Part III
Analysis of the TP Model Based Design Frameworks via a Complex Example

The goal of this part of the book is to study the use of, and to examine the effectiveness of, the theoretical methods presented earlier. This will be done using the recently extended model of the 3 Degree of Freedom (3DoF) aeroelastic wing section that includes strong nonlinear characteristics as well as friction.

Active control of aeroelasticity has been in the focus of aerospace and control engineering for several decades. An introduction to this topic can be found in [8]. The aeroelastic wing section problem has traditionally been used for theoretical as well as experimental analysis of aeroelastic behavior. A number of related studies can be found in a series of papers published in the *Journal of Guidance, Dynamics and Control*. The model used in this chapter originates from the 3DoF Nonlinear Aeroelastic Test Apparatus (NATA) model investigated with unsteady aerodynamics in [4, 5]. The model has 3 degrees of freedom and is extended with both structural nonlinearities and friction [15]. The goal is to design a state variable feedback-controller and an observer-based output feedback controller which guarantee asymptotic stability via a single trailing-edge control surface.

The challenge here lies in the strong nonlinearities and various other phenomena which characterize the wing section, such as limit cycle oscillation and even chaotic behavior emerging in the uncontrolled case. Several active controllers have been developed in [6, 7, 9–14]. The TP model transformation based control design of various aeroelastic wing section models (2DoF, 3DoF, and 3DoF model including friction) is detailed in [1–3, 15].

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