How to calibrate a spatial light modulator



Overview

Spatial Light Modulators Watch a demonstration of an interferometric method for calibrating the phase delay of reflective SLMs. Exulus spatial light modula.

Key Takeaways

Calibrating a spatial light modulator involves measuring and correcting pixel-level phase variations and optical flatness, typically using interferometry or software-assisted automated methods.

Interferometric Calibration

One of the most precise methods for calibrating phase-only SLMs is using Twyman–Green interferometry. This approach allows you to measure both the phase response and optical flatness of the SLM at single-pixel resolution. The procedure generally involves: Displaying a series of gray-level patterns on the SLM to modulate the interference intensity.

Capturing interferograms corresponding to each gray level. Extracting the phase shift and flatness correction from the interferograms. Applying a pixel-wise correction map to compensate for nonuniformities.

This method can be performed with as few as 18 interferograms, significantly reducing acquisition time compared to traditional N-step phase shift interferometry, while maintaining high accuracy.



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Software-

Assisted Calibration

Modern SLM control software, such as slmsuite, provides automated calibration routines that handle Fourier-to-image-space transformations, aberration correction, and optimized hologram generation. These tools can: Automatically map SLM pixels to camera pixels. Correct for phase curvature and optical aberrations.

Enable high-performance holography with minimal manual intervention. Using such software, you can perform automated Fourier-domain calibration, which is particularly useful for complex holographic or 3D optical setups.

Practical Steps for Calibration

Mount the SLM securely using kinematic mounts or clamps to minimize mechanical drift.

Connect the SL

M to a compatible input (HDMI or USB) and ensure the control software is installed. Generate calibration patterns, such as double-slit gratings or uniform gray levels, to probe phase response. Capture the resulting interference or diffraction patterns using a camera or photodetector.

Analyze the patterns to determine phase differences, curvature, and pixel-level variations. Apply corrections in the SLM software or via a lookup table to achieve uniform phase modulation.

Tips for Accurate Calibration

Perform calibration in a stable optical environment to reduce phase drift. Use high-resolution cameras for precise measurement of interference fringes. Repeat calibration periodically, especially if the SLM is exposed to temperature changes or high-power illumination.

For high-speed applications, consider GPU-accelerated software to update calibration maps in real time. By combining interferometric measurements with software-assisted corrections, you can achieve precise, high-resolution phase control across the entire SLM panel, enabling accurate holography, beam shaping, and optical experiments.

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Article Content

Spatial Light Modulators

Watch a demonstration of an interferometric method for calibrating the phase delay of reflective SLMs. Exulus spatial light modulators are driven by an input video

Methods and apparatus to calibrate spatial light modulators

Methods and apparatus to calibrate spatial light modulators are disclosed. Examples include processor circuitry to execute and/or instantiate instructions to provide a greyscale image to a...

An open-source, accurate, and iterative calibration method for liquid ...

An iterative method for accurately measuring and calibrating liquid crystal-based spatial light modulators (SLMs) through Michelson interferometry is described here. In this framework,

Simple and fast calibration method for phase-only spatial light

In practice, our calibration method works well with as few as 18 interferograms, which can be quickly acquired without concern for phase drift. We detail the calibration procedure and

How to characterize and calibrate a phase-only SLM

How to characterize and calibrate a phase-only SLM For most applications in complex media, spatial light modulators are used for their ability to control the phase of a laser beam.

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To enhance the precision of wavefront phase modulation by a spatial light modulator, this paper proposes a method for measuring the phase modulation characteristics of the spatial light

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We present a quantitative phase measurement and calibration method for a parallel aligned liquid crystal spatial light modulator (PAL-SLM) based on Pancharatnam phase-shifting...

AN020 Calibration of Spatial Light Modulators

on: Kavita Chand and Justin Mansell 10/05/10 A calibration of Spatial Light Modulator (SLM) is an experimental determination of the relationship between the grey levels of the entrance signal and the

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Fast and robust calibration method of liquid-crystal spatial light ...

We propose a fast and robust method for calibrating Spatial Light Modulators (SLMs) based on polarization phase-shifting interferometry. Our method effectively calibrates the SLM by

Simple and fast calibration method for phase-only spatial light modulators

Phase-only spatial light modulators (SLMs) are widely used to engineer the phase of light in various applications. However, liquid-crystal-on-silicon SLMs have undesirable spatial variations in

Calibration of phase-only liquid-crystal spatial light modulators by ...

Phase-only spatial light modulator (SLM) is a key device for light manipulation. It is critical to calibrate the grayscale-phase response to the drivi

Progress in Phase Calibration for Liquid Crystal Spatial Light Modulators

Phase-only Spatial Light Modulator (SLM) is one of the most widely used devices for phase modulation. It has been successfully applied in the field with requirements of precision phase

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Rapid stochastic spatial light modulator calibration and pixel ...

Holographic light potentials generated by phase-modulating liquid-crystal spatial light modulators (SLMs) are widely used in quantum technology applications. Accurate calibration of the

High-Precision Calibration of Phase-Only Spatial Light Modulators

As spatial light modulators (SLMs) are becoming flexible and the preferred device for light steering, the SLM''s modulation calibration still remains challenging.

Spatial Light Modulators and Their Applications in Polarization ...

Therefore, calibration of LC-SLM for grayscale-phase is recommended for its precise utilization in various holographic applications. Digital holography is a conventional optical technique

Calibration Method of Liquid-Crystal Spatial Light Modulator Based on

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Liquid-crystal spatial light modulator (LC-SLM) has been widely applied as a programmable digital device. However, the LC-SLM can only manipulate on light fields accurately

Generalized phase calibration method of liquid crystal spatial light ...

Spatial light modulators (SLMs) are widely used in many optical fields such as wavefront modulation, beam shaping and diffractive optical elements. It is necessary to calibrate SLM to

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