Preface

This book is about the theory of continuous-state automated systems whose inputs, outputs and internal variables (temperature, speed, tension, etc.) can vary in a continuous manner. This is contrary to discrete-state systems whose internal variables are often a combination of binary sizes (open/closed, present/absent, etc.).

The word "linear" requires some explanation. The automatic power control of continuous-state systems often happens through actions in relation to the gaps we are trying to control. Thus, it is possible to regulate cruise control by acting on the acceleration control proportionally to the gap observed in relation to a speed instruction. The word "proportional" precisely summons up a linear control law.

Some processes are actually almost never governed by laws of linear physics. The speed of a vehicle, even when constant, is certainly not proportional to the position of the accelerator pedal. However, if we consider closed loop control laws, the return will correct mistakes when they are related either to external disturbances or to gaps between the conception model and the actual product. This means that modeling using a linear model is generally sufficient to obtain efficient control laws. Limits to the automated systems performances generally come from the restricted power of motors, precision of captors and variability of the behavior of the processes, more than from their possible non-linearity.

It is necessary to know the basics of linear automated systems before learning about the theory of non-linear systems. That is why linear systems are a fundamental theory, and the problems linked to closed-loop control are a big part of it.

Input-output and the state representations, although closely linked, are explained in separate chapters (1 and 2). Discrete-time systems are, for more clarity, explained in Chapter 3. Chapter 4 explains the structural properties of linear systems. Chapter

5 looks into deterministic and statistical models of signals. Chapter 6 introduces us to two fundamental theoretical tools: state stabilization and estimation. These two notions are also covered in control-related chapters. Chapter 7 defines the elements of modeling and identification. All modern control theories rely on the availability of mathematical models of processes to control them.

Modeling is therefore upstream of the control engineer. However, pedagogically it is located downstream because the basic systems theory is needed before it can be developed. This same theory also constitutes the beginning of Chapter 8, which is about simulation techniques. These techniques form the basis of the control laws created by engineers.

Chapter 9 provides an analysis of the classic invariable techniques while Chapter 10 summarizes them. Based on the transfer function concept, Chapter 11 addresses pole placement control and Chapter 12 internal control. The three following chapters cover modern automation based on state representation. They highlight the necessary methodological aspects. H_2 optimization control is explained in Chapter 13, modal control in Chapter 14 and H_∞ control in Chapter 15. Chapter 16 covers linear time-variant systems.