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GUEST EDITORIAL

Fuzzy Control Using Bio-inspired Learning Algorithms

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Fuzzy systems have been successfully applied in many areas, such as system modeling and controls. A major task in fuzzy controller (FC) design is deriving fuzzy control rules, which is often difficult and time-consuming, and requires expert knowledge. The advent of bio-inspired learning algorithms, such as neural learning, genetic algorithms and particle swarm optimization, has inspired new methods for solving optimization problems. Design of FCs can be regarded as an optimization problem, and therefore, the application of bio-inspired learning algorithms to automate the design of FCs has drawn much attention in recent years. These automatic design approaches not only ease controller design efforts, but also improve system control performance. This special issue of IJCIC presents the most advanced and relevant results in the field of fuzzy control using bio-inspired learning algorithms. This issue contains five articles, each of which was recommended for acceptance by two reviewers in the peer review and selection process.

The topologies of recurrent networks include feedback loops, which are used to memorize past information. For dynamic plant control, the use of recurrent network controllers (such as recurrent neural controllers and recurrent fuzzy neural controllers) has been shown to be more efficient than feedfordward network controllers. The first paper, "Synchronization of coupled neurons via a TSK-type recurrent fuzzy neural network with asymmetric Gaussian membership functions" by Hsu, and the fifth paper, "Nonlinear fuzzy neural controller design via EM-based Hybrid Algorithm" by Lee and Lee, use recurrent networks as controllers. The first paper proposes an adaptive Takagi-Sugeno-Kang (TSK)-type recurrent fuzzy neural control (ATRFNC) system that is composed of a neural controller and a robust compensator. This control approach avoids deriving complicated mathematical models of controlled plants, which is a typical advantage of using computational intelligence technique in control problems. All of the parameters in the ATRFNC are online tuned with stability analysis using Lyapunov function. The control approach has been applied to the synchronization of coupled neurons. The fifth paper uses recurrent fuzzy neural networks for nonlinear system control. Parameters in the networks are optimized using a hybridization of electromagnetism-like (EM) algorithm and PSO method. This modified PSO algorithm has been shown to be more efficient and effective than traditional PSO and GA in illustrated control examples.

The second paper, "Intelligent dgital redesign of T-S fuzzy controller via particle swarm optimization" by Hsu, Chu and Chien, proposes a novel intelligent digital redesign method by using a TSK fuzzy model for complex continuous-time systems. The FC redesign approach consists of two steps. The first step processes continuous-time nonlinear systems using the TSK fuzzy model, followed by designing a continuous-time controller using individual rules. The next step expresses all possible linear systems as interval systems and searches for the range of digital-controller parameters using PSO.

Optimization of controller parameters using GAa and PSO is uaually performed off-line. The third paper, "Backstepping-based genetic fuzzy-neural controller and its application in motor control with buck DC-DC converters" by Leu, Lin and Lu, proposes an online genetic fuzzy control approach. This paper combines the idea of conventional nonlinear controller design with genetic fuzzy control. An FC is derived using the backstepping control law and Lyapunov stability analysis. The parameters of the FC are tuned using GA for backstepping-based fitness function minimization.

The fourth paper, "Evolutionary computation and DSP based intelligent aircraft landing control" by Juang, Chiou and Lee, is a typical representative of complementing traditional controllers using FCs. This paper uses a fuzzy cerebellar model articulation controller (FCMAC) to compensate for the PID control signal. Control gains are selected by evolutionary computation. This paper applies the hybrid control approach to aircraft landing control problem and the control performances are analyzed and compared with different control approaches.

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