Data-driven prediction of subsystem dynamics for explicit co-simulation

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Explicit co-simulation is an efficient means to couple subsystem dynamics in multiphysics environments, allowing each subsystem to integrate its dynamics independently from the others and keeping the dynamics consistency via the exchange of a reduced set of coupling variables at discrete-time communication points. Hardware/Human- and System-in-the-Loop interfaces also need to couple physical and virtual components through explicit, noniterative schemes. Such a solution suffers from interface discontinuities that compromise the accuracy of the integration, and can sometimes lead to instability. Polynomial extrapolation has traditionally been used to predict future subsystem inputs with the aim to alleviate interface discontinuities. Extrapolation, however, does not reflect the physical behaviour of the subsystems, which is often unknown to the rest of the environment because the only information about subsystem internals is the one contained in the coupling variables. We present a data-driven prediction of subsystem dynamics based on dynamic mode decomposition, which only uses information exposed to its environment by the subsystem. The method has been tested with nonlinear and multirate benchmark problems.