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Finding unstable periodic orbits: a hybrid approach with the use of polynomial optimization MAYUR LAKSHMI, SERGEI CHERNYSHENKO, GIOVANNI FANTUZZI, Imperial College London, DAVIDE LASAGNA, University of Southampton — A novel hybrid method of computing unstable periodic orbits (UPOs) for polynomial ODE systems is presented. Turbulent coherent structures can correspond to UPOs. This new technique combines the use of polynomial optimization with collocation and numerical continuation methods. Our method requires no a priori knowledge of trajectories. Instead, the UPO search procedure is initiated by first constructing suitably constrained auxiliary functions with polynomial optimization. In previous work (Lakshmi et al. SIAM J. Appl. Dyn. Syst., 19, 763-787, (2020)), the sublevel sets of such functions have been shown to localize UPOs. We will show how auxiliary functions can also be used to implement a simple yet effective control strategy to stabilize UPOs. This enables one to formulate a family of controlled ODE systems parameterized by a parameter k. The original ODE system is recovered as k tends to zero. Solutions that are highly unstable for k = 0 may be less unstable for other k. Periodic orbits can be converged for the controlled ODE systems with a collocation method. Numerical continuation of the obtained orbits in k allows one to find UPOs for the original system. The potential of this new method is illustrated by presenting the results of applying it to selected ODEs.

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