Contribution ID: **170** Type: **Poster**

Modeling, design and implementation of plasma vertical position controller using neural network in Damavand tokamak

Wednesday 29 November 2023 14:10 (20 minutes)

In this work, a nonlinear model is introduced to determine the vertical position of the plasma column in Damavand tokamak. Using this model as a simulator, a nonlinear neural network controller has been designed. Also this controller is implemented on digital signal processor (DSP) control system.
In the first stage, a nonlinear model is identified for plasma vertical position, based on the multilayer perceptron (MLP) neural network (NN) structure. Estimation of the model parameters has been performed by back-propagation error algorithm using Levenberg–Marquardt gradient descent optimization technique. The model is verified through experimental data of plant. As the second stage, a MLP neural network controller is designed for model. Also, online training is performed to tune the controller parameters. Finally, we implement a neural network controller with offline and online learning for controlling vertical position of plasma based on DSP processor in Damavand tokamak. The structure of neural controller is direct adaptive neural controller. Gradient descent with momentum and RPROP algorithms have been used for online learning of neural controller. For implementing these algorithms in real-time, we used the fastest methods for coding until in sampling time of 10us it can run the controller once and update the neural network parameters. The practical results show appropriate performance of this controller.
keywords: Tokamak, Plasma, Neural network modeling Neural network controller, Online learning, Gradient descent with momentum, DSP.

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Session Classification: Posters Session

Track Classification: AI