The making of a Mona Lisa hologram

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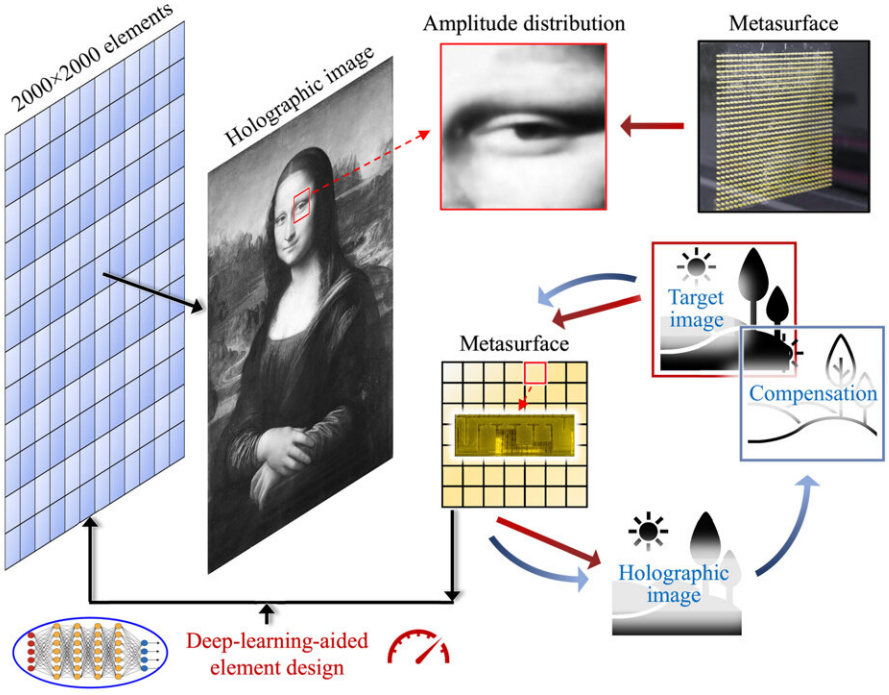

Holographic reconstruction of the Mona Lisa by a megapixel acoustic metasurface. Credit: Miao et al.

Holograms are often displayed in science fiction as colorful, life-sized projections. But what seems like the technology of the future is actually the technology of the present, and now it has been used to recreate the Mona Lisa.

In *Applied Physics Reviews*, researchers from Tianjin University, the

Beijing Institute of Technology, Rowan University, the University of Missouri, Qingdao University, Shijiazhuang Tiedao University, and Beijing Jiaotong University developed an acoustic metasurface-based holography technique that uses a deep learning algorithm to generate and iteratively improve a hologram of the Mona Lisa.

Holograms are images created by recording and reconstructing the interference pattern of light or sound waves. They provide realistic and immersive visual or auditory experiences and can be applied in entertainment, medical imaging, and communication, among other fields.

Metasurfaces, or two-dimensional materials made of an array of tiny antenna-like components, can help a lot with the holography process.

"A metasurface-based hologram works by precisely controlling the phase and amplitude of the waves interacting with the metasurface," said author Yue-Sheng Wang. "As a result, the outgoing waves at each pixel exhibit a certain amplitude and phase, which results in the desired holographic image based on their interference."

The team wanted to develop a metasurface holography optimization method to enhance efficiency and precision. They used a deep neural network-based algorithm to customize the antenna-like structures within their metasurface. By iteratively reducing inconsistencies between the original and holographic image, they tweaked the metasurface and created a high-quality hologram.

"We chose to recreate the Mona Lisa as a proof of concept," said Wang. "It is so famous that almost everyone knows about it. It is filled with countless delicate and subtle transitions of layers, which enhances the softness, haziness, and mystery of the painting. So it is a great way to demonstrate the effectiveness of our method."

The holographic method successfully reconstructed the Mona Lisa, and, in even more detail, her left eye. While the Mona Lisa hologram is two-dimensional, the technique can be extended to create three-dimensional images as well.

"The precise control of sound waves offered by our holography method is crucial for advancing non-invasive medical therapies, effective noise control, and optimizing acoustic environments like concert halls," said Wang. "These improvements have the potential to enhance quality of life and various technological applications."

The authors believe their technique could revolutionize the field of holography. They plan to explore ways to generalize it, make it compatible with 3D printing, and reduce training time.

More information: Yue-Sheng Wang et al, Deep-Learning-Aided Metasurface Design for Megapixel Acoustic Hologram, *Applied Physics Reviews* (2023). DOI: 10.1063/5.0136802

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