Suitability of the least-squares support vector machine method for modelling transient voltage in polymer electrolyte fuel cells

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The dynamic behaviour of the polymer electrolyte fuel cell (PEFC) has a major impact on its power generation and performance, which can benefit from a reliable model. Validations of such a model are critical for determining the credibility and suitability of the model, so that quantitative and qualitative validations should be carried out in order to verify the suitability of the model for real world application. In this paper, the least squares support vector machine (LS-SVM) method is used to construct a transient voltage model of a PEFC in the first phase, including a validation based on experimental data from a test rig. In the second phase, a thorough discussion of the effect of the fuel cell's operating conditions and the exterior load changes on the model's performance are implemented. In this phase, the influences of the sampling interval and ramp ratio are discussed. Four criteria are utilized to validate the model's performance. As the model passes a large number of tests under different operating conditions, its viability is proven. In addition, the results show that sampling with short time intervals is an effective way to improve the model's performance. A smooth change to the exterior load is more likely to be approximated by the LS-SVM model. Moreover, the voltage model is sensitive to the ramp change amplitude in comparison with the ramp time. A set of instructions for using the LS-SVM method when modelling operating PEFCs is also provided. With this, covering different accuracy requirements in PEFC applications, the sampling interval and exterior load change could be adjusted in advance to reach satisfactory model accuracy for fuel cell operation.

Keywords: PEFC; data-driven method; least squares support vector machine; model validation; model suitability.