# Control-oriented dynamic identification modeling of a planar SOFC stack based on genetic algorithm-least squares support vector regression

Key words: Solid oxide fuel cell (SOFC), Control-oriented, Dynamic modeling, Least squares support vector regression (LSSVR)

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## **Main Goal**

- A control-oriented dynamic modeling study of the SOFC is reported , which considers both the electrochemical and thermal aspects of the SOFC.
- ➤The validity of the proposed GA-LSSVR model is verified by comparing the results with those obtained from the physical model.
- Simulation studies further indicate that the GA-LSSVR model has higher modeling accuracy than the SAA-LSSVR and the 5FCV-LSSVR models.



## **Modeling methods**

- LSSVR is employed to model the nonlinear dynamic characteristics of the SOFC.
- A genetic algorithm (GA), by comparing with a simulated annealing algorithm (SAA) and with a 5-fold cross-validation (5FCV) method, is preferably chosen to optimize the LSSVR's parameters.



# **Optimization of the LSSVR's parameters**



Fig.1 Process of optimizing the LSSVR's parameters based on GA.



#### > The simulations for the output voltage of the SOFC.



Fig. 2 Output voltage responses of the physical and the GA-LSSVR models.

Fig. 3 Output voltage responses of the physical and the SAA-LSSVR models.



#### > The simulations for the output voltage of the SOFC.



Fig. 4 Output voltage responses of the physical and the 5FCV-LSSVR models.



#### > The simulations for the temperature dynamics of the SOFC.



Fig. 5 Temperature responses of the physical and the GA-LSSVR models.

Fig. 6 Temperature responses of the physical and the SAA-LSSVR models.



The simulations for the temperature dynamics of the SOFC.



Fig. 7 Temperature responses of the physical and the 5FCV-LSSVR models.



### Conclusions

- To investigate the dynamic behaviors of the SOFC and facilitate model-based controller design, the LSSVR identification model whose parameters are optimized by GA is proposed to simultaneously describe the electrochemical and thermal characteristics of the SOFC.
- The results indicate that the prediction accuracy of the GA-LSSVR model has been immensely improved; in addition, its convergence rate is much faster.
- These results verified the applicability of the GA-LSSVR model in modeling the transient behaviors of the SOFC.

