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Special Issue on ''Smart Systems in Fire Engineering''

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With the rise of transformative technologies: such as artificial intelligence (AI), Internet-of-Things (IoT), robotics, sensors etc., the field of fire engineering and safety is embracing a new era to realize smart and fire-resilient structures and systems. This special issue aims to highlight the unprecedented potential for leveraging some of the aforenoted smart systems into our domain. The idea behind this issue stems from the success noted in parallel fields (such as medicine, space exploration, etc.), which managed to adopt AI and its derivatives successfully. This idea then blossomed during a series of short communications between the guest editors and the Editor-in-Chief, Prof. Guillermo Rein, towards the end of 2019, and a call for papers was released in 2020. Little did we know, Prof. Jack Watts (a former Editor-in-Chief of Fire Technology) had in fact published a short editorial titled ''*Expert systems*'' in 1987 [1]; foreseeing the use of smart systems in fire engineering. We hope that this special issue complements Prof. Watts' visions and will be of service to the valuable members of the fire engineering community.

Convergence of smart systems ''Internet of Things and AI'' to be leveraged in the fire engineering domain.Convergence of smart systems ''Internet of Things and AI'' to be leveraged in the fire engineering domain

This special issue includes 15 original papers and one editorial letter spanning the different dimensions of smart systems at varying scales, including the community, buildings and component systems. Additionally, Naser [2] presented a state-of-the-art review on AI-based methods and their applications in the fire engineering domain. The original papers are briefly described herein.

First, we start by describing papers with a focus on predicting fires and fire hazards at the community and infrastructure scale. Li et al. [3] developed an AI-based approach to predict wildland fire burned areas by using an improved version of a long short-term memory (LSTM) neural network model. Also, Liu et al. [4] combined citizen scientists with transfer machine learning to identify fire hazards in communities. For tunnel fires, Wu et al. [5] created an extensive database

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from numerical simulations on these fires and then used AI methods to explore such a database.

Then, we dive into the works that explore smart systems in predicting, matching and detecting fires (or smoke) at the building scale. First, Buffington et al. [6] explored the use of deep learning methods to emulate fire simulations in compartment fires. Cabrera et al. [7] developed a Bayesian methodology to extract correct fire-evolution scenarios from heat flux measurements. Ryder et al. [8] described how a hierarchical temporal memory continuous learning methodology can use sensor data to determine fire state in buildings. Baek et al. [9] developed a new fire detection algorithm that is built on support vector machines with dynamic time warping kernel function. Jiang et al. [10] developed a new strategy to combine the Python-OpenSees framework to model real-scale localized fires and to estimate the thermal response of structural members subjected to various scenario fires. Mensch et al. [11] also applied machine learning to develop a framework that prevents cooktop ignitions. Related to imaging, Choi et al. [12] developed a new convolutional neural network for a semantic fire image segmentation method that outperforms image processing algorithms; and Huang et al. [13] proposed an end-to-end attentive DesmokeGAN procedure that implements visual attention into a Generative Adversarial Network (GAN) to effectively learn the smoke features and their surroundings.

Also, at the building scale, but with a focus on the occupants rather than the fire itself, Rahouti et al. [14] created a validated non-immersive virtual reality prototype that can be used for healthcare fire safety training.

Four papers were also published on the potential of smart systems at the component level. Panev et al. [15] applied machine learning to predict fire resistance of composite shallow floor systems accurately. Węgrzyński et al. [16] devised a novel ''smart smoke control'' (SSC) system for historic buildings. Brown et al. [17] leveraged data obtained from wireless sensor networks embedded in fire hoses to enable smart firefighting activities. Chaudhary et al. [18] combined probabilistic and surrogate modeling techniques to evaluate the fire response of concrete slabs. Finally, one letter to the editor by Gomaa et al. [19] was also published. This letter presents big ideas for a framework for intelligent fire detection and evacuation system in buildings.

Collectively, the aforenoted contributions provide us with a glimpse of the future of fire engineering. In a way, these papers set the foundation for future works and hence are of interest to academics, practitioners, and officials. The Guest Editors are grateful to all of the contributors, together with Fire Technology's reviewers and staff, who made this special issue possible. The Guest Editors would also like to take this opportunity to thank Prof. Guillermo Rein, Editor-in-Chief of the Fire Technology journal, for granting us the platform and the opportunity to bring this special issue to light.

Note: The paper by Wu et al. [5] was added to a regular issue by mistake. Apologies for the authors.

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