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NPP EMERGENCY RESPONSE PLANNING UTILIZING TREE SEARCH ALGORITHM AND DEEP LEARNING MODELS

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Currently, responses to emergency situations of a nuclear power plant (NPP) are guided by emergency operating procedures (EOPs). These procedures illustrate a series of steps for mitigating the emergency, such as monitoring parameters or activating components. There are two ways to organize these procedures: symptom-based and event-based. However, both ways are inappropriate to provide an optimized response for a current emergency as it is impossible to prepare procedures for every possible combination of events and symptoms.

To address this problem, this research proposes an investigation method for an optimal response. The proposed method utilizes data-driven methods including tree search algorithms and deep learning. Given a set of response, this method constructs a tree with nodes and edges corresponding to plant status and responses, respectively. As brute-force tree expansion is inefficient, tree search algorithm is applied with deep learning models for policy and value estimation are implemented to guide the expansion. The expanded tree is evaluated by a deep learning model for plant parameter future trend prediction, which had been widely researched in last decade as a fast-running surrogate of thermal hydraulic system code. The proposed method is unsupervised learning and can be solely reinforced over time by conducting training in a simulated environment (i.e., simulator).

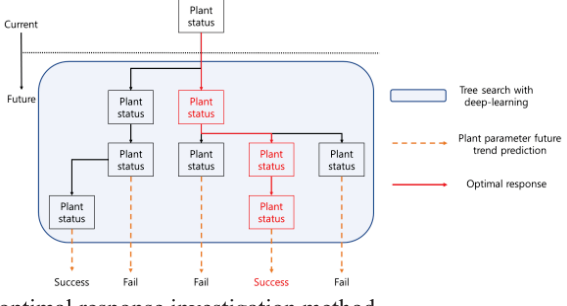

Fig. 1. Framework of an optimal response investigation method

We tested the proposed method using a compact nuclear simulator (CNS) and its emergency response procedures. We believed that this research could advance the current research in dynamic procedures and automation of NPP operations.

Keywords: Nuclear Power Plant, Emergency Operation, Tree Search Algorithm, Deep-learning, Reinforcement Learning, Plant parameter prediction.

References

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