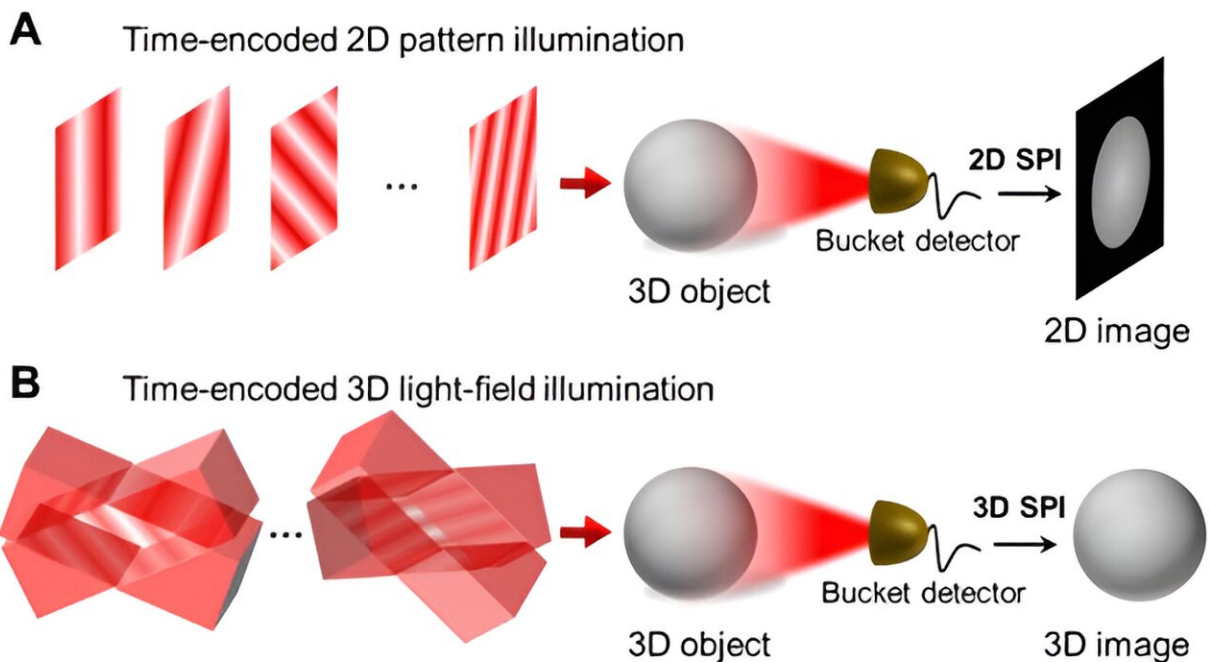


Realizing single-pixel imaging of single living cells

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Schematic diagram of 3D-SPI technique. Credit: LIU Yifan

A research team led by Prof. Gong Lei from the University of Science and Technology (USTC) of the Chinese Academy of Sciences (CAS) and collaborators developed a three-dimensional single-pixel imaging (3D-SPI) approach based on 3D light-field illumination (3D-LFI), which enables volumetric imaging of microscopic objects with a near-diffraction-limit 3D optical resolution.

They further demonstrated its capability of 3D visualization of label-free optical absorption contrast by imaging single algal [cells](#) in vivo. The study titled "Optical Single-Pixel Volumetric Imaging by Three-dimensional Light-Field Illumination" was published in *Proceedings of the National Academy of Sciences (PNAS)*.

SPI has become an attractive 3D imaging modality. Through single-pixel detectors instead of conventional array sensors, the performance of SPI exceeds the conventional ones in spectral range, detection efficiency, and timing response. Furthermore, the single-cell cameras outperform conventional imaging methods at weak intensity, single-photon level, and precise timing [resolution](#).

3D-SPI techniques generally depend on time-of-flight (TOF) or stereovision to extract depth information. However, existing implementations can only reach a millimeter level at best, which is incapable of imaging microscopic objects like cells.

To exceed the resolution limitation, the researchers built a 3D-LFI-SPM prototype. As a result, the prototype achieves an imaging volume of $\sim 390 \times 390 \times 3,800 \mu\text{m}^3$ and a resolution of up to $2.7 \mu\text{m}$ laterally and $37 \mu\text{m}$ axially. They performed label-free 3D imaging of living *Haematococcus pluvialis* cells and successfully counted the [living cells](#) in situ.

Predictably, the approach can be applied to visualize various absorption contrasts of biological samples. With depth-resolved imaging ability, scientists might be potentially able to monitor cell morphology and growth in situ in the future. The research opens the door to high-performance 3D SPI with applications in [biomedical research](#) and optical sensing.

More information: Yifan Liu et al, Optical single-pixel volumetric

imaging by three-dimensional light-field illumination, *Proceedings of the National Academy of Sciences* (2023). [DOI: 10.1073/pnas.2304755120](https://doi.org/10.1073/pnas.2304755120)

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