

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

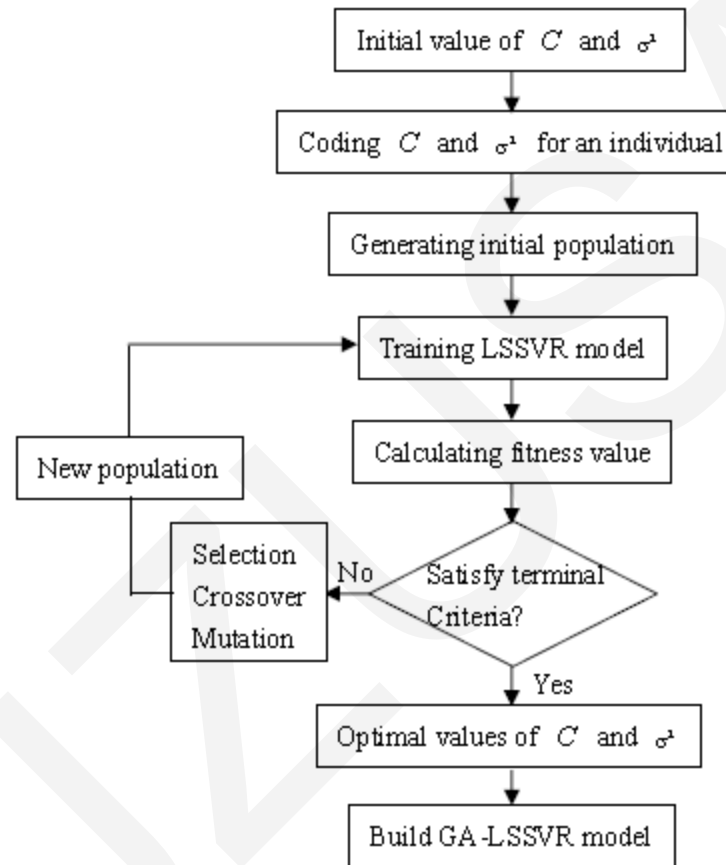


Fig.1 Process of optimizing the LSSVR's parameters based on GA.

Identification results

➤ The simulations for the output voltage of the SOFC.

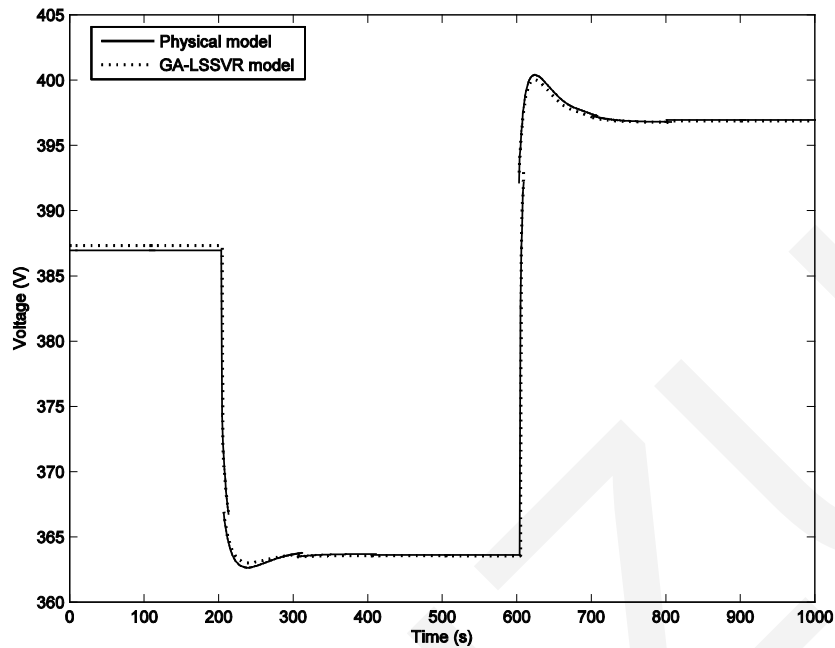


Fig. 2 Output voltage responses of the physical and the GA-LSSVR models.

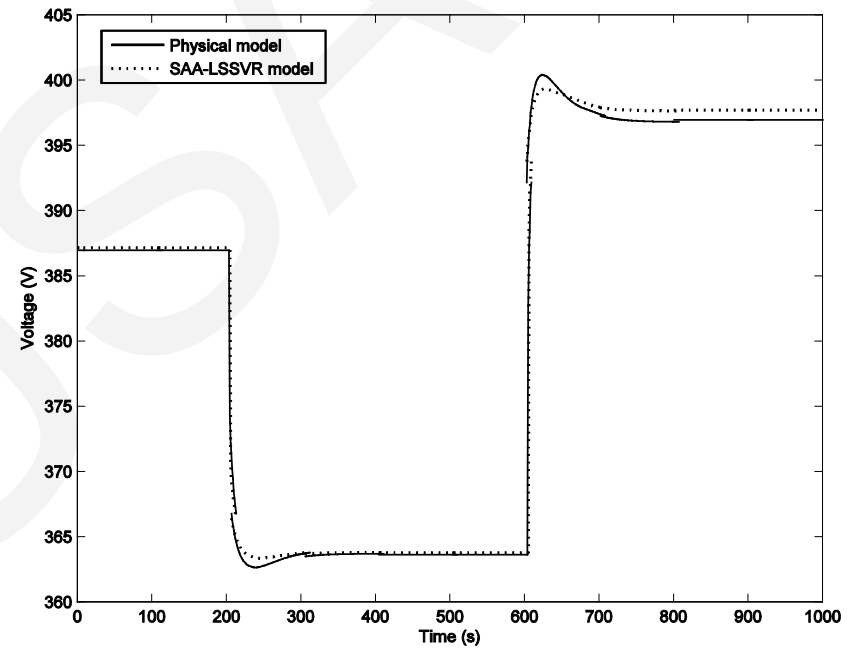


Fig. 3 Output voltage responses of the physical and the SAA-LSSVR models.

Identification results

- The simulations for the output voltage of the SOFC.

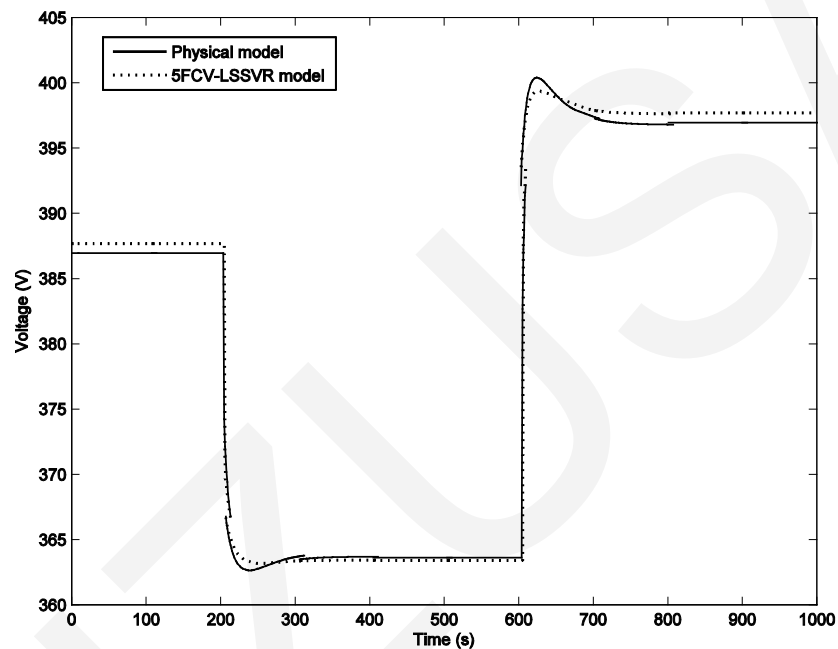


Fig. 4 Output voltage responses of the physical and the 5FCV-LSSVR models.

Identification results

- The simulations for the temperature dynamics of the SOFC.

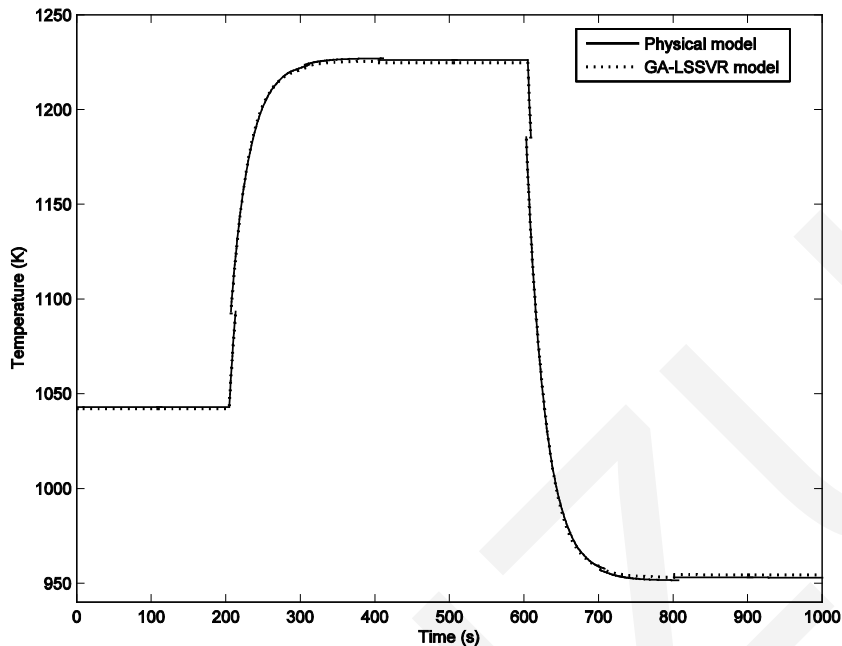


Fig. 5 Temperature responses of the physical and the GA-LSSVR models.

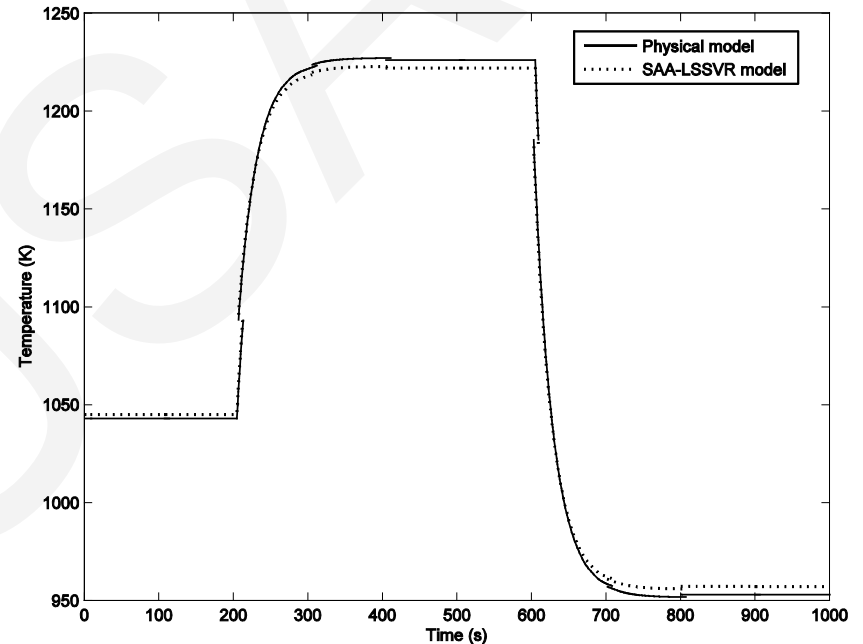


Fig. 6 Temperature responses of the physical and the SAA-LSSVR models.

Identification results

- The simulations for the temperature dynamics of the SOFC.

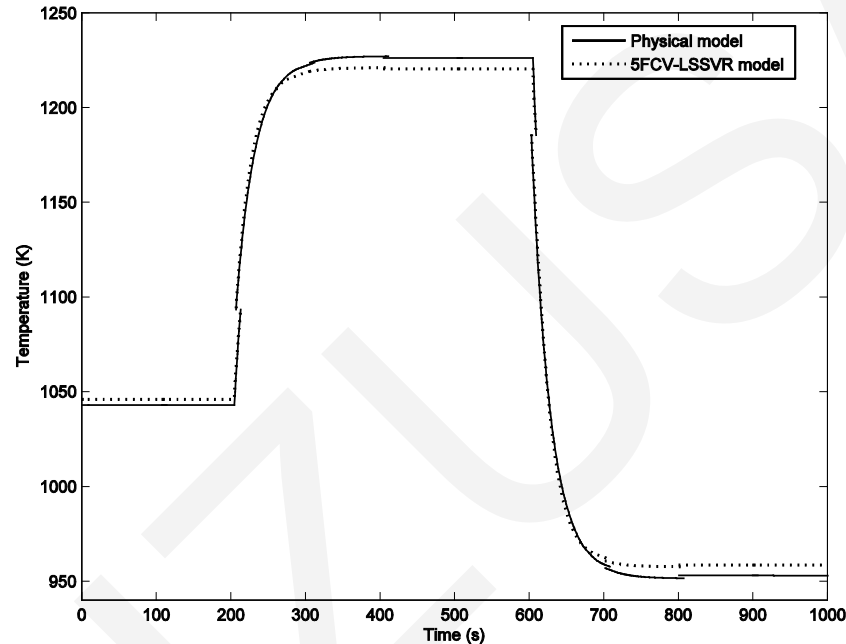


Fig. 7 Temperature responses of the physical and the 5FCV-LSSVR models.

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.