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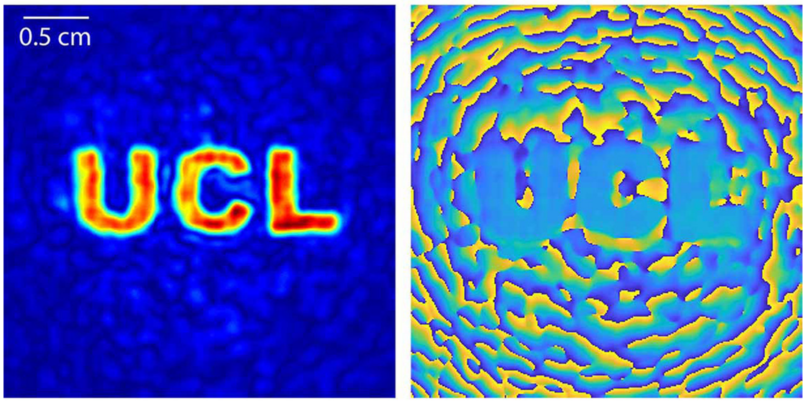
New design strategy for acoustic holograms demonstrates potential for biomedical applications

Savannah Mandel

The inability of acoustic holograms to independently modulate both phase and amplitude of incident waves is circumvented by multiple phase holograms designed using an iterative Fourier transform algorithm.



Acoustic holograms are a low-cost method for generating complex wave patterns, shapes and designs in the air or under water using ultrasonic waves. They are 3D printed plates designed to diffract sound emitted by a source to form a designed field. Currently, this is limited by the inability of these holograms to independently modulate both the phase and amplitude of an incident wave.

Through an iterative Fourier transform algorithm, author Michael Brown overcame this limitation. Inspired by a method used in optics, the new approach uses two spatially separated phase holograms. The first controls the amplitude of the field incident on the second, while the latter corrects the phase distribution to form the final design. Brown demonstrated this technique using two phase holograms to form the phase conjugate of a target pattern that spelled out 'UCL,' the acronym for University College London.

"Achieving similar control with phased arrays – the standard technology – would require potentially thousands of separate sources. This is highly expensive and poses significant practical challenges when scaling in size and frequency," Brown explained.

Compared to the current technology, the new method can form any arbitrary acoustic pattern using just a single source. The novel approach may lead to new biomedical applications, especially for procedures related to the skull, which is highly aberrating of acoustic waves.

"It's been shown that these lenses can be used to correct for these aberrations and focus at different locations inside the skull. This allows the tissue to be locally heated, ablated, or modulated depending on the desired application," Brown said.

Source: "Phase and amplitude modulation with acoustic holograms," by Michael D. Brown, *Applied Physics Letters* (2019). The article can be accessed at https://doi.org/10.1063/1.5110673.

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