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A hybrid data-driven deep learning technique for fluid-structure interaction THARINDU MIYANAWALA, University of Moratuwa, RAJEEV JAIMAN, University of British Colombia — This presents the development of a hybrid data-driven technique for unsteady fluid-structure interaction systems. The proposed data-driven technique combines the deep learning framework with a projection-based low-order modeling. While the deep learning provides low-dimensional approximations from datasets arising from black-box solvers, the projection-based model constructs the low-dimensional approximations by projecting the original high-dimensional model onto a low-dimensional subspace. Of particular interest is to predict the long time series of unsteady flow fields of a freely vibrating bluff-body subjected to wake-body synchronization. We consider convolutional neural networks (CNN) for the learning dynamics of wake-body interaction. The time-dependent coefficients of the proper orthogonal decomposition (POD) subspace are mapped to the flow field via a CNN with nonlinear rectification, and the CNN is iteratively trained using the stochastic gradient descent method to predict the POD time coefficient when a new flow field is fed to it. The time-averaged flow field, the POD basis vectors, and the trained CNN are used to predict the long time series of the flow fields and the flow predictions are quantitatively assessed with the full-order simulation data. The proposed POD-CNN model based on the data-driven approximation has a remarkable accuracy in the entire fluid domain including the highly nonlinear near wake region.

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