World Academy of Science, Engineering and Technology
International Journal of Nuclear and Quantum Engineering
Vol:15, No:10, 2021

# Neural Network Supervisory Proportional-Integral-Derivative Control of the Pressurized Water Reactor Core Power Load Following Operation

**Authors :** Derjew Ayele Ejigu, Houde Song, Xiaojing Liu

**Abstract :** This work presents the particle swarm optimization trained neural network (PSO-NN) supervisory proportional integral derivative (PID) control method to monitor the pressurized water reactor (PWR) core power for safe operation. The proposed control approach is implemented on the transfer function of the PWR core, which is computed from the state-space model. The PWR core state-space model is designed from the neutronics, thermal-hydraulics, and reactivity models using perturbation around the equilibrium value. The proposed control approach computes the control rod speed to maneuver the core power to track the reference in a closed-loop scheme. The particle swarm optimization (PSO) algorithm is used to train the neural network (NN) and to tune the PID simultaneously. The controller performance is examined using integral absolute error, integral time absolute error, integral square error, and integral time square error functions, and the stability of the system is analyzed by using the Bode diagram. The simulation results indicated that the controller shows satisfactory performance to control and track the load power effectively and smoothly as compared to the PSO-PID control technique. This study will give benefit to design a supervisory controller for nuclear engineering research fields for control application.

**Keywords :** machine learning, neural network, pressurized water reactor, supervisory controller
**Conference Title :** ICNEP 2021 : International Conference on Nuclear Engineering and Principles
**Conference Location :** Beijing, China
**Conference Dates :** October 04-05, 2021