

Preface

Fractional systems and fractional control have received great attention recently, both from an academic and an industrial viewpoint, because of their increased flexibility (with respect to integer-order systems) which allows a more accurate modelling of complex systems and the achievement of more challenging control requirements. In this framework, the aim of this book is to present design methodologies for fractional control systems. Here, fractional control system means that the controller, the process or both can be fractional. Different approaches are described but the common framework is that the robustness of the control system is considered explicitly in the design.

Accordingly, the first part of the book is more industrial oriented and is focused on the design of fractional controllers for integer processes, aiming at evaluating the difference between fractional and integer control. In particular, fractional-order proportional-integral-derivative controllers are considered, since integer-order proportional-integral-derivative regulators are, undoubtedly, the most employed controllers in industry.

The second part of the book deals with a more general approach to fractional control systems. Well-known and effective techniques for integer-order systems, such as $\mathcal{H}_\infty$ optimal control and optimal input-output-inversion-based control are extended to fractional systems.

Actually, apart from the specific topic developed in each single chapter, the leading thread of this book is a widespread effort to generalize to the fractional case methodologies, techniques and theoretical results that are among the reasons for the success of classical (integer) control.

As already mentioned, the performance/robustness trade-off is always explicitly considered in the controller design. It is well known that designing a controller without considering robustness issues is not sensible. Here, different measures of both performance (*e.g.*, integrated absolute error, settling time, closed-loop bandwidth) and robustness (*e.g.*, maximum sensitivity, uncertainty bounds, control effort constraints) are considered, but the common concept remains a control system that explicitly takes into account the fundamental trade-off.

The book can serve as a reference for postgraduate students and academic researchers. It can be also exploited by industrial practitioners to evaluate the suitability of fractional controllers to solve a control problem in a given application. Readers are assumed to know the fundamentals of linear control systems, which are typically taught in a basic automatic control course at the university level.

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