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Type-2 Fuzzy Logic in Intelligent Control Applications

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Preface

We describe in this book, hybrid intelligent systems using type-2 fuzzy logic for intelligent control and mobile robotics. Hybrid intelligent systems combine several intelligent computing paradigms, including fuzzy logic, and bio-inspired optimization algorithms, which can be used to produce powerful automatic control systems. The book is organized in three main parts, which contain a group of chapters around a similar subject. The first part consists of chapters with the main theme of theory and design algorithms, which are basically chapters that propose new models and concepts, which can be the basis for achieving intelligent control and mobile robotics. The second part contains chapters with the main theme of evolutionary optimization of type-2 fuzzy systems in intelligent control with the aim of designing optimal type-2 fuzzy controllers for complex control problems. The third part contains chapters with the theme of bio-inspired optimization of type-2 fuzzy systems in intelligent control, which includes the application of particle swarm intelligence and ant colony optimization algorithms for obtaining optimal type-2 fuzzy controllers.

In the part of theory and algorithms there are 4 chapters that describe different contributions that propose new models and concepts, which can be considered as the basis for achieving intelligent control and mobile robotics. The first chapter offers an introduction to the area of type-2 fuzzy logic for intelligent control applications. The second chapter describes the basic concepts and theory of type-2 fuzzy logic that will be used in the applications mentioned in the book. The third chapter describes a general methodology for the design of type-2 fuzzy logic controllers. The fourth chapter describes the important concept of stability in type-2 fuzzy controllers and a systematic method to achieve it.

In the part of evolutionary optimization of type-2 fuzzy systems intelligent control there are 5 chapters that describe different contributions on achieving control using hybrid intelligent systems based on type-2 fuzzy logic. The first chapter describes the hardware implementation of interval type-2 fuzzy controllers on FPGAs. The second chapter deals with automatic control of aircraft dynamic systems using type-2 fuzzy controllers generated by genetic algorithms. The third chapter describes the design of type-2 fuzzy reactive and tracking controllers for autonomous mobile robot navigation. The fourth chapter describes the application of genetic algorithm for the automatic design of interval type-2 fuzzy controllers for linear and non-linear plants. The fifth chapter proposes the use of the human evolutionary model for the design of intelligent type-2 fuzzy logic controllers for general applications.

In the part of bio-inspired optimization of type-2 fuzzy controllers there are 4 chapters that describe different contributions of new algorithms for optimization and their application to designing optimal type-2 fuzzy logic controllers. The first chapter describes the optimization of type-2 fuzzy logic systems using ant colony optimization for the design intelligent controllers for mobile robots. The second chapter deals with an approach for the optimization of membership functions for fuzzy control based on the ant system algorithm. The third chapter describes the application of particle swarm algorithms in the optimization of interval type-2 fuzzy logic control for autonomous mobile robots. The fourth chapter describes the optimal design of intelligent type-2 fuzzy logic controllers for non-linear plants using particle swarm optimization.

In conclusion, the book comprises chapters on diverse aspects of type-2 fuzzy logic and evolutionary and bio-inspired models for achieving intelligent control for different applications, including mobile robotics. The combination of evolutionary or bio-inspired optimization methods with type-2 fuzzy logic can be considered as a hybrid approach for obtaining efficient and accurate solutions to complex control problems.

July 21, 2011

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