ionization, and three-dimensional momentum electron spectroscopy using a reaction microscope. The latter was used to determine the absolute direction of the driving-field polarization along which the unknown field is measured. This direction could probably be measured much more simply using optical XUV polarimetry, preserving the all-optical character of the technique.

Carpeggiani and colleagues' study represents an important step forward for the advanced characterization of complex optical fields, which is a prerequisite for controlled and reproducible synthesis of ultra-broadband light waveforms with arbitrary polarization. Their technique will benefit a large number of users not only in the strong-field and attosecond communities but also spectroscopists, and molecular and solid-state physicists because, compared with currently available techniques, it can be applied to much weaker pulses. Traditional pump–probe spectroscopy in the infrared–visible–ultraviolet domain makes use of cycle-averaged quantities to resolve the studied dynamics. The possibility to sample the weak oscillating field of the probe beam opens the prospect of accessing complete information about the dynamic electronic response of matter, as is done, for example, in attosecond polarization spectroscopy[12]. Furthermore, full characterization of the time-dependent polarization will benefit polarization-shaping techniques to map the tensor character of the nonlinear response or to achieve optimal control of quantum systems[13]. ❐

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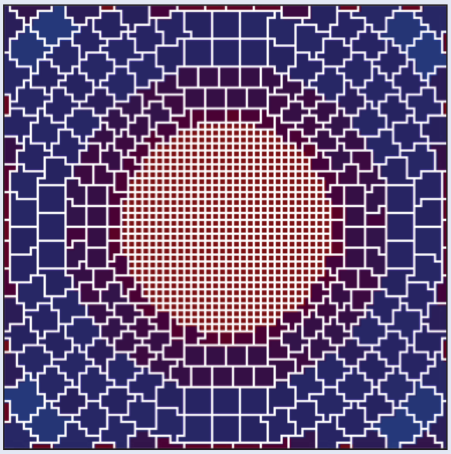
IMAGING

Retina-like single-pixel camera

Inspired by the design of the retina in the human eye, scientists in Scotland have managed to circumvent the usual trade-off between speed and resolution in a single-pixel camera system (D. B. Phillips *et al.*, *Sci. Adv.* **3,** e1601782; 2017).

Single-pixel imaging works by applying a consecutive series of different binary patterns to the optical path of a scene to be imaged and measuring the correlation with data that is synchronously recorded on a single photodetector. However, there is an intrinsic trade-off between the resolution and frame rate of such systems as the number of measurements is equal to the number of reconstructed pixels in the final image.

Miles Padgett, David Phillips and co-workers at the University of Glasgow have now demonstrated a way to get around this limitation by employing binary patterns that, instead of having a uniform resolution, have a spatially varying resolution that resembles the retina of the eye. In particular, the pattern mask (left panel) has a fovea-like region of high resolution that is surrounded by a lower resolution in the periphery. The benefit of the approach is that it allows higher-resolution imaging in a region of interest (right panel) without slowing the frame rate of the imaging to the level that would be needed for a high resolution over the entire field — Padgett's team report a local frame rate enhancement of a factor of 4. Furthermore, the location of the 'fovea' region can be changed at will, allowing the opportunity for object tracking or multiple fovea-like high-resolution regions to be employed.



"We were working together on a system which used patterns of different scale to allow us to switch between different resolutions. Dave had the idea of doing high resolution in the middle and low around the outside — just like the eye," commented Padgett. "We think it is of benefit to all single-pixel cameras or similar systems — for example, we have converted our recent time-of-flight system to use the same approach."

The Glasgow system makes use a white LED torch as a source of illumination and a computer-controlled digital micromirror device with 32 × 32 programmable pixels to create a dynamic binary mask that is applied to the image of the scene prior to detection by an avalanche photodiode (APD). The team says in addition to operation at visible wavelengths, the approach is equally applicable to other wavelength regimes. With this in mind, they have also demonstrated a short-wave infrared (SWIR) single-pixel imaging system that operates in the 800 to 1,800 nm wavelength region by replacing the APD with a SWIR-sensitive detector and using a heat lamp as an illumination source.

Potential applications that could benefit from the approach include machine vision and gas sensing, for example.

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