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Wavelet based dynamic mode decomposition

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Dynamic Mode Decomposition (DMD) has emerged as a prominent data-driven technique to identify the spatio-temporal coherent structures in dynamical systems, owing to its strong relation with the Koopman operator. For dynamical systems with inputs (external forcing) and outputs (measurement), the input-output DMD (ioDMD) provides a natural extension to DMD so that the learned model approximates the input-output behavior of the underlying dynamics. Both DMD and ioDMD assume access to full-state measurements. In this work, we propose a novel methodology, called the wavelet-based DMD (WDMD), that integrates wavelet decompositions with ioDMD to approximate dynamical systems from partial measurement data. Our non-intrusive approach constructs numerical models directly from trajectories of the inputs and outputs of the full model, without requiring the full-model operators. These trajectories are generated by running a simulation of the full model or by observing the response of the original dynamical systems to inputs in an experimental framework. The performance of WDMD is explained through the use of modeling the input output vibrational response of a hollow cantilever beam. We illustrate the effectiveness of WDMD using both simulated beam data and experimental measurements.

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