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3D Unsteady Fluid-Structure Interactions Diagnostics with a Single Plenoptic Camera BRIAN THUROW, VRISHANK RAGHAV, ZU PUAYEN TAN, Auburn University — Rising interests in fluids-structure interactions (FSI) stem from wide-ranging applications including NASA's supersonic parachute deployment, arterial flow, biomimicry and wind/wave power turbines. Conventional experimental studies of FSI nominally treat the flow and structural measurements separately, resulting in a loss of true FSI physics, especially for aperiodic flows. More recently, simultaneous six-camera approaches combining tomographic-particle image velocimetry (PIV) and stereographic-digital image correlation have been explored. However, these approaches are not economically viable and often challenging to implement especially in confined test facilities. Here, we demonstrate an alternative method of simultaneous FSI measurement using a single plenoptic camera. Equipped with a microlens array, plenoptic cameras are specialized imagers that preserve the 4D light-field of a measured volume within a single image. This enables single-camera 3D measurements to be achieved, typically with a higher degree of robustness against particle-particle occlusion than four-camera tomo-PIV. We utilized this principle and employed a newly developed kHz-rate plenoptic camera to simultaneously measure the surface morphology of a rectangular blade and the unsteady flow around it. The $3.8cm$-chord blade was immersed in a water-tunnel, held at known static angles-of-attack (0-45^o), oscillated at known frequencies (0.5-1.0Hz) and alternately switched between rigid and flexible constructions, thus providing a large dataset to benchmark the plenoptic-FSI technique's viability and accuracy.

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