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ABSTRACT BOOK

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ACOUSTIC HOLOGRAMS FOR TRANSCRANIAL FOCUSING OF ARBITRARY ULTRASONIC FIELDS INTO THE BRAIN

Sergio Jiménez-Gambín[1], Noé Jiménez[1], José María Benlloch[1], Francisco Camarena[1]
[1] Instituto de Instrumentación para Imagen Molecular, Consejo Superior de Investigaciones Científicas, Universitat Politècnica de València, Valencia, Spain
e-mail: serjigam@upv.es; nojigon@upv.es; benlloch@i3m.upv.es; fracafe@fis.upv.es

OBJECTIVES

We design 3D printed lenses that generate acoustic holograms correcting the aberrations of the skull and producing ultrasonic fields with the shape of brain structures. Using experimental techniques on a human skull phantom (HSP), a multiple-point focusing lens is designed to simultaneously focus at both human hippocampi; a beam following an arbitrary curved trajectory, i.e., a self-bending beam; and a holographic plate producing a broad focus that overlaps with the left hippocampus (LH).

METHODS

Skull and LH shapes are obtained from CT-scans and MRI, respectively. Time-reversal (TR) method is used to obtain the magnitude and phase of the back-propagated field at the lens surface. Lens height is obtained assuming each element to vibrate as a Fabry-Pérot resonator. Resulting lenses are 3D printed with SLA techniques.

RESULTS

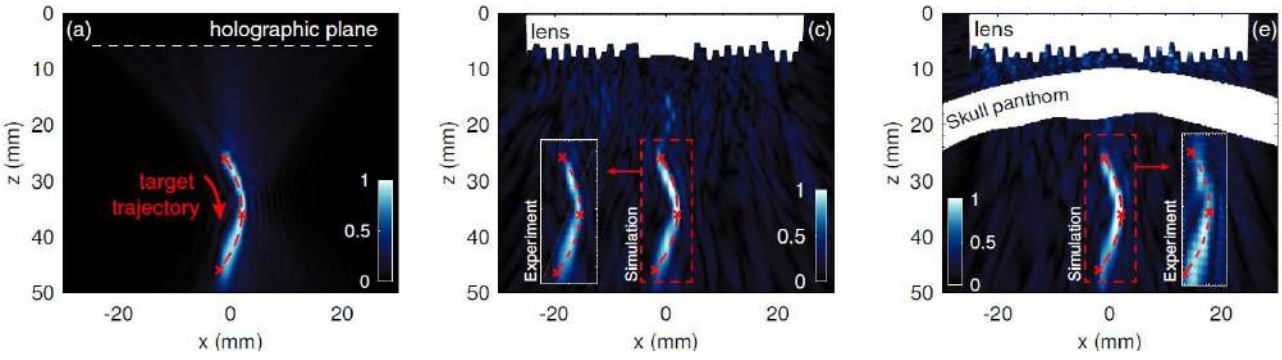
The three studied cases show similar results in simulation and experiment with and without the HSP: for the multi-focal beam, the reconstructed field accurately matches the target foci; for the curved trajectory beam, the holographic lens reconstructs the target acoustic image; for the broad focus beam, results present the same qualitative performance and provide a similar overall covering of the LH.

CONCLUSIONS

The reported holographic lenses can be used to control the spatial features of ultrasonic beams inside the skull in an unprecedented manner using single-element ultrasonic sources.

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CAPTION: Self-bending beam: a) theoretical pressure field in water, b) corresponding simulation; c) simulated field including the skull phantom. Experiments are shown in the corresponding insets.