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Editorial

Feasible, Robust and Reliable Automation and Control for Autonomous Systems

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The global market for autonomous robotics platforms has grown rapidly due to the advent of drones, mobile robots, and driverless cars, while the mass media coverage examining the progress of robotics and autonomous systems field is widespread. There are instances in which such news may be exaggerated, and to a certain extent, surrounded by potentially misleading hype. This is understood in terms of the valuation standing of automation and robotics industries [1]. With lot of startups raising huge number of investments worldwide, and big corporations launching spin-off companies to expedite the deployment of the emerging technologies, the trajectory of this domain continues to escalate [2].

'Deep Learning', 'Machine Learning', 'Artificial Intelligence', 'Data-Driven', and 'Neural Network' are among the terms frequently used to discuss the rapid developments in the future robotics and autonomous systems technologies sectors. However, robotics and automation are complex fields which are not restricted to the aforementioned phrases. Autonomous systems consist of different domains such as 'mapping', 'localization', 'object detection', and 'embedded systems', as well as 'guidance, navigation and control', among many others. Each of these terms requires cross-disciplinary expertise and talents to facilitate innovation and further developments.

In this Special Issue, the editors aim to provide an in-depth assessment of one of the most important elements of autonomous systems, i.e., automation and control. The Special Issue is co-edited by distinguished international control system experts currently based in Sweden, the United States of America, and the United Kingdom, with contributions from reputable researchers from China, Austria, France, the United States of America, Poland, and Hungary, among many others. The main objective of this Special Issue is to highlight current research and development in the automation and control field for autonomous systems, as well as to showcase state-of-the-art control strategy approaches for the autonomous platforms. The editors believe the ten articles published within this Special Issue will be highly appealing to control-systems-related researchers in applications typified in the fields of ground, aerial, maritime vehicles, and robotics, as well as industrial audiences.

In the first article, Hernandez-Barragen et al. [3] investigated an adaptive single neuron anti-windup PID controller based on the extended Kalman filter algorithm, where the experimental tests are performed on a KUKA® Youbot® omnidirectional platform. This work demonstrated that the proposed adaptive PID controller performed better than the conventional PID and other benchmarked PID approaches.

In the article 'Facilitating Autonomous Systems with AI-Based Fault Tolerance and Computational Resource Economy' [4], Deliparaschos et al. proposed the facilitation of fault-tolerant capability in autonomous systems, with particular consideration of low computational complexity and system interface devices (sensor/actuator) performance.

An AI-based control framework enabling low computational power fault tolerance was presented, where the efficacy of the proposed scheme was shown via rigorous analysis of several sensor fault scenarios for an electro-magnetic suspension testbed.

‘On-Line Learning and Updating Unmanned Tracked Vehicle Dynamics’ by Strawa et al. [5] proposed a method by which to estimate vehicle model parameters using a compound identification scheme utilizing an exponential forgetting recursive least square, generalized Newton–Raphson (NR), and Unscented Kalman Filter methods. The proposed identification scheme facilitates adaptive capability for the control system, improves tracking performance, and contributes to an adaptive path and trajectory planning framework, which is essential for future autonomous ground vehicle missions and traversability.

Meng et al. presented ‘High Velocity Lane Keeping Control Method Based on the Non-Smooth Finite-Time Control for Electric Vehicle Driven by Four Wheels Independently’ [6], in which two kinds of tracking error computing methods of lane keeping control for electric vehicles were proposed to tackle different conditions, and a Non-FT lane keeping controller was designed to keep the EV-DFWI running in the desired lane suffering external disturbances.

The topics of path planning and tracking algorithms were studied by Rumetshofer et al. in ‘A Generic Interface Enabling Combinations of State-of-the-Art Path Planning and Tracking Algorithms’ [7]. A generic interface design between the local path planning and path tracking systems was examined. This topic holds significant importance for autonomous driving applications.

Tran et al. [8] authored ‘Integrated Comfort-Adaptive Cruise and Semi-Active Suspension Control for an Autonomous Vehicle: An LPV Approach’, which presents an integrated linear parameter-varying (LPV) control approach of an autonomous vehicle intending to guarantee driving comfort, consisting of cruise and semi-active suspension control. Simulation-based experiments were conducted using a realistic nonlinear vehicle model validated from experimental data. The simulation results demonstrate the proposed approach’s capability to improve driving comfort (a topic that will remain important for future people-carrier autonomous vehicles).

In ‘Development and Verification of Infrastructure-Assisted Automated Driving Functions’ [9], Rudigier et al. extensively discussed the autonomous driving and ADAS applications of control systems. Their paper presents specific use cases in the said context, and the verification results for a proposed system utilizing a simulation framework are reported.

In ‘Automatically Learning Formal Models from Autonomous Driving Software’ [10], Selvaraj et al. shared their Autonomous Driving expertise and applied active learning techniques to obtain formal models of an existing (though still in development) autonomous driving software module implemented in MATLAB. This demonstrates the feasibility of automated learning for automotive industrial use. Practical challenges in applying automata learning, and possible directions for integrating automata learning into the automotive software development workflow, are also discussed in this work.

In ‘Practical Nonlinear Model Predictive Controller Design for Trajectory Tracking of Unmanned Vehicles’, Pang et al. explored the trajectory tracking issue of unmanned vehicles [11]. The authors proposed an improvement of the nonlinear model predictive controller (NMPC) for the trajectory tracking application of an unmanned vehicle (UV). The simulation results confirm that the proposed NMPC scheme reveals better control accuracy and computational efficiency than the standard MPC controller under two different prescribed roads.

Finally, in ‘Leader-Based Trajectory Following in Unstructured Environments—From Concept to Real-World Implementation’, Nestlinger et al. described the issue of guiding a vehicle by means of an external leader [12]. A system was proposed and tested in a simulation framework and then deployed in a demonstrator vehicle for validation under real operating conditions.

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the findings presented in this Special Issue will be beneficial for the reading of interested researchers and general audiences.

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