Jump Linear Systems in Automatic Control*

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A description of the book's content by chapter follows. In Chapter 1 the model for control under uncertainty is introduced and motivated. Examples of control processes with changing dynamics are: a manufacturing process in which machines may be in one of several operating states; a solar thermal receiver in which the controller must adapt to the rapidly changing radiation intensities; control systems that must satisfy high-fault-tolerance specifications as in spacecraft. Chapter 2 presents concepts of controllability, stability, and stabilizability for the class of hybrid systems with linear control systems. Examples are presented that show the interaction of the continuous and discrete parts of the hybrid system.

Control synthesis starts in Chapter 3. Attention is restricted to a deterministic time-invariant finite-dimensional linear system of which the parameters are modelled by a finite-state Markov process. In the complete observations case both the state of the control system and the regime are observed. The set of admissible control laws includes only functions of past states and the past of the regime. The cost function is the expected value of an integral of a quadratic form in the state and the input process. The optimal control law is linear in the state while the parameters of the control law depend on the regime. For this a successive approximation algorithm and a homotopy algorithm are described and illustrated with examples.

Chapter 4, titled "Robustness", actually concentrates attention on the sensitivity of performance measures for changes in the model and in the control law. The cost criterion used in the preceding chapter is the expected value of an integral of a quadratic form in the state and input process. In this chapter the distribution of the integral is considered. In statistical decision theory it is common practice to use nonlinear utility functions that will bring out the risk-sensitivity of a statistical decision problem. In stochastic control the emphasis on minimum variance control and on the Linear Quadratic Gaussian (LQG) problem has long obscured the risk-aspect of control of stochastic systems. Only the recent interest in the exponential cost criterion has rekindled interest in the risk-sensitivity of stochastic control problems. In this chapter attention is focused on the variance of the integral cost, on the probability that the integral cost exceeds a specified bound, and in a special case on the distribution of the cost. The effect of different feedback laws on these performance measures is evaluated. Next a minmax solution is derived in which the upperbound on the support of the integral is minimized. Another viewpoint is that in which the regime process is chosen by nature. The optimum is obtained for a constant regime, hence the optimal control problem reduces to a deterministic control problem. This result is called an equalizing solution.

In Chapter 5 the jump quadratic Gaussian regular problem is considered. The continuous-time stochastic control system is described by a stochastic differential
The purpose of this introductory chapter is to present the basic model that we shall study and to settle corresponding vocabulary and notational conventions. Using examples, we insist on the modelling aspect and on the process of abstracting the main features of a given application into a hybrid model.