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# Artificial Neural Network Based Parameter Prediction of Miniaturized Solid Rocket Motor

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**Abstract :** The working mechanism of miniaturized solid rocket motors (SRMs) is not yet fully understood. It is imperative to explore its unique features. However, there are many disadvantages to using common multi-objective evolutionary algorithms (MOEAs) in predicting the parameters of the miniaturized SRM during its conceptual design phase. Initially, the design variables and objectives are constrained in a lumped parameter model (LPM) of this SRM, which leads to local optima in MOEAs. In addition, MOEAs require a large number of calculations due to their population strategy. Although the calculation time for simulating an LPM just once is usually less than that of a CFD simulation, the number of function evaluations (NFEs) is usually large in MOEAs, which makes the total time cost unacceptably long. Moreover, the accuracy of the LPM is relatively low compared to that of a CFD model due to its assumptions. CFD simulations or experiments are required for comparison and verification of the optimal results obtained by MOEAs with an LPM. The conceptual design phase based on MOEAs is a lengthy process, and its results are not precise enough due to the above shortcomings. An artificial neural network (ANN) based parameter prediction is proposed as a way to reduce time costs and improve prediction accuracy. In this method, an ANN is used to build a surrogate model that is trained with a 3D numerical simulation. In design, the original LPM is replaced by a surrogate model. Each case uses the same MOEAs, in which the calculation time of the two models is compared, and their optimization results are compared with 3D simulation results. Using the surrogate model for the parameter prediction process of the miniaturized SRMs results in a significant increase in computational efficiency and an improvement in prediction accuracy. Thus, the ANN-based surrogate model does provide faster and more accurate parameter prediction for an initial design scheme. Moreover, even when the MOEAs converge to local optima, the time cost of the ANN-based surrogate model is much lower than that of the simplified physical model LPM. This means that designers can save a lot of time during code debugging and parameter tuning in a complex design process. Designers can reduce repeated calculation costs and obtain accurate optimal solutions by combining an ANN-based surrogate model with MOEAs.

**Keywords :** artificial neural network, solid rocket motor, multi-objective evolutionary algorithm, surrogate model
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