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Application of data driven modeling for MARS-KS code constitutive equation

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Introduction

- In order to improve the physical model of safety analysis codes, various institutes in each country are continuously conducting IET and SET for various scenarios and thermal hydraulic conditions.
- However, due to complexity of two phase flow and the difficulty of modeling, there are stil cases which the experiments and code calculated results do not exactly match when IET or SET is performed.
- In this study, SUBO experiment conducted by KAERI selected as the reference experiment that the original system code cannot accurately predict experimental void fraction.

Methods

- Using MATLAB, separate platform that performs the same calculations as the original MARS-KS constitutivbe equation was used to randomly generate input output datasets for feedforward network.
- Sigmoid fuction and ReLu was used as the activation fuctions, and the number of hidden layers was 2 with 20 to 30 nodes for the given datasets.

Table 1. Input parameter thermal hydraulic condition

Input parameter	Unit	Value
P (Pressure)	kPa	150-200
Tsf (Tf – Ts)	K	-30 – 0
Tsg (Tg – Ts)	K	-0.01 – 0.01
vl (liquid velocity)	m/s	1.0 – 3.0
vg (vapor velocity)	m/s	0.0 – 5.0
ag (void fraction)	-	0.0 - 0.7

- MARS-KS code has been modified to read the weight and bias values of the neural network by additional input file and to perform the same calculations as the neural network during the code calculation for interfacial heat transfer coefficient calculation.
- The weight and bias values of the trained feedforward network were saved as input files, and the MARS-KS has been modified to read both input filed for the original simulation and feedforward network simultaneously.

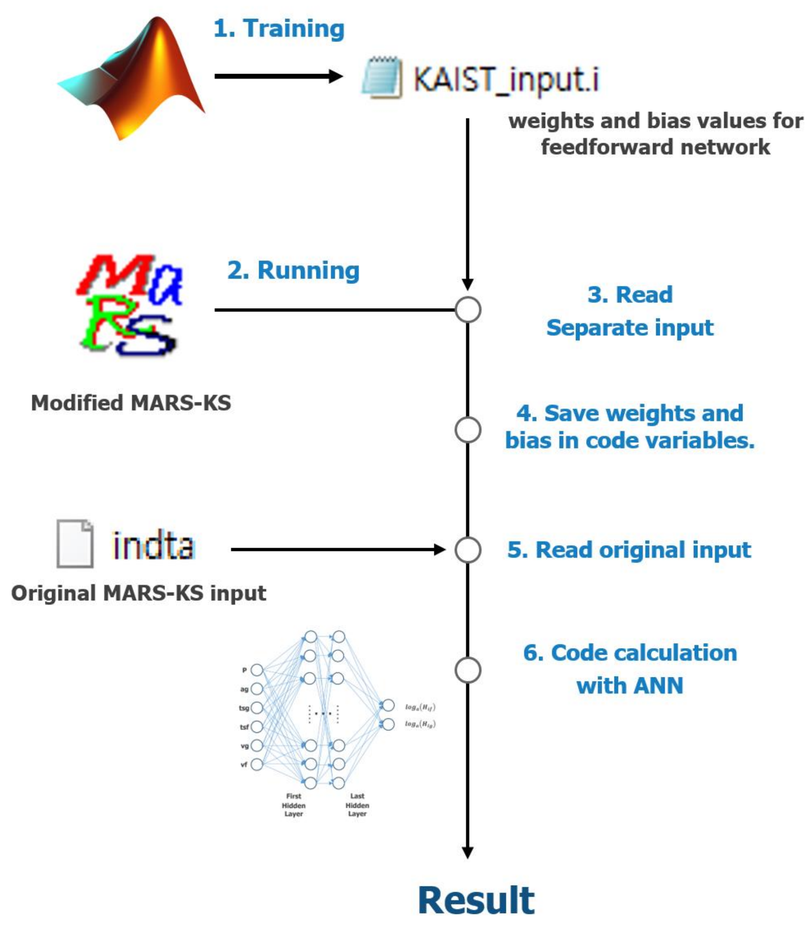

Fig 1. Code progress of modified MARS-KS code

- In this study, it is needed to modify pre-trained feedforward network by using a small number of experimental data.
- Random values were used in the weight and bias values of the feedforward network, and a minimum error set was obtained by applying simulated annealing method.

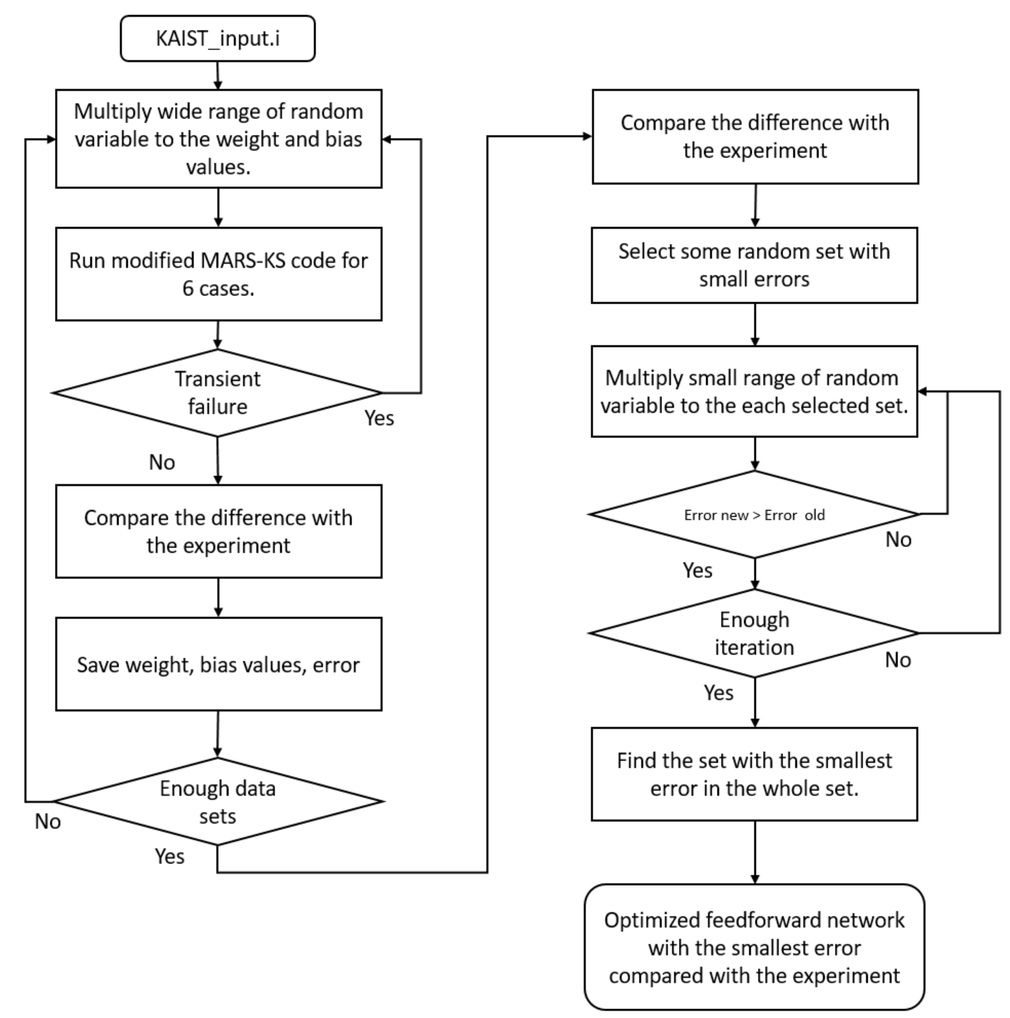

Fig 2. Flowchart of weight and bias optimization

Results

- It is confirmed that random perturbation of the weight and the bias values of the feedforward networkj change the predicted void fraction of the modified MARS-KS code.

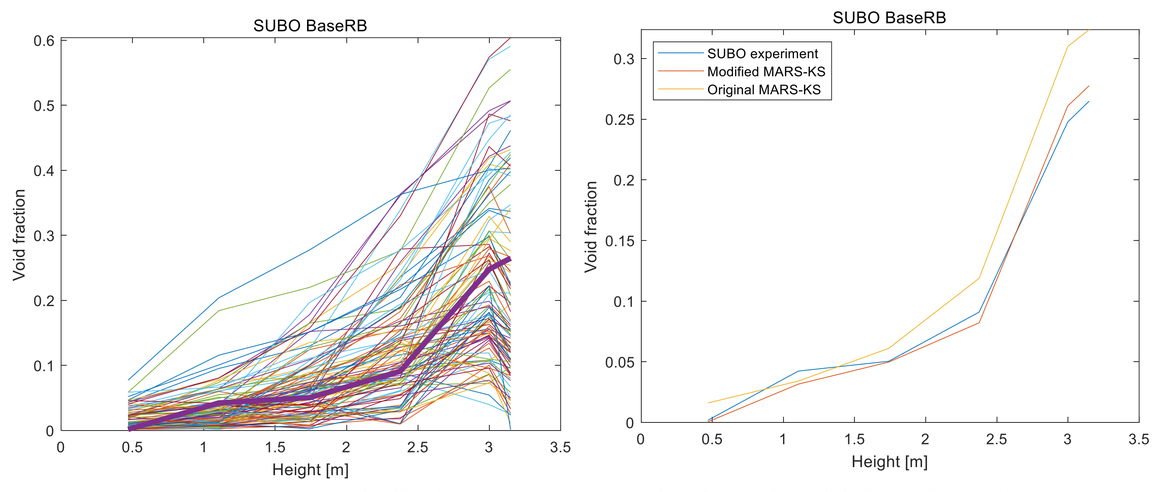

Fig 3. Modofied MARS-KS calculated void fraction of radom perturbation and smallest error-set

- Original MARS-KS has a total void fraction error of 0.182, and the modified code shows a total void fraction error of 0.0473, which shows the modified MARS-KS code predicts the experimental data much better than the original MARS-KS code.

Conclusions

- As a result of study, it was possible to replace interfacial heat transfer constitutive equation with feedforward network.
- Also, it is confirmed that random perturbation of the weight and the bias values of the feedforward network changes the predicted voidf fraction of the modified MARS-KS code.

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