Preface

Hydrosystems are an important element of the hydraulic cycle. In this book we deal with hydrosystems that can be managed, and focus our attention on the management of surface water flows. Other important aspects of the water cycle such as underground water flow are not considered in this book.

With population growth and climatic change impacting water resources, the existing water transport systems need to be modernized, in order to optimize the use of this precious resource.

The methods developed in this book apply to hydrosystems that can be controlled: in irrigation canals, the gates need to be operated in order to deliver water to the user; in navigation waterways, water levels need to be controlled accurately to ensure given water depths along the reaches; in combined sewer systems, overflow may be prevented by opening or closing of gates; hydroelectric power plants in regulated rivers need controllers to maintain the river water levels close to some target value; and regulated rivers used to transport water to users need to have the water release adjusted from the upstream dam to satisfy the water demand. The book mainly focuses on the control of irrigation canals and of regulated rivers, but the techniques presented can easily be adapted to other hydrosystems.

To design automatic controllers for such systems, one needs accurate models describing the open channel dynamics. The Saint-Venant equations are commonly used by hydraulic engineers to describe open channel flow dynamics. These equations are nonlinear partial differential equations, which have a complex behavior in general, can exhibit shocks, and are therefore difficult to study for control design.

In this book we propose to study the linearization of the Saint-Venant equations around realistic steady flow solutions, and to design controllers that stabilize the set of linearizations. This pragmatic approach is closely related to the gain-scheduling approach commonly used in the automatic control community to control real systems such as power plants, airplanes, missiles, etc.

This book uses concepts from automatic control and from hydraulic engineering. We wrote the book in an attempt to bring together both communities. Some developments considered as well-known by one readership may appear rather new to the other one. The book is intended for automatic control researchers or engineers, environmental hydraulics researchers or engineers, but it may also attract the interest of open channels managers and of graduate and undergraduate students in both fields.

The mathematical prerequisites are basic algebra, undergraduate mathematics, and some basic physics. Some sections of the book contain more theoretical material, but they can be skipped by the reader who is more interested by practical applications. We tried to explain the mathematical results by giving physical explanations, including figures and graphs, to illustrate the practical interest of our results.

A set of MATLAB® files are provided (available from www.springer.com/978-1-84882-623-6) so that the interested reader can test the methods developed in the book. These MATLAB® files also use Simulink® and the Control System Toolbox™.

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The methods proposed in this book have been validated on an experimental canal located at the University of Évora in Portugal. The collaboration with Professor Manuel Rijo was supported by the French Ministry of Foreign Affairs and GRICES (Gabinete de Relações Internacionais da Ciência e do Ensino Superior), through the French–Portuguese scientific collaboration projects PAI no. 547-B4 in 2000–2003 and PESSOA no. 09685UE in 2005–2007. We thank Professor Rijo for giving us the opportunity to use the canal, and for his hospitality during our stays in Portugal.

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