or phase of a laser beam. They are widely used in research areas where manipulation of the spatial phase of light is required, including laser beam shaping, microscopy, and optical computing.

The key component of an SLM is a liquid crystal display (LCD) consisting of a pixelated layer of liquid crystals. Liquid crystals exhibit properties characteristic of both liquids and crystalline solids. In particular, they combine long-range molecular ordering, typical of crystalline materials, with the ability to flow, characteristic of liquids. The orientation of liquid-crystal molecules affects the propagation of polarized light, allowing the polarization state of transmitted light to be modified. Moreover, the molecular orientation can be controlled by an applied electric field. As a result, the voltage applied to each pixel locally modulates the intensity, phase, or polarization state of the transmitted light. Because the SLM matrix can be readily controlled by a computer, this approach enables real-time manipulation of the optical wavefront.

In this work, we demonstrate how spatial light modulators can be implemented in undergraduate laboratory settings. Several exemplary optics experiments suitable for instructional laboratories are presented, including single- and multiple-slit diffraction, implementation of a Fresnel lens, polarization effects, and optical Fourier transformations. Finally, we show that, by employing amplitude holography, the device can also be used to generate structured light beams.

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[2] C. Rosales-Guzmán and A. Forbes (2017). How to Shape Light with Spatial Light Modulators, SPIE Press. http://dx.doi.org/10.1117/3.2281295