Editorial

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Biographical notes: Hong Chen received her BS and MS degrees in Process Control from the Zhejiang University, China, in 1983 and 1986, respectively, and her PhD degree from the University of Stuttgart, Germany, in 1997. In 1986, she joined Jilin University of Technology, China. From 1993 to 1997, she was a 'wissenschaftlicher Mitarbeiter' at the Institut fuer Systemdynamik und Regelungstechnik, University of Stuttgart. Since 1999, she has been a Professor at the Jilin University, where she serves currently as Tang Aoqing Professor. Her current research interests include model predictive control, optimal and robust control, nonlinear control and applications in process engineering and mechatronic systems.

Chin-Yuan Perng is currently a CAE Supervisor in Transmission and Driveline Engineering at Ford Motor Company. He leads a CAE team responsible for developing analytical methods in computational fluid dynamics, multi-body dynamics, hydraulic controls, and dimensional management to support system and component product developments. He is also responsible for leading technical integrations of CAE methods into design verification process. He received his PhD in ME from Stanford University. He also serves as an Adjunct Assistant Professor at the University of Michigan, Dearborn.

Henry Zhang is the Director of Center for Technology Development, and Associate Professor of Mechanical Engineering Technology at Purdue University. Before he joined Purdue University, he was a senior specialist of automatic transmission engineering at the Chrysler Technology Center. His research interests are vehicle powertrain design, manufacturing and controls, and electro-mechanical system design. He received his PhD in Mechanical Engineering from University of Michigan, Ann Arbor. He also has other four engineering degrees in mechanical engineering, hydraulic control, and electrical and computer engineering.

Electronic control has become the core enabling technology in the automotive industry to meet the increasingly stringent emission legislation and dynamic performance requirements. Accordingly, automotive electronics are accounting for more and more proportion of the manufacturing cost of the whole vehicle, including not only hardware cost but also the development cost of control software.

Although at present the widely used control algorithms are still based on event-driven (rule-based) feed-forward and PID control, how to design high-performance control program efficiently using model-based methods has become a hot topic in the fields of automotive powertrain control.

The application of model-based control is attractive because of its potential to reduce the calibration workload and improve the dynamic control performance under numerous driving conditions and large environmental variations. The papers in this special issue cover the fields of engine, alternative power-plant, hybrid electric vehicle and their transmissions.

In papers ‘Fuel air ratio control of spark ignition engine using delayed feedback approach’ and ‘Periodic time-varying model-based predictive control with input constraints for air-fuel ratio control in IC engines’, in-depth investigations of air-fuel ratio control of engines are carried out, wherein time-delay, parameter uncertainties, imbalance between cylinders are considered.

In ‘Multi-cylinder spark-assisted homogeneous charge compression ignition engine balancing control’, the authors aim to achieve HCCI in multi-cylinder engines. A practical balancing control strategy, utilising a novel lambda lean limit searching method and CA50 mid-range control strategy, is proposed to address the challenges imposed by cylinder-to-cylinder variations.

In ‘Model-based calibration for the control variables of an Atkinson cycle engine’, a physical model-based calibration methodology, in combination with a novel load control strategy, is proposed to improve the fuel economy for an Atkinson cycle engine over its entire part-load range. The resulting physical experiments show that the measured fuel economy could be improved up to 7.67% against a baseline Otto cycle engine.

In the paper ‘Model based rail pressure control of GDI engine’, the researchers present a model-based rail pressure control (RPC) scheme for gasoline direct injection (GDI) engines. A control-oriented first-principle physics model is established and backstepping technique is used to derive a non-linear controller with guaranteed stability. After comprehensive consideration of practical implementation, the proposed rail pressure controller is tested on the pump test rig and engine test bench.

In papers ‘Non-linear observer of laminar flame speed for multi-fuel adaptive spark-ignition engines’ and ‘Ethanol diesel dual fuel clean combustion with FPGA enabled control’, the issues of estimation and control of multi-fuel engines are considered. A virtual laminar flame speed sensor was developed in the former paper. Laminar flame speed is emphasised because it is a primary physical parameter related to ignition timing prediction, and it will change if a different fuel source is used. In the later paper, the real-time implementation of advanced control algorithm in FPGA is carried out.

In papers 'Braking torque control for parallel hybrid electric truck' and 'Power management of a hybrid electric powertrain system – design, power flow control, and optimisation targets', brake energy recovery and optimal management of multi-energy-sources are addressed. Non-linear control and easy-implemented optimal control are used to improve the efficiency, availability and life time of HEVs.

The paper 'Model-based control of automotive step-ratio transmissions' provides an up-to-date literature survey on automotive drivetrains with step-ratio transmissions, including automated manual transmission, automatic transmission, and dual clutch transmission. The authors review and discuss the issues related to the controls of step-ratio transmissions, their applications to electric and hybrid electric vehicles, and the current trend in model-based control developments.

In summary, this special issue provides a great collection of papers that highlighted the potential of model-based control in automotive powertrains. We would like to express our gratitude to the authors and reviewers. Given the page limit of a single journal issue, the special issue is split into two parts. It was our great pleasure to provide the readership of *International Journal of Powertrains* with these two parts of the special issue.