Editorial

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1 Introduction

Heavy commercial vehicles continue to be the dominant mode of road transportation in North America and Europe (Gerdes, 2002). Compared with other road vehicles, commercial vehicles exhibit various performance limitations and greater safety risks owing to their unique physical and dynamic characteristics (Kang and Deng, 2007).

These include poor manoeuvrability at low speeds and unstable motion modes at high speeds, such as jack-knifing, rollover and trailer swing. Crashes involving commercial vehicles continue to be of traffic safety concern.

Over the past decades, the advances in mechatronics and system integration technologies have promoted the development and implementation of various active safety systems (such as electronic stability control, roll stability control and active trailer steering system) for commercial vehicles to achieve enhanced handling, stability and safety performance (Li et al., 2018). The current stability control systems, however, heavily rely on prior knowledge of various properties of the vehicle and its subsystems. Commercial vehicles, however, exhibit wide variations in various operating conditions and thereby the dynamic characteristics, which pose considerable challenges concerning parameters and state estimations, and controllers' syntheses. Designing smart control strategies that not only identify the changes in vehicle and environment conditions but also adapt to these changes would constitute a promising solution.

This special issue compiles recent research and development efforts in active safety control of heavy commercial vehicles, including stability status monitoring and warning, vehicle parameter and state estimations, performance measures or targets, advanced driver assist systems, electric vehicle technology, advanced control techniques and their applications. Twenty manuscripts were received and 11 papers are selected after careful review for this special issue. The selected papers are roughly classified into three categories: driver assistance systems (four papers), yaw and rollover stability control vehicles (five papers), and electric vehicle control (two papers). In the following sections, the papers in each category are briefly summarised.

2 Driver assistance systems

Zheng et al. (2019) investigated the braking intention identification approach adaptive to the Electronic Braking System in commercial vehicle. Two models are developed in this study:

- braking intention identification model based on neural network considering general braking and emergency braking
- multi-condition intention model using fuzzy control with respect to four typical braking conditions.

The experimental results demonstrated that the driver braking intention can be identified well with proposed models.

Han et al. (2019) proposed a novel lane departure warning (LDW) system taking the driver behaviour characteristics into account and a lane keeping assisted system (LKAS) based on active steering assisted control. The co-simulations using TruckSim, AMEsIM and Matlab/Simulink were conducted to verify the proposed LDW and LKAS systems. When lane departure is detected, LKAS system can quickly respond and adjust the steering angle to keep the vehicle in the lane.

Dou et al. (2019) proposed a path planning and tracing framework based on relation space method (RSM) for autonomous mining articulated vehicles. RSM is used to identify the space around the vehicle. A PID controller and a model predictive control (MPC) are designed for vehicle speed control and steering control, respectively. Through the co-simulation with ADAMS-Matlab, the effectiveness and path tracking performance of proposed path-tracking controller is verified.

Zhu et al. (2019) proposed a new dynamic driving condition identification method is developed in this paper through incorporating Hierarchical Hidden Markov models (HHMM) into the rollover warning system for heavy duty vehicles. This can assist the driver to be aware of the driving conditions. The corresponding data under typical driving conditions are collected and then put into test with the Student's t-test method and Grubbs's test method (T-G test method). The outliers filtered by T-G test from the data are detected and eliminated. The K-means algorithm is used to set up the rollover threshold value and the Baum-Welch algorithm is used to optimise the proposed rollover warning model. The simulation results under different driving conditions show that the proposed rollover warning method can effectively identify the driving status with a high accuracy and could be used for real-time rollover warning control.

3 Yaw and rollover stability control

Jin et al. (2019) developed an optimised slide mode steering control strategy to improve rollover stability and reduce tracking error. Slide mode control based roll angle and slide mode control based lateral displacement strategies are developed, respectively. Through simulations under some typical driving conditions, such as J-turn, fishhook and double lane change, the optimised slide mode steering control strategies are verified and can effectively reduce vehicle rollover risk and significantly improve the performance of tracking the driver's intention for a heavy vehicle.

Gao et al. (2019) derived a nonlinear articulated steer vehicle (ASV) model coupled by 12-DOF dynamic model and full-hydraulic steering system model. The developed ASV model is verified using field tests of single-lane change at unloaded and loaded condition. Compared with 3-DOF linear model, ASV model has a reduced unstable area. Numerical results revealed that the unloaded ASV is stable and loaded ASV will show a jack-knife mode if the mass centre of the rear section is in front of the rear axle, and the ASV will show a snaking mode if the mass centre of the rear section is behind the rear axle. Considering that the torsional stiffness is influenced by the fluid pressure when the oil is entrapped with air, a new approach using filling-oil pressure control to improve the stability of ASV is presented. Simulation results show that the jack-knife and snaking behaviour are eliminated and the appropriate filling-oil pressure for this ASV is confirmed at 1.0 MPa for the vehicle used in the study.

Miao and Cebon (2019) investigate the tracking performance of a path-following active trailer steering system when operating off-highway. Three types of vehicle model: tractor-semitrailer, B-double and A-triple, are studied under a straight-line and a 450 roundabout with various road cambers, grades and adhesions. Results indicated that the path-following steering system was unable to provide good tracking performance under those conditions owing to longitudinal and lateral wheel slip interference.

Nie et al. (2019) proposed an active trailer steering and differential braking integrated control strategy to improve lateral performance of articulated heavy vehicles (AHVs). Two modes, path following control mode and rollover control mode, are designed. A mode switching method is employed by the strategy to achieve good path following and yaw stability under normal working conditions and to avoid vehicle rollover under the limit conditions. Moreover, the genetic particle swarm optimisation algorithm is used to obtain the optimal weight coefficients of the strategy. Experimental results indicate that the presented strategy achieves good control for AHVs across a wide range of operating conditions.

Wan et al. (2019) studied the degree of vehicle-liquid coupling and its influence on the whole vehicle in actual manoeuvres and the modelling theory of liquid sloshing in liquid tank trucks. A complicated two-way coupled dynamic model and three simplified models for tank trucks were developed. On the basis of the four models, the vehicle-liquid coupling dynamic characteristics and their influence are discussed in terms of handling stability and braking performance, with various actual manoeuvres of different emergency level.

4 Electric vehicle control

Yin et al. (2019) presented a robust $H\infty$ optimal controller to improve the handling and stability of an in-wheel motor drive electric vehicle using active suspensions with considerations of parameter uncertainties and control saturation. Active suspensions are designed with linear matrix inequalities (LMIs) feedback control method to attenuate the effect of the lateral acceleration on the roll angle and the suspension stroke. The uncertain parameters include the vehicle body mass, suspension spring and suspension damping coefficient. The control saturation considered results from the physical limitations of actuators. Simulation results show that the vehicle lateral stability has been improved and the vertical dynamic displacements of suspensions have decreased.

Chen et al. (2019) introduced a multilevel integrated control including motion controller and control allocation for a four-wheel independent control electric vehicle. The motion controller based on model prediction control (MPC) optimises the vehicle control forces and moments within the actuators' characteristics and tracks the longitudinal and lateral references. Based on the outputs of MPC controller, the control allocation minimises each wheel's tyre workload, and distributes the wheels' steering angles and driving/braking torques. From the co-simulation results and experimental validation, the integrated controller can effectively regulate the four wheels' workloads and improve the vehicle's handling and stability significantly compared with ESC control.

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