“Modelling, Analysis and Design of Control Systems in MATLAB and Simulink”

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<http://mechatronics.ucmerced.edu/MADbook>

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Preface

Although the benefits from the wise use of control engineering such as improved product/life quality, minimized waste materials, reduced pollution, increased safety, reduced energy consumption etc. are widely recognized, as per Karl J. Astrom, “Control is a hidden technology.” To promote the appreciation of control subject, an interesting book “Feedback and Control for Everyone” (2010, Pedro Albertos and Iven Mareels, Springer) serves the purpose. Conventional control systems are mostly signal-based control systems which are the foundation to our modern life. While moving from signal-based control to information-based control systems, the basic ideas of control systems are ubiquitous even in this increasingly information-rich world.

This textbook is about signal-based control systems following the so-called “MAD (modeling, analysis and design) notion” suggested by Prof. Kevin L. Moore of Colorado School of Mines in 1990s. To have a good control system, one needs to be asked on “What do you have?” and “What do you want?” Many iterations may be needed to design a controller with knowledge about plant model (“What do you have?”) and performance and constraints (“What do you want?”). Clearly, a computer aided design (CAD) platform must be used. MATLAB and Simulink are considered as the dominant software platform for control system modeling, analysis and design, with numerous off-the-shelf toolboxes and blocksets dedicated to control systems and related topics. The major objective of this book is to provide first-hand information on how MATLAB/Simulink can be used in control system modeling, analysis, design as well as hardware-in-the-loop rapid prototyping. The main structure of the book is outlined as follows:

* Foundation: Chapters 1, 2 and 3;
* Modeling: Chapters 4, 6
* Analysis: Chapters 5, 6, 11
* Design: Chapters 7, 8, 9, 10, 11
* Rapid Prototyping: Chapter 12

The inclusion of Chapter 12 is on purpose since in industry, MATLAB/Simulink is widely used for control system MAD and even deployment via the hardware-in-the-loop real time simulation and targeting onto various microprocessors. Another distinguishing feature is the inclusion of a dedicated PID control design chapter (Chapter 8) with various tuning methods introduced with the dedicated handy tools (e.g. {\tt PID\\_Tune} and {\tt OptimPID}) developed for this book. Chapters 10 and 11 are both interesting and useful with emerging topics for potential further research and development. Chapter 10 presented concise introduction to some major adaptive and intelligent control system design methods with illustrative design examples. Chapter 11 serves as a survival guide to the analysis and design of fractional-order systems governed by fractional order differential equations with differentiation or integration of non-integer orders. Extensive illustrative examples are presented in cartoon style so the readers can reproduce the results and gain hands-on working experience on fractional order control systems analysis and design. This is a nice feature of this book consistently seen in each section with smooth mixture of MATLAB scripts and figures. These scripts are carefully designed so the readers can mimic and even reuse the codes in their own future work.

This book can be used as a reference text in the introductory control course for undergraduates in all engineering schools. The coverage of topics is broad, yet balanced, and should provide a solid foundation for the subsequent control engineering practice in both industry and research institutes. For graduates and researchers not majoring in control, this textbook is useful for knowledge enhancement. The authors also believe that this book will be a good desktop reference for control engineers and many codes and tools in this book may be directly applicable in real world problem solving.

The first version of this textbook was published by the first author in Chinese by Tsinghua University Press, Beijing, China in 1996. It was the earliest textbook on CADCS (computer aided design of control systems) in MATLAB in China and together with its several later editions, it has been among the most popular textbooks in control systems in China with more than 60,000 copied sold. This new English edition has leveraged all welcoming aspects of the past Chinese editions in terms of the presentation style that has been optimized for self-learning as well as classroom teaching. Most importantly, we followed the MADCS (modeling, analysis and design of control systems) notion and organized the contents in the MADCS way as outlined above. The enhancement in contents includes the intelligent control, fractional order control as well as rapid prototyping of real-time control systems etc.

This textbook has a book companion website (<http://mechatronics.ucmerced.edu/MADbook>) which contains downloadable resources such as teaching slide set with over 1,000 PPTs, solution manual (for instructors only), all codes/scripts for reproducing the figure/results in this textbook, as well as several useful MATLAB tools developed exclusively for this textbook.

We would like to thank Prof. Kevin L. Moore for preparing a foreword for this book sharing his further insights in MAD.

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