Stability prediction in PDE models with hysteresis operator approximations derived from time series analysis

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Abstract

We consider the asymptotic stability behaviour of a PDE model consisting of a parabolic equation and hysteresis nonlinearities in the boundary condition. The hysteresis nonlinearities are assumed to belong to a class of generalized play or stop operators, e.g. elasto-plastic material laws or dry friction operators. In order to predict stability or instability behaviour of the initial-boundary value problem (IBVP) we use measurements on the boundary for the characterization of a class of hysteresis nonlinearities by quadratic constraints. An essential property of such a class is the passivity of the operators which follows from the second law of thermodynamics. The linear part of the IBVP is given by a transfer operator function which can also be derived from measurements. Knowing this transfer function and the quadratic constranints for the hysteresis operators we use frequency-domain stability criteria ([1]) for the prediction of asymptotic stability (i.e. weak convergence of all solutions to the stationary set) or of oscillations ([2]).

References

[1] Reitmann,V. and H. Kantz, Frequency domain conditions for the existence of almost periodic solutions in evolutionary variational inequalities. Stochastics and Dynamics, 4 (3), 483 – 499 (2004).)

[2] Reitmann,V. and H. Kantz, Convergence in evolutionary variational inequalities with hysteresis nonlinearities. Proc. EQUADIFF 11, Bratislava (2005).