

Preface

Networked Cyber-Physical Systems (NCPSs) consist of computing devices acting synergically by a communication network and interacting with a complex physical process distributed over a given area.

The technological advances in the fields of communication networks and embedded systems have been a major driving force for the widespread, ubiquitous, and emerging NCPS applications ranging from power systems, smart buildings to medical devices to robot autonomous systems.

An NCPS monitors and controls physical variables via sensor, actuator, controller, and robot nodes closed in a feedback loop with the distributed process. Nodes operations are coordinated through a communication network. In this way the performance of NCPS is affected by both the reliability of the network supporting the communication functionality and the efficiency of the control systems interacting with the physical environment. Therefore, the design of NCPS requires basic science foundation synergically drawing on several branches including control theory and computer science.

The book is triggered by the challenging interdisciplinary problem to formulate design approaches for NCPSs. In this respect, the book first introduces a novel multilayer conceptual framework taking into account the communication network and control system features of NCPS. Then a multilayer distributed and cooperative control is devised to simultaneously cope with NCPS network and control requirements. A practical aim of the proposed control approach is to distribute the computational burden among the different devices that cooperatively achieve NCPS' goals.

The intended audience of this book will mainly consist of researchers, research students, and practitioners in automatic control and computer science. The book is also of interest to industrial practitioners in areas such as automation, engineering, sensor networks, robotics, and computer networks. It is suitable for classroom use or as a reference for professionals. Presenting co-design examples that illustrate practical applications derived from theory, the textbook is also suitable for use in upper undergraduate and graduate-level university courses. Nevertheless, I hope

that this text will be helpful for readers with very different backgrounds as required to deal with NCPS' design and analysis.

The book is organized in five chapters: Chap. 1 introduces the basic notion of NCPS and the novel multilayer control system conceptual framework to deal with the NCPS design. The multilayer control system is composed of the *network layer control system* and the *application layer control system*. The first one copes with NCPS communication network requirement while the latter with the NCPS control system performance. At each layer a cooperative consensus-based control law is formulated. Chapter 2 presents convergence and stability results, performance and implementation issues of the *network layer control system*. Chapter 3 is devoted to present convergence and stability results, performance, and implementation issues of the *application layer control system*. Design and co-design indications are also provided for the design of the overall multilayer control system. Chapter 4 focuses on the application of the design approaches presented in Chap. 2 to different kinds of autonomous and queuing systems (Content delivery, TCP/ATM and wireless networks). Finally Chap. 5 shows the application of the proposed multilayer control approach to the design of representative NCPSs including monitoring and robots systems. Co-design examples are given in order to illustrate how to take into account the algorithms implementation features in the NCPS design.

Italy
May 2016

Sabato Manfredi

Multilayer Control of Networked Cyber-Physical Systems
Application to Monitoring, Autonomous and Robot
Systems

Manfredi, S.

2017, XVIII, 137 p. 75 illus., 57 illus. in color., Hardcover

ISBN: 978-3-319-41645-8