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Robust Principal Component Analysis for Modal Decomposition of Corrupt Fluid Flows[1] ISABEL SCHERL, BENJAMIN STROM, University of Washington, JESSICA K. SHANG, University of Rochester, OWEN WILLIAMS, BRIAN L. POLAGYE, STEVEN L. BRUNTON, University of Washington —
Modal analysis techniques have been used to identify patterns and structures in a variety of fluid applications. However, experimentally acquired flow fields may be corrupted with incorrect and missing entries, which will degrade subsequent modal analyses. Here we explore how robust principal component analysis (RPCA) can be used to leverage global coherent structures to identify and replace spurious data points. RPCA decomposes a data matrix into a sparse component and low-rank matrix of coherent structure. We explore RPCA on a range of fluid simulations and experiments of varying complexity and assess how accurately the low rank structure in the data is recovered.In all cases, we find that RPCA extracts dominant fluid coherent structures and identifies and fills in incorrect or missing measurements. The performance is particularly striking when flow fields are analyzed using dynamic mode decomposition, which is sensitive to noise and outliers.

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