research highlights

IMAGING

Reconstruction simplified

Appl. Phys. Lett. **114**, 161901 (2019)

Credit: AIP Publishing

Most methods for complex wavefront reconstruction require arrayed sensors to detect the light pattern. Now, Ruifeng Liu and colleagues at Xi'an Jiaotong University in China have demonstrated detection and reconstruction of a field of unknown amplitude and phase using a single-pixel detector. The team exploited a checkerboard pattern on a digital micromirror device (DMD) to sample the unknown complex amplitude field, using a single-beam approach that they say is compact and stable. The beam to be analysed and reconstructed originated from a He–Ne laser (632.8 nm) and was sent to a phase spatial light modulator (SLM) and spatially encoded so that it had a complex wavefront. To perform the reconstruction, the beam was imaged onto a DMD and a pinhole was used to block undesired diffraction orders from the SLM. Another pinhole and a single photodiode were used to detect the intensity in the central position of the interference pattern. The demonstration was done with up to 128 × 128 discretized pixels (each with area of about 55×55 µm^2) and real-time wavefront reconstruction was achieved at a rate of 6 Hz (for 32×32 pixels). *DFPP*

https://doi.org/10.1038/s41566-019-0480-9

OPTICAL TRAPPING

Super oscillation beams

Opt. Lett. **44**, 2430–2433 (2019)

Super oscillation (SO) beams, which consist of a subwavelength central spot surrounded by a side ring, can be used to implement optical trapping below the diffraction limit. Harel Nagar and co-workers from Israel systematically investigated the effect of particle size and beam waist on the stiffness of an SO-beam-based optical trap. The SO beam was generated by sending a 1,083-nm laser beam to a spatial light modulator, and then focusing it onto a polystyrene bead against a cover glass. Four different bead diameters were prepared from 490 nm to 1,370 nm. The beam waist of the central spot was controlled by changing the radius of a mask aperture at the pupil plane. The bead position was recorded using video microscopy. The trapping quality was characterized by calculating the trap stiffness as a function of the ratio between the bead diameter and the width of the beam waist of the central spot in the range from 0.67 to 2.4. The scientists found that interference from the side ring caused instability in trapping for the larger beads or the narrower beam waist. Consequently, the maximum stiffness was obtained when the ratio was 1.5. *NH*

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TERAHERTZ OPTICS

Room-temperature comb

Nat. Commun. **10**, 2403 (2019)

A frequency comb in the terahertz region and that operates at room temperature could prove useful for applications in spectroscopy. The device, designed and built by scientists from Northwestern University in the US, relies on difference-frequency generation from a mid-infrared (mid-IR) quantum cascade laser (QCL). A distributed feedback grating is integrated into the QCL's cavity in order to simultaneously generate a single mode at one distinct wavelength in the mid-IR as well as a mid-IR comb. The two are then mixed together to perform down-conversion into the terahertz region. The approach is attractive as it offers a compact semiconductor chip-based approach to comb generation and operates at room temperature. When the laser was driven at a current of 1.55 A, a total of 5 comb lines with a spacing of 245 GHz were generated between 2.2 and 3.3 THz. *OG*

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OPTICAL THERMOMETRY

Sensitive nanodiamonds

ACS Photon. https://doi.org/c6th (2019)

Nanodiamonds featuring a high concentration of silicon–vacancy centres can function as a fast, ultrasensitive all-optical thermometer. Sumin Choi and co-workers from Australia, France and Russia report how analysis of the near-infrared (~740 nm) photoluminescence emitted from the nanodiamonds can enable ultrafast, low-noise thermometry. With a size of just 250 nm or smaller the nanodiamonds can be used to detect a temperature change as small as 0.4 °C in a measurement that takes on the order of 0.001 s. The nanodiamonds are grown by a high-pressure, high-temperature technique and the photoluminescence measurements performed using a confocal microscope and a 532-nm green excitation laser and an electron-multiplying CCD camera. Potential applications include temperature mapping of solid-state electronics. *OG*

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METAMATERIALS

Flexible coating

APL Photon. **4**, 056107 (2019)

A flexible, low-loss metamaterial with an epilson near zero (ENZ) response has been made by scientists from the University of St Andrews University in Scotland and CNR-SPIN institute in Italy. The structure consists of thin stacked layers of silver, germanium and SU-8 polymer with a total thickness of 100 nm and a 15:85 metal-to-dielectric ratio. The layers are deposited on a sacrificial substrate that allows the metamaterial membrane to be removed following fabrication. The result is a free-standing thin coating that is flexible and conformable and can be applied to non-flat devices. Tests indicate that the coating retains its optical properties after 10,000 bending cycles and can be bent to fit surfaces with a radius of curvature of a few micrometres. ENZ materials are of interest as they provide spectral regimes where the refractive index approaches zero, stretching the wavelength within the material so the electromagnetic field remains near constant over an extended area. They are useful for applications including wavefront engineering, sub-diffraction-limit imaging and the enhancement of optical activity. *OG*

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