Abstract Submitted
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Closed loop control of the acoustic energy shielding by cavitation bubble clouds[1] KAZUKI MAEDA, Stanford University, ADAM MAXWELL, University of Washington — A closed loop control system is developed to regulate the transmission of ultrasound burst into a solid obstacle that is shielded by a layer of cavitation bubble clouds. The study is motivated by interest in improving the efficacy of kidney stone comminution during a recently proposed ultrasound-based lithtoripsy. In the system, pulses of ultrasound with a frequency of $O(100)$ kHz and an amplitude of $O(1)$ MPa are focused on a stone model from a multi-element array transducer with a pulse-repetition-frequency (PRF) of $O(10)$ Hz. The far-field, bubble-scattered acoustic waves are concurrently measured at the transducer arrays. With a high PRF, the layer of bubbles is excited on the proximal side of the stone and scatters a large portion of the incoming acoustic energy. A data-driven, reduced-order model is used to estimate the portion of the energy transmitted into the stone from the acoustic measurement in real-time. Based on the offset of the estimation from a set point, a proportional-integral controller modulates the PRF to control cavitation. The controller showed favorable performance during $O(100)$ s of continuous insonification. Lastly, the system is used to identify the optimal set point that maximizes the effective rate of energy transmission into the stone.

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