Spatial Light Modulator Optical Path



Overview

Spatial Light Modulation Principles This generates an optical path difference between adjacent pixels, which is tunable up to one full wave, enabling preci.

Key Takeaways

A Spatial Light Modulator (SLM) modulates the optical path of light by controlling the phase, amplitude, or polarization at each pixel, effectively altering the wavefront without changing the beam's intensity profile. Optical Path Modulation in SLMsSLMs consist of a matrix of independently addressable pixels, typically made of liquid crystal (LC) elements. Each pixel acts as a variable optical retarder, meaning it can introduce a controllable phase delay to the incident light depending on the applied voltage ( ).

Light linearly polarized along the LC's extraordinary axis experiences a phase shift proportional to the voltage, creating a spatially varying optical path difference across the beam ( ). The optical path difference (OPD) between adjacent pixels can be tuned up to one full wavelength, allowing precise control of the wavefront for applications like beam steering, holography, and adaptive optics ( ). This modulation occurs without altering the intensity of the incident light, which is critical for phase-only SLM applications.

Physical Optical Path in Reflective and Transmissive SLMsSLMs can be transmissive or reflective: Transmissive SLMs: Light passes through the LC layer, and the phase is modulated as it propagates through the material. The optical path length is effectively the product of the LC thickness and its voltage-dependent refractive index ( ).

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Reflective SL

Ms (LCOS): Light reflects off a mirror placed behind the LC layer. The round-trip through the LC layer doubles the phase modulation effect, and the mirror ensures high reflectivity and minimal absorption ( ). The physical optical path is therefore determined by the LC layer thickness, refractive index, and applied voltage, and it can be dynamically adjusted for each pixel to shape the outgoing wavefront.

Pixel-

Level Control and Wavefront ShapingEach pixel's electrode is patterned via photolithography, allowing independent voltage control ( ). Minimizing pixel spacing improves resolution and reduces diffraction artifacts. By programming the voltage across the pixel array, the SLM can create arbitrary phase patterns, effectively controlling the optical path of the entire beam.

This enables applications such as: Ultrafast pulse shapingFourier transform correlationBeam steering and wavefront correctionHolographic data storage ( )SummaryThe physical optical path in an SLM is the cumulative effect of the voltage-controlled phase shifts introduced by each pixel. By adjusting these shifts, the SLM can precisely manipulate the wavefront of light in space and time, enabling advanced optical applications without changing the beam's intensity profile.

Reflective LCOS SL

Ms enhance modulation efficiency by doubling the optical path through the LC layer, while transmissive SLMs modulate the path directly as light passes through the LC medium.

Article Content

Spatial Light Modulation Principles

This generates an optical path difference between adjacent pixels, which is tunable up to one full wave, enabling precise light modulation. Such modulation

Spatial Light Modulators | MEETOPTICS Academy

An optical path difference between adjacent pixels, tunable to one full-wave, is easily accomplished. This enables a precise control of the phase of the reflected light. SLMs often operate in polarization

Spatial light modulator

The image on an optically addressed spatial light modulator, also known as a light valve, is created and changed by shining light encoded with an image on its front or back surface.

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Spatial light modulator via optically addressed metasurface

Emerging demands for dynamic wavefront modulation in holographic displays, augmented/virtual reality, and light detection and ranging require spatial light modulators (SLMs) with

Liquid-Crystal Spatial Light Modulators and Their Applications

Liquid-crystal spatial light modulators control the optical path of light waves by modulating the refractive index. They play an important role in adaptive optics as phase-correction devices.

A 10 Megahertz Spatial Light Modulator

Here we introduce a new class of spatial light modula-tor that provides both 2D pixel geometry and high speed. The device operates by encoding spatial information in frequency bins via a broadband

Spatial Light Modulators

HOLOEYE´s Spatial Light Modulator systems are based on translucent (LCD) or reflective (LCOS) liquid crystal microdisplays. The use of LC materials in SLMs is

Ultrafast, reconfigurable all-optical beam steering and spatial light ...

Achieving spatiotemporal control of light at subwavelength and subcycle scales is an important milestone in the development of new photonic materials for signal processing, pulse

spatial light modulator

A spatial light modulator (SLM) is a pixellated liquid crystal device that can individually control the phase value of each pixel. It imposes spatially varying modulation onto an incident beam, allowing for the

101946522 Stereo projection using polarized solid state light sources

A stereoscopic digital image projector includes (a) a plurality of light modulation assemblies, each comprising: (i) at least one solid-state light source energizable to provide illumination having a first

Trapping of single atoms in metasurface optical tweezer arrays

The ability to scale such arrays has become a defining challenge. Typically, optical tweezer arrays are generated using acousto-optic deflectors or liquid-crystal spatial light modulators.

Spatial light modulators

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S patial light modulation is a well-established optical technology with a wide range of applications. Spatial light modulators (SLMs) are two-dimensional objects, enabling to modulate, at any point of

Spatial Light Modulator Principles

An optical path difference between adjacent pixels, tunable to one full-wave, is easily accomplished. With phase modulation, an optical path difference of up to one full-wave is produced between

High Fidelity Spatial Light Modulator Configuration for ...

Abstract For their capacity to shape optical wavefronts in real time into any desired illumination pattern, phase-only Spatial Light Modulators (SLM) have proven to be powerful tools for

An Introduction to Spatial Light Modulators

Spatial light modulators are used to spatially modify an optical wavefront in two dimensions. The most commonly used models are electrooptical with liquid crystal molecules used as the modulation

Spatial Light Modulators and Their Applications in Polarization ...

Spatial light modulators (SLMs) are electro-optical devices, pertaining to manipulating the fundamental characteristics, viz., amplitude, phase, and polarization state of light.

Spatial Light Modulator Microscopy

The use of spatial light modulators (SLMs) for two-photon laser microscopy is described. SLM phase modulation can be used to generate nearly any spatiotemporal pattern of light, enabling

High resolution multispectral spatial light modulators based ...

Spatial light modulators (SLMs) are the most relevant technology for dynamic wavefront manipulation. They find diverse applications ranging from novel displays to optical and quantum

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