Acoustofluidic Control of Optical Caustics

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Caustics are the unique patterns created when light reflected or refracted from one surface of an object is projected onto another surface. However, it is difficult to manually control the projected image because slight changes in the refracted surface cause nonlocal changes in the projected image. In this study, we propose a new approach to generate arbitrary caustics images by controlling the shape of the liquid surface using ultrasonic waves generated by a phased array transducer (PAT) and by manipulating the phase of the ultrasonic waves. This approach overcomes the limitations of conventional methods by using the liquid surface as a refractive surface and controlling the phase of the ultrasound. We also attempted to optimize the caustics in the loop section with a supervised neural network. Furthermore, we compared the results of an optimization method for acoustic holograms using automatic differentiation (Diff-PAT) and the caustics images generated using the acoustic holograms. We also suggested extending caustics generation to the time axis direction using a high-speed camera that captures ultrasonic-induced changes in the liquid level.

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