ICCEPM 2024 https://dx.doi.org/10.6106/ICCEPM.2024.1285
The 10th International Conference on Construction Engineering and Project Management
Jul. 29-Aug.1, 2024, Sapporo

Advancing Process Plant Design: A Framework for Design Automation Using Generative Neural Network Models

Minhyuk JUNG[1]*, Jaemook CHOI[2], Seonu JOO[3], Wonseok CHOI[4], Hwikyung Chun[5]
[1] *Future Construction Innovation, Samsung Electronics,* E-mail address: minhyuk.jung@samsung.com
[2] *Future Construction Innovation, Samsung Electronics,* E-mail address: jaemook.choi@samsung.com
[3] *Future Construction Innovation, Samsung Electronics,* E-mail address: seonu.joo@samsung.com
[4] *Future Construction Innovation, Samsung Electronics,* E-mail address: archiws.choi@samsung.com
[5] *Future Construction Innovation, Samsung Electronics,* E-mail address: hkyung.chun@samsung.com

Abstract:

In process plant construction, the implementation of design automation technologies is pivotal in reducing the timeframes associated with the design phase and in enabling the generation and evaluation of a variety of design alternatives, thereby facilitating the identification of optimal solutions. These technologies can play a crucial role in ensuring the successful delivery of projects. Previous research in the domain of design automation has primarily focused on parametric design in architectural contexts and on the automation of equipment layout and pipe routing within plant engineering, predominantly employing rule-based algorithms. Nevertheless, these studies are constrained by the limited flexibility of their models, which narrows the scope for generating alternative solutions and complicates the process of exploring comprehensive solutions using nonlinear optimization techniques as the number of design and engineering parameters increases. This research introduces a framework for automating plant design through the use of generative neural network models to overcome these challenges. The framework is applicable to the layout problems of process plants, covering the equipment necessary for production processes and the facilities for essential resources and their interconnections. The development of the proposed Neural-network (NN) based Generative Design Model unfolds in four stages: (a) Rule-based Model Development: This initial phase involves the development of rule-based models for layout generation and evaluation, where the generation model produces layouts based on predefined parameters, and the evaluation model assesses these layouts using various performance metrics. (b) Neural Network Model Development: This phase transitions towards neural network models, establishing a NN-based layout generation model utilizing Generative Adversarial Network (GAN)-based methods and a NN-based layout evaluation model. (c) Model Optimization: The third phase is dedicated to optimizing the models through Bayesian Optimization, aiming to extend the exploration space beyond the limitations of rule-based models. (d) Inverse Design Model Development: The concluding phase employs an inverse design method to merge the generative and evaluative networks, resulting in a model that outputs layout designs to meet specific performance objectives. This study aims to augment the efficiency and effectiveness of the design process in process plant construction, transcending the limitations of conventional rule-based approaches and contributing to the achievement of successful project outcomes.

Key words: process plant construction, design automation, generative neural network, inverse neural network