processes

Editorial

Special Issue "Active Flow Control Processes with Machine Learning and the Internet of Things"

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The desired changes in flow characteristics are obtained by flow control, which implies manipulating flow behavior such as drag reduction, mixing augmentation, or noise attenuation, employing active or passive devices. The active devices are operated by external means and hence require an additional power source, whereas passive controls do not have such requirements. However, passive techniques are associated with significant drawbacks, such as the thrust penalty in the case of jet mixing enhancement. The typical active flow control methods include oscillation and flow perturbation, acoustic excitation, synthetic jet, plasma actuator, and Lorentz force. Apart from active flow control, this Special Issue also deals with the active process control of parameters that are not necessarily about fluids only, for instance, the active control of process parameters in freight trains.

This Special Issue concerns active flow control and related processes or those that can be actively reconfigured or optimized using machine-learning algorithms and sensors that cooperatively work under the broad framework of the Internet of Things. Most of the work focuses on data-intensive machine (or deep) learning methods and possible utilization of the industrial internet. The editors have curated a series of articles to aid in upgrading state of the art in multiple areas involving these broad themes. This edition begins with a paper by Tayyaba et al., carried out by a team of researchers from Pakistan, Qatar, UAE, and China [1]. In this study, under the 10T-based environment, the authors simulated and fabricated bio-engineered, bio-endurable, and bio-compatible microchannels for implantation in the varicose veins in such a way that avoids tissue damage. It has been demonstrated that such channels may replace varicose veins to allow natural blood flow in the veins. Such an active flow management for natural blood flow is an important contribution. Although not covered in this article, machine learning and the Internet of Things may provide requisite data to avoid tissue damage when the flow process challenges are well-categorized for microchannels for varicose veins. Next, Brezulianu et al. describe how railway companies efficiently manage their logistical operations to reinforce their strategically advantageous positions in the market and for maximizing profit [2]. This article classifies the whole system into three parts, which are used to transmit the status and the operating information to a web server and can be viewed in real-time for efficient coordination and appropriate response.

This work is followed by an article by Jinag et al., which highlights the importance of dynamic reconfiguration of integrated modular avionics for aircraft configuration and also to act as an appropriate tool to manage resource failures [3]. A three-step procedure is developed and successfully tested on a case study. Such a technique is advantageous to validate dynamic reconfiguration at the start of system design, and is cost-effective. Reconfiguration under resource failure conditions requires active process control, and naturally, under multiple constraints, the available prior data, industrial internet, and machine-learning algorithms may additionally aid in an improved reconfiguration process. Following this, Tkáčik et al. elaborate on a new frontend device (FRED) framework to enable possibly connecting customized electronics to standard and existing SCADA systems for modern distributed control systems, which reduces the load on the SCADA systems as the FRED performs the bulk of the computations [4]. Next, Kim et al. propose a discrete wavelet transform-based stacked auto-encoder-based CNC machine tool diagnosis [5], utilizing the well-known benefits of machine-learning algorithms in cutting tool wear prediction, diagnostics, and prognostics. Next, Wang et al. [6] present test results for an accurate droplet judgment method using an advanced machine-learning technique based on dimensionalized data and a logistics classifier for improved infusion monitoring equipment without adopting advanced signal processing circuits that may increase the equipment cost and power consumption. Consequently, the hospitals under study have set up several devices for infusion monitoring. In this work, the authors have stipulated a method for accurately measuring the droplets without increasing the cost.

Another article by Kaushik et al. looks into the mixing characteristics of cold and flame jets. Jet mixing has many applications, from household appliances to rocket science [7]. Mixing fuel and an oxidizer in the combustion chamber should occur efficiently and within a small distance to begin efficient burning. Moreover, it is also vital to investigate the mixing behavior of fuels and oxidizers in the presence of sustainable combustion. Given these aspects, the authors numerically investigated three inline jet configurations with a methane jet (center) and two peripheral oxygen jets, with and without combustion. Interestingly, the results reveal that the combustion significantly impacts jet mixing characteristics.

A mobile wireless sensor network (MWSN) is vital in many military and civil applications, for instance, to cover designated arenas using a swarm of unmanned aerial vehicles (UAV), as addressed by Wang et al. [8]. An active process flow in this application is essential for efficient trajectory tracking, which can be further improved with machine-learning techniques. Subsequently, Chen et al. reconsider the Q-Learning method for discrete-time linear systems' quadratic optimal control problem [9]. Through various applications, this article discusses the possibility of actively improving the process flow by selecting existing Q-Learning based controllers and modifying them through ridge regression using model-free methods. Identifying reconfigurable manufacturing systems (RMSs) introduces the difficulty of adequate and swift modification to resolve dynamic updates in a manufacturing setup using an active process flow reconfiguration, as addressed by Kaid et al. [10]. Following this, Karodi et al. utilize the available data accumulation and data dependency analysis and puts forward subsequent steps in a proactive and non-invasive decision and control solutions for reduced energy consumption in water treatment processes [11]. Furthermore, Li et al. discuss the problem of the parameter stability region of linear active disturbance rejection control (LADRC) controllers [12]. The dual-locus diagram method helps find the upper limit of the LADRC bandwidth for both first-order and second-order time-delay systems. Finally, Deb et al. present a detailed review of different mathematical models of microbial fuel cells available in the literature [13], which aid in pollutant removal purposes using microorganisms as bio-catalytic contents with suitable parametrizations of three different variants, and are attractive options for power generation and also cheaper mechanisms for extracting clean water.

The above papers provide a detailed technical repertoire of the interplay of several essential fields such as active flow control, machine learning, and the Internet of Things. With many applications currently under development in active process flows, we are confident in the continued relevance of these topics. We thank all the contributing authors, the funding agencies which facilitated their work, the Editor-in-Chief for support on the Special Issue, and the editorial staff of *Processes* for their dedicated efforts. The Guest Editors, Dr. Valentina E. Balas and Dr. Dipankar Deb, are also thankful to Dr. Mrinal Kaushik for participating in this editorial along with us.

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