Preface

The $\mathcal{H}_\infty$-disturbance-attenuation approach to robust control has been an active research area since the 80th of the last century. If confined to linear systems, this approach is fully understood from both the frequency-domain and state-space perspectives [29, 40, 57, 98, 141, 142]. In the state-space formulation, the underlying problem of minimizing the $\mathcal{H}_\infty$ norm of a linear control system is viewed as a differential game of two antagonistic persons, and a solution of the problem is represented in terms of certain solutions of the Riccati equations arising in linear quadratic differential game theory [14].

An appropriate extension to nonlinear systems requires a controller design that would guarantee both the internal asymptotic stability of the closed-loop system and its dissipativity with respect to admissible external disturbances. The standard approach here is to construct a storage function for the closed-loop system that would constitute a Lyapunov function verifying the internal stability [61, 66, 122].

For smooth nonlinear systems, the state-space approach has been developed at nearly the same level of generality as that in the linear case. The existence of a desired controller relates to the existence of suitable solutions of appropriate Hamilton–Jacobi–Isaacs partial differential equations, which replace the aforementioned Riccati equations, and the controller synthesis is associated with these solutions.

Due to the robustness and simplicity of implementation, the nonlinear $\mathcal{H}_\infty$ controllers are widely used in practice. For example, in electromechanical applications [92], they are used when the synthesis is based on the passivity of the closed-loop system resulting from a natural storage function, which consists of the energy. Since complex nonlinear phenomena such as dry friction and backlash are not captured by the passivity-based approach, the practical utility of the approach and the achievable performance remain severely limited.

The nonsmooth $\mathcal{H}_\infty$ approach, proposed in [2] for vector fields of class C^0, admits time-periodic and time-varying settings as well [1, 89], and it is capable of counting for sampled-data measurements [16] and for hard-to-model frictional forces and backlash effects [4, 91]. We develop the latter approach in this book, within the Hamilton–Jacobi–Isaacs framework, whose meaning is augmented with http://www.springer.com/978-1-4939-0291-0

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