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Title: Backstepping control of hyperbolic PDEs in drilling via neural operators

Abstract: Traditional backstepping control for PDEs requires solving complex kernel PDEs anew whenever system parameters change, creating a computational bottleneck. We overcome this limitation by using a neural operator to learn the mapping from parameters to gain kernels offline. Focusing on torsional vibrations in drilling modeled as a damped wave equation, we reformulate it as a hyperbolic system. We prove the underlying operator’s continuity, approximate it with a DeepONet, and show that the resulting neural operator-based controller ensures stabilization, offering an efficient alternative to exact kernel computations.