Systems & Control: Foundations & Applications

Maria Prandini
Ricardo G. Sanfelice
Editors

Computation-Aware Algorithmic Design for Cyber-Physical Systems

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Preface

In the fast-evolving landscape of cyber-physical systems (CPSs), where the physical and digital realms seamlessly intertwine, the need for efficient and reliable algorithmic design has become increasingly paramount. The purpose of this book is to lay the foundations of a comprehensive framework for computation and communication-aware algorithmic design of CPSs, encompassing a multitude of disciplines and expertise. By uniting the minds of practitioners and researchers in the realms of cyber-physical systems, data-driven design, optimization, computer science, control, information theory, and safety, the book aims to identify challenges and put forth solutions with the potential of leading to computationally aware CPSs.

With a primary focus on the design of algorithms for CPSs, this book delves into the intricate realm of computation-aware algorithmic design, emphasizing the inclusion of computational and communication constraints from the very inception of the design process. By acknowledging the impact of these constraints on performance and safety, the material included in the book strives to unlock valuable insights into promising approaches and uncover the potential synergies that can arise from the integration of diverse methodologies. Through the exploration of formal methods, model-predictive control, distributed optimization, data-driven techniques, reconfigurable/adaptive methods, and information theoretic principles, we hope that the book will foster innovation and empower the emergence of novel approaches in CPS design.

Our sincere aspiration is that this book serves as a catalyst, sparking fruitful collaborations among researchers from different fields. By bridging the domains of control theory, telecommunication, computer science, and operational research, we endeavor to stimulate collective efforts in the development of algorithms for CPSs, with a focus on achieving performance guarantees under computation constraints.

We must acknowledge that the journey of this book has been beset by unexpected challenges. The emergence of the global pandemic disrupted the conventional rhythm of our work, causing significant delays in the completion of this endeavor. Nevertheless, the perseverance and dedication of the contributors, combined with the support and understanding of the publisher, have enabled us to surmount these obstacles and make this work available.

We extend our deepest gratitude to all the experts who have contributed their knowledge, insights, and experiences to this book. Their collective wisdom has enriched the content and ensured its relevance in the ever-changing landscape of CPSs. We also extend our appreciation to the readers, whose curiosity and commitment to advancing the field of CPSs inspire us to continue our pursuit of excellence. In addition, we would like to thank the sponsors of the research projects that resulted in the advances reported in this book, including the United States Air Force Office of Scientific Research and the Air Force Research Laboratories, as well as the National Science Foundation, in particular, through the project entitled CPS: Frontier: Computation-Aware Algorithmic Design for Cyber-Physical Systems Under Uncertainty. It is our hope that this book will serve as a cornerstone for computation and communication-aware algorithmic design of cyber-physical systems, laying the groundwork for future breakthroughs and fostering collaborations that drive us toward a more intelligent and interconnected world.

Milan, Italy — Maria Prandini
Santa Cruz, CA, USA — Ricardo G. Sanfelice

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