Trapping and correcting

J. Opt. **12,** 124004 (2010)

Spatial light modulators (SLMs) are often used to create multiple optical traps in holographic optical tweezers. In such systems, aberration correction is important for maximizing performance. Richard Bowman and co-workers in the UK have now demonstrated an SLM-based Shack–Hartmann wavefront sensor that can estimate and correct for aberrations in optical tweezers without altering the experimental set-up. The SLM projects an array of spots onto the sample plane, with each spot being focused onto a particular point in the Shack–Hartmann array. Spot displacements are used to estimate the tilt of each region on the SLM and hence give a phase map through Zernike polynomial fitting. Comparing this with the reference phase map allows the wavefront to be corrected. The researchers say that aberrations of up to ten wavelengths can be recovered, and that the system is sensitive to aberrations much smaller than one wavelength. The approach provides a fourfold improvement in optical trap stiffness. Because the spot displacement is relatively large, the spot pattern can be used to align the system by eye.

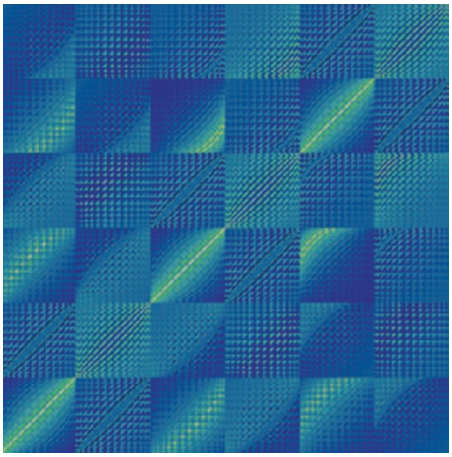
Boosting data storage

J. Eur. Opt. Soc. **5,** 10036s (2010)

Photopolymers are some of the most promising media for holographic data storage, owing to their large diffraction efficiencies and high stability. However, the holographic writing process causes photopolymers to shrink, which distorts the recorded interference fringes and so degrades the signal-to-noise ratio (SNR) of the reproduced data. Compensation can be performed using SNR calculations — known as the SNR index — but this method requires considerable calculation time. Norihiko Ishii and co-workers in Japan have now demonstrated a technique that compensates for these distorted fringes by controlling the wavefront of the reference beam, providing high sensitivity, low noise and fast calculation time. Their ‘space–frequency amplitude-to-distortion ratio’ index is similar to the SNR index because the signal intensity is divided by the signal distortion, allowing it to be used as a direct replacement of the SNR index in compensation calculations. Using this technique, the researchers improved the SNR from 2.1 dB to 3.4 dB in the most distorted part of their reproduced image, with improvements in peak intensity and full-width at half-maximum of 6% and 10%, respectively.

Learn and apply

J. Opt. Soc. Am. A **27,** A253–A264 (2010)



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Observing distant or dim objects in the field of astronomy requires extremely large telescopes with adaptive optics (AO) systems. Correcting for distortions typically requires the determination of large covariance matrices, which describe the relationship between the wavefront distortions and the sensors. Fabrice Vidal, Eric Gendron and Gérard Rousset in France have now numerically demonstrated a new approach called ‘learn and apply’ that can retrieve the turbulence profile directly from real measurements of the wavefront sensors, identifying all parameters relevant to defining the matrices. This is achieved by first recording a set of open-loop wavefront measurements for identifying the turbulence and instrument parameters (the ‘learn’ phase). This knowledge can then be ‘applied’ in a serial of steps, including more measurements of wavefront sensors and theoretical calculations to determine the covariance matrices needed for wavefront reconstruction. The idea is expected to be useful in new multi-object AO systems that are designed for simultaneous observation of objects spread across the telescope’s entire field-of-view.

Ultrabroadband shaping

Opt. Express **18,** 23147–23152 (2010)

Femtosecond pulse shaping is crucial in the field of ultrafast science. Although devices such as SLMs and acousto-optic dispersive filters have been used to synthesize shaped pulses, they suffer from limited spectral range and low throughput. Deformable mirrors — thin membranes that can be deformed to create smooth phase variations — offer high throughput from the ultraviolet to the mid-infrared range, but so far have allowed only relatively simple deformations. Now, Stefano Bonora and co-workers from Italy have demonstrated a push–pull approach for synthesizing more complex spectral phase profiles to enable true pulse shaping. Their push–pull deformable mirror consists of a 5-μm-thick silver-coated nitrocellulose membrane faceted on both sides by an array of linear electrodes. The front electrodes push the membrane to positive deformations, while the back electrodes pull it to negative deformations. Together with a diffraction grating and a silver spherical mirror, the push–pull deformable mirror constitutes a pulse shaper. The team demonstrated that their set-up can shape ultrabroadband pulses in the range of 1.1–1.7 μm, with an overall throughput of approximately 60%. They also showed that their push–pull deformable mirror can be used to control the photoexcitation state of the laser dye LD690.

A wider view

J. Opt. Soc. Am. A **27,** A265–A277 (2010)

Adaptive optics is an extremely useful tool in the field of ophthalmology and vision research, but most current systems are only capable of operating over a field of view of 1–3°.The limited angles involved, particularly at such high magnification, limit the flexibility of AO systems and make it difficult to return to a particular area of the retina with sufficient accuracy. R. Daniel Ferguson and co-workers in the USA have now developed a unified implementation of the AO scanning laser ophthalmoscope (AOSLO) that incorporates a wide-field line-scanning ophthalmoscope and a closed-loop optical retinal tracker. The wide-field imager and large-spherical-mirror optical interface design, together with a large-stroke deformable mirror, allow the AOSLO image to be corrected at any retinal coordinates of interest within a field of >25°. The interface allows the high-resolution imaging field to be placed anywhere within the wide field without re-fixation of the subject, enabling easier retinal navigation and faster, more efficient AOSLO montage capture and stitching. The researchers say that their new AOSLO design has the potential to greatly improve and simplify the clinical applications of AO retinal imaging, and may lead to more widespread use of high-resolution imaging technology by optometrists, ophthalmologists and vision researchers.