Preface

Neural networks have become a well-established methodology as exemplified by their applications to identification and control of general nonlinear and complex systems; the use of high order neural networks for modeling and learning has recently increased.

Using neural networks, control algorithms can be developed to be robust to uncertainties and modeling errors. The most used NN structures are Feedforward networks and Recurrent networks. The latter type offers a better suited tool to model and control of nonlinear systems.

There exist different training algorithms for neural networks, which, however, normally encounter some technical problems such as local minima, slow learning, and high sensitivity to initial conditions, among others. As a viable alternative, new training algorithms, for example, those based on Kalman filtering, have been proposed.

There already exists publications about trajectory tracking using neural networks; however, most of those works were developed for continuous-time systems. On the other hand, while extensive literature is available for linear discrete-time control system, nonlinear discrete-time control design techniques have not been discussed to the same degree. Besides, discrete-time neural networks are better fitted for real-time implementations.

This book presents a solution for the trajectory tracking problem of unknown nonlinear systems based on four schemes. For the first one, a direct design method is consider, the well known backstepping one, under the assumption of the complete access to the state; the second one considers an indirect method, solved with the block control and the sliding mode techniques, under the same assumption. For the third scheme, the backstepping technique is reconsidered, including a neural observer; and finally the block control and the sliding mode techniques are used again, with a neural observer. All the proposed schemes are developed in discrete-time and include the respective stability analyses, using the Lyapunov approach, for each one of the proposed schemes.

To this end the real-time implementation for the schemes proposed in this book are presented, validating the theoretical results, using a three phase induction motor benchmark. The control of an induction motor is challenging, since its dynamics is described by multivariable, coupled, and highly nonlinear system; besides, it is one of the most used actuators for industrial applications due to its reliability, ruggedness, and relatively low cost.

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