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Identification and Control

The Gap between Theory and Practice

Springer

Foreword

This book is an ambitious attempt to bridge the infamous gap between theory and practice in control. The book has ten chapters, written by seasoned researchers from all over the world. It is organized in four parts: Large-scale Problems, Aerospace, Vision and Sound and Electromechanical, and covers a very wide range of problems from chemical reactors to magnetic bearings. In spite of the wide diversity of topics and authors a coherent presentation is obtained by a uniform organization imposed by the editors. Each chapter begins with a brief summary of the theory and a description of the application, followed by results of simulations or experiments and conclusions. The problem descriptions and the discussions about the relevance of the theory are more detailed than presentations normally found in papers. The book is a nice complement to traditional textbooks and the wide range of topics illustrate the richness and ubiquity of identification and control.

Santa Barbara, California, USA
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Karl Johan Åström

Preface

System theory, in particular, automatic control and system identification have experienced a fast evolution in the past decades. Many new methods have been developed, performance requirements in traditional engineering areas have significantly increased and new and more demanding applications in other areas of engineering and science have appeared. Many textbooks have been written that present the relevant theory and sometimes "practical" examples to which the theory has been applied. Other books focus directly on the practical issues involved, leaving the theory out. However, there is still an important gap between theory and its application to practical problems. Engineering decisions are usually made without the complete assessment of existing theoretical tools. Many times, the key to the applicability of new methods is based on such decisions. Hence, a problem appears when either theory is lacking – it trails behind the practical issues, or when engineering decisions are taken without the knowledge of recent theoretical developments.

Usually the theory/practice gap is covered by extensive simulations and/or experimental testing. There are very few (if any) situations in which the theory "fits" the practical application without any extra modification. This gap is even more important in critical situations such as nuclear plants and space applications, where the misfit between theory and practice could lead to dangerous or disastrous scenarios. Nevertheless, this gap is the motor that keeps theoreticians and practitioners active in developing new techniques and applying them in all areas of engineering. The purpose of this book it to present some examples of this gap and in this way serve as a reference, where new applied research areas are pointed out.

All chapters are written by textbook authors involved in "real world" applications from different areas of engineering: acoustics, aerospace, chemical, computer vision, electromechanical, industrial and mining. The chapters are organized with a similar format: (1) a brief theoretical background section with references to previous works; (2) the description of the application(s); (3) a presentation of simulations and/or experimental results, and (4) conclusions highlighting the discrepancy between theory and practice. The latter is what distinguishes this book from others: the gap is deliberately exposed, not hidden. Furthermore, in each chapter the complete analysis and

design process is covered, describing practical issues and decisions that accomodate the existing theory to the particular problem.

The book will be useful for engineers facing complex applications and willing to use recent methods of identification and control in solving them, in order to take sound engineering decisions. In addition, applied researchers looking for areas in which to contribute in reducing the theory/practice gap and exploring practical issues should also benefit greatly from it.

The chapters describe how different identification and control techniques are applied to a wide variety of engineering applications. The identification methods go from parametric identification of linear and nonlinear models, to robust set membership identification and model (in)validation. Control techniques range from stochastic optimal control to model predictive or robust $\mathcal{H}_\infty$ and μ-synthesis control. Also, fault tolerant and linear parameter varying (LPV) control, and the recent area of hybrid systems control techniques, have been used. Among the applications we can mention: mine planning, polymerization reactors, a copper foundry process, and the sewer network of Barcelona. Also, some electromechanical processes such as active transmission and suspension, and a magnetic-bearing rotor appear. Computer vision, aerospace applications like the NASA-JPL flexible structure or aeroservoelasticity in the F18 aircraft and acoustic-noise attenuation, are also included.

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