Artificial Neural-Network Aided Model-Parameter Identification

for Zero-Dimensional Radiator Heat Balance Models

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ANN modelling is applicable well to model thermal conductances for heat balance analysis of mechanical components. On the other hand, if the operating conditions of the element are not in the condition regions of ANN learning, ANN prediction accuracy must not be good. One idea to improve such insufficient accuracy is to convert the learned ANNs to physical heat balance models. Such converted heat balance models are expected to be effective outside ANN learning conditions if the governing physical laws are the same as those inside ANN learning conditions. The model parameter identification using learned ANN is desirable to convert the ANN to heat balance models.

In this study, a numerical procedure using an artificial neural network (ANN) has been developed to identify the model parameters of 0-dimensional radiator heat balance models. This model parameter identification method includes two steps as follows. The first step is an ANN learning step. The second step is a computational analysis step to identify the model parameters using learned ANN. The model parameters to be identified are radiator-water thermal conductance as a function of water flow rate, radiator-air thermal conductance as a function of air velocity, and radiator heat capacity as a constant. We used a 0-dimensional radiator heat balance model (Fig. 1) with pre-set model parameters to generate temperature data instead of measured temperature data for ANN learning (Fig. 2) in the first step. In the second step, the learned ANN was used for numerical experiments with well-controlled input data, and the model parameters were identified by analyzing the results of the numerical experiments. The identification results and pre-set model parameters were compared to validate the present identification method. The validation results showed that this identification method sufficiently regenerated all the pre-set model parameters (for example, Fig3).
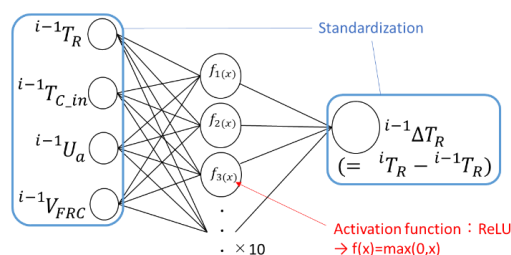

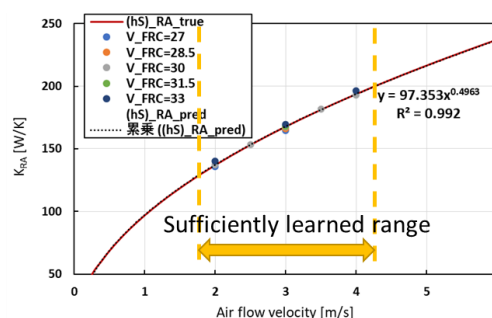Fig. 2 ANN diagram for radiator heat balance
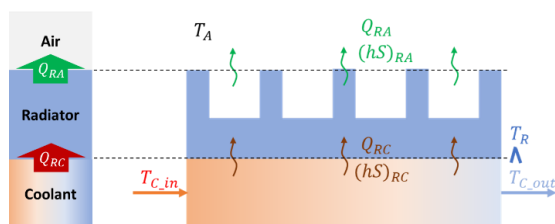

Fig. 3 K_{RA} physical model fitted to identified values

Fig. 1 Radiator model schematics