Editorial

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Being different from other traditional research disciplines, the research of fuzzy control stems in the early 1980s from applications, instead of from theoretical development. Fuzzy control has become a practice alternative for numerous challenging control applications because it can provide ways of constructing non-linear controllers with the use of heuristic information or some intelligent means. In recent years, the research of fuzzy control has been extensively explored and has gained a variety of achievements in the theoretical aspect. However, the applications of those achievements are not well discussed and analysed. In this special issue, we intend to bring a comprehensive coverage for the technologies in fuzzy control applications.

There were 33 papers submitted for consideration for publication in this special issue. Those papers came from more than ten countries. It is surely a big success for the call-for-paper process. We thank those who submitted papers to this special issue. After two rounds of reviewing processes, only 12 papers were selected for publication in this issue. Given the volume of papers received, we were able to accept only papers that are clearly outstanding and without any negative comments. We are sorry that we do not have space for some quite good papers. We briefly summarise those papers as follow.

'Fuzzy logic controller design methodology for Cartesian robot control', by Touati and Amirat, proposes a two-stage approach for designing fuzzy logic controllers for hybrid force/position robot control. In the offline learning stage, Solis' and Wetts' algorithm is employed to constrain the interpretability and semantics of the predefined fuzzy rules. In the online learning stage, the system is online modified through the use of the back-propagation learning algorithm. The proposed approach has been implemented in a C5 parallel robot and showed efficiency in the experiment.

'Liapunov stability for a fuzzy PID controlled flexible-joint manipulator', by Misir and Malki, presents Liapunov stability analyses for flexible-joint robotic manipulators controlled by a fuzzy proportional-integral-derivative (PID) controller. This novel fuzzy PID controller preserves the simple linear structure of its conventional counterpart, and yet enhances its self-tuning control capability, thereby significantly improving tracking control performance. A two-link flexible-joint robot arm is used as an example to demonstrate the superior performance of the proposed approach.

'Fuzzy-scheduling integral control of induction servo motor with actuator saturation via LMI approach', by Chang et al., proposes a fuzzy-scheduling integral control scheme for induction servo motor systems. The saturation phenomenon of inputs has been dealt with in terms of perturbation. The approach has been implemented in a DSP based induction motor and the results indeed show satisfactory performance.

'Fuzzy gain scheduling technique for power flow control', by Oudalov et al., describes an application of fuzzy logic-based control for power systems governing multiple Flexible Alternative Current Transmission System (FACTS) devices. In the proposed approach, sufficiently accurate relations are derived to determine the set-points of FACTS devices, using fuzzy reasoning. These expressions are based on the coefficients of influence, which are online adapted through a fuzzy gain scheduling method. The approach has

been tested using simulation software for Swiss power systems. Results show that the developed control strategy is a very effective tool for dealing with power flows in complex transmission networks, using multiple FACTS devices.

'Fuzzy control with input energy and state variance constraints for perturbed ship steering systems', by Chang and Wu, considers the fuzzy controller design problem for non-linear perturbed ship steering systems. The non-linear perturbed ship steering system is represented by a Takagi-Sugeno (T-S) fuzzy model, which has similar dynamics to the original non-linear system. By using linear feedback controller design technology, a non-linear fuzzy controller is constructed for the perturbed T-S type ship steering model. The stability conditions, minimum control input energy, and individual state variance constraints for the proposed fuzzy control system are then addressed in the paper. A numerical simulation has been conducted to show the effectiveness of the proposed approach.

'Optimal tuning of a fuzzy logic single-phase active power filter via the Nelder-Mead method', by Cecati et al., describes an optimisation method for fuzzy logic, based single-phase active power filters (APFs). A two-step optimisation technique, based on the Nelder-Mead simplex method is proposed to real-time tune the controller. Simulations and experimental results obtained using a low cost micro-controller (SH7045) demonstrate system capability of achieving fast convergence rate, nice power factor correction, and low harmonics content.

'Online context switching for real time control applications using re-configurable fuzzy inference chip', by Cao et al., reports the work of a hardware fuzzy inference process. The system is referred to as the re-configurable fuzzy inference chip (RFIC), which can support online real-time context switching. The RFIC can be extended to support evolvable fuzzy hardware. The results confirm the applicability of the RFIC in supporting the implementation of intrinsic evolvable fuzzy hardware.

'Annealing robust fuzzy basis function for modelling with noise and outliers', by Jeng, proposes an annealing robust fuzzy basis function (ARFBF), to improve the modelling capability of the fuzzy basis function under noise and outliers. A repeated support vector regression (RSVR) approach is proposed to determine the initial structure of ARFBF. An annealing robust learning algorithm (ARLA) is then used as the learning algorithm to adjust the parameters of ARFBF. Simulation results show the validity and applicability of the proposed ARFBF.

'Fuzzy sliding mode control for a class of non-linear continuous systems', by Essounbouli, Hamzaoui, and Zaytoon, presents a fuzzy sliding model control scheme for non-linear uncertain and disturbed systems. Two adaptive fuzzy systems are used to determine the equivalent control signal. To overcome the design constraints in the classic sliding mode control, an adaptive fuzzy system and an attenuation term are introduced in the control law. A PID adaptation law is used to update the adjustable parameters of this fuzzy system. The synthesised controller efficiently eliminates the chattering phenomenon without requiring any particular knowledge about the upper bounds of both the external disturbances and the approximation errors. The simulation results indeed show nice tracking performance of the proposed algorithm.

'Fuzzy controller design for a class of model reference adaptive systems', by Han, proposes a way of designing fuzzy controllers for a class of model reference adaptive systems with uncertainties, which may be completely unknown or partially unknown. A switching function with an adaptive coefficient based on the tracking error is adopted to deal with the uncertainties. A non-linear system is used as an example to demonstrate the effectiveness of the proposed approach.

'A fuzzy rule based adaptive centre weighted median filter', by Chiang, Chiu and Wang, presents a fuzzy rule based adaptive centre weighted median (FCWM) filter for image restoration. Based on statistical measures of image, the parameters of fuzzy membership functions are determined. The adequate centre weight is the output of fuzzy rules and is used to attain the final output pixel. The proposed filter establishes the associated rules straightforwardly and quickly without looking for the threshold iteratively. Simulation results show superior performance of the proposed FCWM filter, either in detail preservation or in noise suppression.

Finally, 'Design of proportional parallel distributed compensators for non-linear systems', by Er, Zhou and Chen, presents a design methodology for stabilising of a class of non-linear systems. The considered non-linear system is approximated by a Takagi-Sugeno fuzzy model. Then, 'Parallel Distributed Compensators' (PDC) and 'Proportional Parallel Distributed Compensators' (PPDC) are designed to stabilise the system. Novel PPDC design with a more flexible controllable range for various coefficients of the compensator is proposed. Both compensators are applied to controlling an agile missile system. Simulation results show that the closed-loop system is stable and the proposed PPDC has more superior performance than PDC does.

Indeed, the above papers do not cover a wide range of the current development for fuzzy control applications. Nevertheless, we hope this collection of fuzzy control application studies can serve as a cornerstone that can provide researchers with ideas about how fuzzy control can possibly be employed in various applications. Hopefully, after years of adventure, fuzzy control can indeed play an important role in human civilisation, as expected by us.