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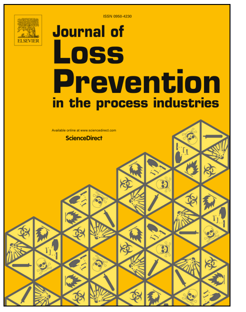

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Surrogate Modelling for Enhancing Consequence Analysis based on Computational Fluid Dynamics

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Abstract

In place of traditional empirical methodologies, computational fluid dynamics (CFD) is used for more accurate consequence modelling as it takes into account of geometrical obstructions. However, its use is costly and not practical for large-scale use in the industry. The present paper explores the integration of design of experiments and surrogate modelling methodologies to enhance the use of CFD-based consequence models. A new integrated methodology is applied to a case study of liquefied nitrogen gas (LNG) pool fire, showing the challenges of training and evaluation of large-scale surrogate models. This study investigates the differences between using a non-linear global surrogate model (namely, least-squares support vector machines) and a linear piece-wise surrogate model (namely, linear nearest neighbour interpolation), as well as the use of sequential sampling algorithm as a means of improving overall surrogate accuracy. The results are analysed and localization of surrogate error regions is discussed in the paper. The new integrated methodology shows potential in improving the way consequence analysis is performed, and it could be an enabler of real-time risk monitoring systems.

1 Introduction

The oil and gas industry is essential for producing numerous materials that the modern society needs. The raw materials, by-products and end-products in the production processes could be flammable and/or toxic. Keeping large quantities of these in a single location inevitably exposes the society to a higher level of risk. To understand and control the amount of additional risk, government regulations have been put in place requiring companies to conduct safety studies before any permits are granted for the construction of new or extended chemical process facilities, storage terminals or warehouses. A key component of the safety studies is the Quantitative Risk Assessment (QRA), which calculates the number of expected fatalities per year around the facility. Companies and regulators use these risk values to make decisions on the need for additional safety systems, formulate emergency response plans, etc. (Wang et al., 2014).