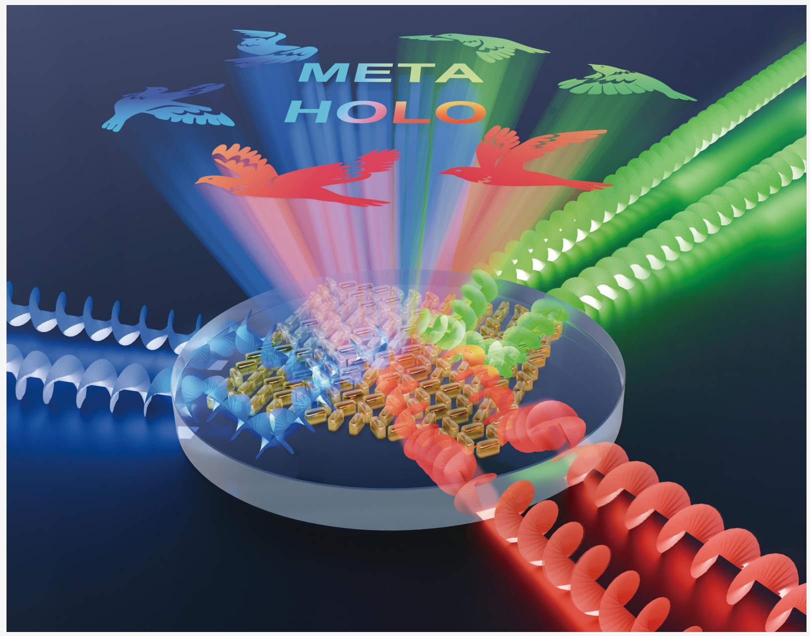
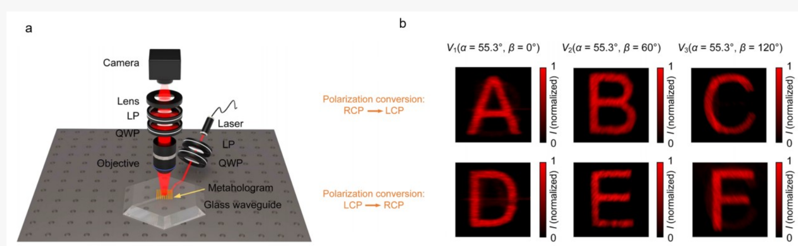
K-space translation strategy lets metasurfaces project multiple images without crosstalk

USA, June 7, 2024 /EINPresswire.com/ -- Researchers have developed a new type of planar-glass-waveguide-based metasurface holograms that feature multiple crosstalk-free display channels by precisely manipulating guided incident light. Depending on both the spin and azimuthal angle of guided incident light, the metaholograms can project six distinct single-color images or even two full-color images by leveraging a novel k-space translation strategy. This groundbreaking study opens new possibilities for compact virtual/ augmented reality (AR/VR) displays, information storage, image encryption, and beyond.



Depending on the azimuthal angle and polarization state of guided incident light, the metahologram can selectively project six independent single-color images or two full-color images.

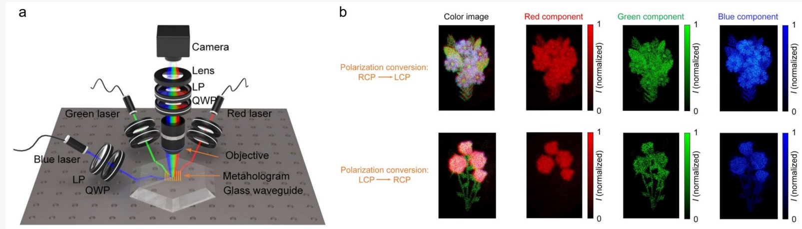


(a) Schematic diagram of the experimental system for single-color imaging. (b) Experimental results of the waveguide-based six-channel metahologram.

Researchers have developed a new type of holograms, known as “metaholograms”, capable of projecting multiple high-fidelity images free of crosstalk. This breakthrough paves the way for next-generation technologies including virtual/augmented reality (AR/VR) displays, information storage, and image encryption.

Metaholograms offer several advantages over traditional holograms, including broader operational bandwidth, higher imaging resolution, wider viewing angle, and more compact size. However, a major challenge for metaholograms has been their limited information capacity that only allows to project a few independent images. Existing methods typically can provide a small number of display channels and often suffer from inter-channel crosstalk during image projections.

To overcome this limitation, the new research introduces an innovative approach based on the k-space translation design strategy, enabling multiple target images to seamlessly switch between “displayed” and “hidden” states. The proposed metahologram employs the geometric phase encoding method and consists of millions of subwavelength-scale poly-silicon nanopillars, each measuring approximately 100 nm, all identical in size but with spatially varying rotation angles. The device further incorporates a planar glass waveguide to convey incident light and leverages properties such as polarization and angle to switch the projection of up to six unique high-fidelity images without crosstalk. Additionally, the researchers have created a two-channel full-color metahologram and even an eighteen-channel metahologram using a combination of different multiplexing techniques.



(a) Schematic diagram of the experimental system for full-color imaging. (b) Experimental results of the waveguide-based full-color metahologram.

This innovation has the potential to significantly improve AR/VR displays by enabling the projection of more complex and realistic scenes. It also holds promise for applications in image encryption, where the information is encoded into multiple holographic channels for enhanced security.

The research(doi: https://doi.org/10.1186/s43593-024-00063-9) is a significant step forward in developing high-performance metaholograms with a vastly increased information capacity. This study paves the way for exciting new possibilities in various fields, from advanced displays to information encryption and information storage.

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