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SERIES INTRODUCTION

Neural and Fuzzy Systems: The Emerging Science of Intelligent Computing, twelfth in the SPIE Institute Series, is representative of SPIE's primary goal for this series: to provide, in a timely manner, authoritative overall introductions and reviews of emerging or critical technologies based on or related to optics and optoelectronics.

The eleven contributions present topics in what one might term the "science of reasoning," discussing, as they do, the principles and algorithms for neural network and autonomous robot systems. Matters of control and decision in systems having nonlinear dynamic characteristics are at the core of modern research in these areas. Again, as demonstrated by previous Institute volumes, the time lapse between fundamental research and technological applications in this field is narrowing significantly. Developments on one side of the R&D ledger lead to, and are balanced by, new concepts and approaches in the other. The Institute Series hopes to encourage and abet such synergism.

It is expected that this book will be of interest to those bodies of scientists and engineers involved in the R&D of a variety of technologies—computer vision, image processing, artificial intelligence, neural networks, and robotic command and control. That there are other technologies that might have an interest in and benefit from developments in this field of neural and fuzzy systems, I have no doubt.

Roy F. Potter
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PREFACE

The concept of adaptive learning of system parameters in nonlinear systems has been addressed by system theorists for quite some time. The independent use of neural networks and fuzzy logic to facilitate such adaptive learning is, however, very recent. An even more recent trend has been to combine the strength of adaptive learning in neural networks with the fuzzy membership values of input/output data for designing better identification, recognition, and control systems.

The idea of publishing an SPIE Institute Series volume on the emerging science of intelligent computing was first discussed with Roy F. Potter, the series editor, while planning a workshop on Neuro-Control Systems that was held during the SPIE Symposium on Aerospace Sensing, 20–24 April 1992 in Orlando. This workshop was made possible by the sponsorship of Northrop Corporation through a symposium grant awarded to Texas Tech University. Keynote speakers at the workshop included Lotfi Zadeh (Univ. of California/Berkeley), James Bezdek (Univ. of West Florida), Madan Gupta (Univ. of Saskatchewan), James Keller (Univ. of Missouri/Columbia), and Robert Lea (NASA/JSC). Wolfgang Kraske (Northrop Corp.) and Sunanda Mitra (Texas Tech Univ.) were among the other speakers.

This twelfth volume in the SPIE Institute Series, *Neural and Fuzzy Systems*, presents some of the ideas and applications involving neural networks and/or fuzzy logic for better representation and operation of dynamical systems. Eleven chapters from researchers in six countries have been included. Chapter 1 describes the general behavior of nonlinear dynamical systems that are often chaotic. During the evolution of a dynamical system, information content may undergo degradation under iteration of usual fuzzified chaotic mappings. This chapter investigates more general classes of fuzzy chaos based on t-norms/conorms. Chapter 2 discusses the implementation of fuzzy rules for approximate case-based reasoning in neural network units. Chapter 3 presents a hierarchical structure of intelligent servo control for robotic motion, including fuzzy logic combined with neural networks. Chapter 4 describes a neural model for constrained inverse kinematic transformations for two- and three-linked robots. Chapter 5 presents a fuzzy controller model of highly complex and nonlinear dynamics of tether operations in space. Chapters 6 through 8 investigate different approaches for fuzzy and neuro-fuzzy techniques as applied to problems in computer vision, image processing, and pattern recognition. Chapters 9 through 11 discuss fuzzy and fuzzy morphological operators and algorithms used in analyzing higher-dimensional data sets. Chapters 6 and 8 present new neuro-fuzzy and possibilistic approaches to clustering techniques, while Chapter 11 reviews current fuzzy morphological filtering techniques for clustering noisy multidimensional data.

Clustering is a well-known technique that has been used primarily for partitioning complex data sets of unknown data distribution. However, interest has grown recently in using clustering for identification of system parameters in nonlinear dynamical systems.

I would like to thank Madan Gupta for his encouragement in organizing the workshop in Orlando, as well as the other keynote speakers, Lotfi Zadeh, James Bezdek, James Keller, and Robert Lea, for their valuable help in making the workshop successful. I am grateful also to Wolfgang Kraske, without whose support the workshop and book would not have materialized, and to Roy Potter, editor of the SPIE Institute Series. Finally I would like to thank SPIE staff Mary Horan, Anne Noteboom, and Eric Pepper, and all the authors, for their valuable contributions and efforts in making this volume possible.

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