Mechanical Systems and Signal Processing

Editorial

Special Issue on Interdisciplinary Aspects of Vehicle System Dynamics Integration

Vehicle system dynamics integration encompasses interdisciplinary challenges innovations in various aspects related to vehicle system/subsystems/components dynamic characteristics, modeling and validation, vehicle dynamics state measurement and estimation, vehicle/chassis control systems, coordination of power management and dynamics/stability control, etc [1-4]. These are becoming more critical due to the increasing concern and rapid development in electric and hybrid vehicles, which tend to exhibit different vehicle dynamics/stability and control characteristics when compared to conventional vehicles.

In order to contributing to addressing these associated challenges, the Journal of Mechanical Systems and Signal Processing compiles a Special Issue on Interdisciplinary Aspects of Vehicle System Dynamics Integration. More than thirty manuscripts were received and carefully reviewed and commented, where ten papers are selected for the Special Issue, which are briefly summarized below.

Powertrain and driveline system dynamics and control strongly affect vehicle longitudinal dynamics, drivability, as well as driving comfort and energy-efficiency. Galvagno et al. [5] derive the formulations for the kinematic and dynamic characteristics of a torque assist automated manual transmission integrated with an assist clutch. The power contributions during gearshifts are also investigated. The simulation results and discussions indicate the potential benefits of the proposed transmission system in enhancing the vehicle longitudinal dynamics, drivability, and driving comfort. Balau et al. [6] develop a linearized input-output model for an electro-hydraulic actuated clutch, whose validity is shown by comparing with the experimental data. Based on the model, a predictive controller is designed for the clutch so as to reduce the negative effects of the network communication delays in the control performance.

Weissenborn et al. [7] propose a model-based approach for the estimation of combustion features of diesel engines, where a newly-developed empirical cylinder pressure model is extended by using crank-angle resolved engine speed signal information. The results show the accuracy improvement in the cylinder pressure model, which is potentially used for advanced engine controls. Walker et al. [8] propose an integrated speed and torque control of vehicle powertrains with dual clutch transmissions for the both engine and clutches. A novel method is further proposed for minimizing undesirable shift transient responses. The powertrain dynamics improvements are demonstrated through simulation studies.

Efforts on characterization of hydraulic dampers, one of the key suspension components, have been made for the last few decades. However, partly due to the complexity of hydraulic damper system and vehicle operating conditions, an improved understanding of damping properties is still in high demand so as for enhancing damper design and damping tuning/optimization, and thus improving vehicle dynamics/stability as well as NVH characteristics. Czop and Slawik [9] develop a comprehensive model for the combined system including a hydraulic damper and a servo-hydraulic tester, for assessing the vibration isolation properties of dampers over a relatively wide frequency range. The proposed validated model could help to serve as a generic virtual testing platform for different hydraulic dampers for evaluating the effects of damper parameters design/tuning in overall damping performance.

Vehicle dynamics and stability control systems and their integration demand enhanced information of various vehicle dynamics states, which can be either directly measured or estimated. One of these vehicle dynamics states is tire-road contact force, whose direct measurement however is very expensive and also requires significant modifications in vehicle unsprung mass and rotational inertia of the wheel/tire system. Cheli et al. [10] develop a novel low-cost tire-road contact force measurement device based on the principle of measuring three deformations of the wheel rim through strain gauges. The effectiveness of the proposed measurement device is demonstrated through the both laboratory tests and vehicle field testing. Keighobadi [11] proposes a fuzzy batch-least-square (BLS) algorithm for online calibration of magnetic compass on a vehicle so as to meet the requirements of the vehicle navigation system. Both simulated and experimental results demonstrate the superior performance of the proposed approach.

Leung et al. [12] propose a novel integrated Kalman Filter (IKF) approach for vehicle dynamics state estimation, using low-cost Global Positioning System (GPS) and Inertial Navigation System (INS), upon assuming known vehicle parameters. The effectiveness of the proposed scheme in the linear tire property range is shown by comparing to a few other methods using simulations. However, future work is needed for an application to nonlinear tire property range, which is critical in terms of the vehicle stability and safety. For addressing the challenges in the vehicle sideslip angle estimation, Melzi and Sabbioni [13] present a layered neural network approach based on a 7 degree-of-freedom (DOF) vehicle model, so as to avoid issues associated with reference model parameters identification and adaptation. The performance and robustness of the proposed approach are verified through vehicle field tests subject to different handling maneuvers on various road surfaces.

Communication-based safety applications empowered by vehicular ad hoc networking (VANETs) have been recently attracting considerable concerns, for contributing to vehicle active safety and also future green transportation system. Zhuang et al. [14] provide a comprehensive overview of different radio channel access protocols and resource management methods, together with their suitability for infotainment and safety-service support within VANETs. Recent advances and future challenges related to vehicular communications are also presented.

The novel technologies/methodologies developed and knowledge obtained from this Special Issue would also be mostly applicable for the development of next-generation energy-efficient vehicles and the associated vehicle dynamics/control systems integration. Due to the very high

complexity and diversity of vehicle systems (particularly with different hybridization/electrification architectures) and operating conditions, considerable efforts should be continued to be made in vehicle system dynamics integration. Apart from the relevant topics discussed above that still require further significant exploration and enhancement, there are also some other emerging topics associated with the development of next-generation energy-efficient vehicles. These include the improved understanding and characterization of driver-vehicle systems, driver-command interpretation, integration of energy management optimization and vehicle dynamics/stability control, battery management systems and integration, scalable integrated vehicle control architecture with flexibility in customerization, etc.

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