



Editorial

Guest Editorial: Recent advances in reliable control and cost-effective engineering design for autonomous systems



1. Introduction

Autonomous systems are gaining more attention in industrial systems like manufacturing, robotics, vehicles, etc. However, due to complexities raised by the required system design, environment uncertainties and system operation conditions, the issues of reliability and cost-effectiveness cast a heavy shadow on the technological readiness level of these systems. Specifically, there could be substantial risks in the autonomous system operation to be mitigated and controlled. Therefore, reliability enhancement, cost-effective system design, sensing instrumentations and actuation mechanisms are highly contributing to the level of autonomy. Meanwhile, there is a tradeoff between higher level of system autonomy and autonomous system design costs due to the necessity of implementing higher levels of redundancy in the system. Under this point of view, advanced automation systems such as remote sensing systems, networked control systems are integrated with autonomous systems for dealing with data processing, enhancing system reliability, accuracy as well as reducing operation and maintenance costs. Consequently, integrating, developing and implementing advanced control systems through a cost-effective sensing and actuation mechanisms can highly contribute to safety, reliability and higher level of autonomy for autonomous systems.

The main objective of this issue is to address latest theoretical and technological achievements and to identify critical issues and challenges for future investigation on the advanced automation and reliable control technologies for autonomous systems.

2. Highlights of the special issue

With a stringent peer review process, there are twenty-two papers finally included in this Special Issue, which are covering the following aspects within the context of autonomous systems: (1) Cost-effective Engineering Design; (2) Reliable control design. A brief summary of the accepted papers is discussed in the following.

2.1. Cost-effective engineering design

An in-depth review of the recent advances and challenges of the control designs for transient performance, including finite-time stability and control, adaptive and prescribed performance control, and funnel control are addressed by Wang, Sun, et al. (2023a). In the context of robotic, Paolillo, Forgione, Piga, and Hoffman (2023) proposed a control architecture with a reference governor to enhance visual servoing with a predictive behavior, without giving up on the fast execution of the original reactive controller. Experiments on a real 7-

axis manipulator is given as well. Liu, Wang, and Li (2023b) proposed a real-time network for unstructured road segmentation at night based on thermal infrared images (URTSegNet).

In the context of autonomous navigation, an integrated navigation method combining the information of polarization navigation system (PNS), inertial navigation system (INS), and celestial navigation system (CNS) is presented by Yang, Wang, et al. (2023) for attitude determination at night by designing a two-mode attitude determination system, which includes the PNS/INS/CNS (PIC) mode and PNS/INS (PI) mode. The experimental data is provided to illustrate the accuracy and stability of attitude estimation problem. The authors in Ren, Sun, Zhao, and Tang (2023) proposed a domain generalization framework based on meta-learning to dig out representative and discriminative internal properties of real hazy domains without test-time training. In Xia, Zhao, Sun, Cao, and Tang (2023), the authors developed a Modality Translation and Fusion (MTF) framework to distill diverse cross-modality knowledge based on a Residual-based Coordinate Attention Fusion (RCAF) module to fuse the multi-scale features from different modalities.

In the context of cell microinjection, the authors in Ma, Xie, Chen, Yu, and Zhou (2023) proposed design of a cell puncture mechanism (CPM) driven by a piezoelectric actuator to complete the cell puncture process. In Ren, Xi, et al. (2023), the authors proposed an accurate model focused on analyzing the characteristics variation mechanism of the wet-clutch for an automatic transmission by considering oil temperature and rotational speed. Wang, Guan, et al. (2023) developed an acoustic communication and imaging sonar guided docking method to improve the docking accuracy for autonomous underwater vehicles (AUVs). In the context of intelligent fault diagnosis, a human-like fault identification module is developed by Yang, Karimi, and Pawelczyk (2023) based on a deep reinforcement learning framework.

2.2. Reliable control design

The problem of event-triggered finite-time stabilization is studied by the authors in Wu, Yang, Sun, and Zhu (2023) for nonlinear switched affine systems under mode-dependent and state-dependent switching signals, respectively. In Hu et al. (2023), the authors studied resilient H_∞ path-following control problem for autonomous vehicles under false data injection attacks and denial-of-service attacks, simultaneously. In Jiang, Wu, Liu, and Li (2023), the authors studied the security control problem of a wheeled mobile manipulator that is subjected to various challenges, such as Markov switching parameters, actuator

<https://doi.org/10.1016/j.conengprac.2023.105632>

Available online 30 July 2023

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false data injection attacks, un-modeled nonlinearities, and deficient transition rates.

In Xu and Wu (2023), the authors proposed a data-driven learning algorithm for the human-in-the-loop cooperative tracking control of multi-agent systems with completely unknown dynamics. The authors in Lei and Karimi (2023) proposed a novel efficient dual long short-time memory method for concentration prediction in the deep cone thickener system. In Liu et al. (2023a), the authors proposed a hierarchical robot manipulation control scheme for the manipulator pushing task.

In Zhang, Zhu, Tang, Yuan, and Wang (2023), the authors studied the mathematical modeling problem of a general turbofan aeroengine control system used in autonomous aircraft. In Wang, Wei, Zhang, Xu, and Sun (2023b), the authors developed an autonomous reliable intelligent controller using online estimation and condition monitoring for the six-degree of freedom dynamics of the flight vehicles. Moreover, in Li, Zhu, and Yin (2023), the authors proposed an actuator fault detection method for a quadrotor unmanned autonomous vehicle, in which sensitivity to fault and robustness to disturbance are simultaneously guaranteed.

In Song and He (2023), an improved robust filtering method is designed for autonomous underwater vehicles to estimate system states and alleviate the effects of stochastic system uncertainties. The authors in Wang, Wen, He, and Xu (2023c) proposed a robust trajectory tracking control method for an X-rudder autonomous underwater vehicle subject to imprecise model parameters, unknown disturbances, and actuator uncertainty. Moreover, the authors in Song, Wu, Stojanovic, and Song (2023) studied the fixed-time prescribed performance trajectory tracking control problem for the unmanned surface vehicle with unknown dynamics and disturbances.

Declaration of competing interest

The authors have no conflict of interest to declare.

Acknowledgments

We really appreciate all the authors and anonymous reviewers who contributed to this Special Issue. Meanwhile, we would like to thank the supports from the Editor-in-Chief and the journal manager to our Special Issue. This work was partially supported by the Italian Ministry of Education, University and Research through the Project “Department of Excellence LIS4.0-Lightweight and Smart Structures for Industry 4.0” and in part by the Horizon Marie Skłodowska-Curie Actions program (101073037).

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