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Computer-Aided Hazop: Ontologies and Ai for Hazard Identification and Propagation

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Abstract

The Hazard and Operability (HAZOP) study is an accepted hazard identification technique in the chemical process industry. It is a time and labor-intensive process and it can be prone to human error. Computer-aided HAZOP systems can be used to support human experts. In this research approach a semantically connected knowledge structure in the form of an ontology was developed that stores process safety engineering knowledge. Based on ontologies artificial intelligence methods and semantic reasoners are used to analyze the knowledge structure. Preliminary results show that an ontology-based reasoning algorithm in combination with case-based reasoning or a support vector machine algorithm is well-suited to infer hazards including their propagation.

Keywords: Computer-aided HAZOP studies, safety engineering ontologies, inference-based hazard identification, case-based reasoning, support vector machine

1. Introduction

During the entire life cycle of a chemical process plant, safety assessments are conducted during the process and plant design phase, plant revisions or in order to comply with amended legal regulations. Hazard and Operability (HAZOP) studies are conducted to identify and assess hazards and malfunctions that arise from processes and process plants. The HAZOP methodology is a human-centered and moderated technique and it is conducted by an interdisciplinary team of experts. The capabilities of the HAZOP practitioners can be reduced by repetitive tasks, stressful conditions and large amounts of data. Also, it is time and labor-intensive while the results of the study depend on the personal experience, level of training, moderation of the study, communication and safety culture. Computer-aided systems allow an experience-independent, completely systematic and uniform approach. They can assist HAZOP practitioners and serve as a decision support system. For over 30 years, different research groups proposed rule-based expert systems or graph-based approaches in order to automate HAZOP studies, see (Single et al., 2019). Some approaches make use of promising technologies, such as ontologies (Rodríguez and Laguía, 2019), case-based reasoning (Zhao et al., 2009), and model-based reasoning, but in many cases requirements from a process safety engineer's point of view are not considered. Thus, none of these approaches have been used in the process safety engineering community so far. In this paper an ontology-based computer-aided HAZOP systems (CAHS) approach to automatically identify hazards is proposed. The focus of this paper is on the ontology and the usage of artificial intelligence methods to detect the propagation of potential hazards.

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