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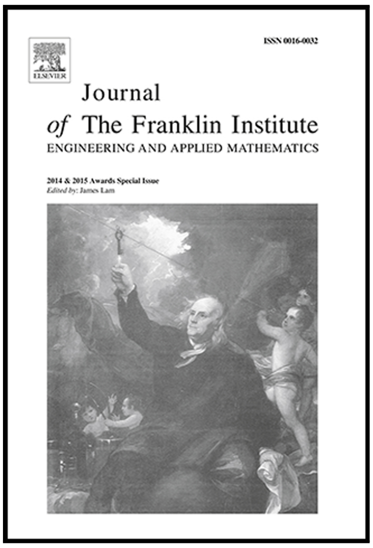

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Efficient Point-by-point Engine Calibration using Machine Learning and Sequential Design of Experiment Strategies

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Abstract

Modern engines are controlled by electronic control units (ECUs), which operate all the engine actuators based on the signals from various sensors in the engine. The control parameters of the actuators are stored in the form of look-up tables in ECUs. Traditionally, these parameters are obtained through huge amount of trial-and-error experiments. However, using traditional approach to calibrate these parameters becomes more challenging with the increasing incorporation of new technologies into advanced engines. In order to reduce the number of experiments required in the calibration process of modern engines, a novel point-by-point engine calibration approach based on machine learning methods is proposed in this study. It is an iterative procedure that, for a given operating point, sequential design of experiment (DoE) strategy is utilized to measure the responses of different engine sensors corresponding to different actuator signals, and a machine learning algorithm called initial-training-free online extreme learning machine (ITF-OELM) is utilized to incrementally learn the relationship between the sensors and actuators of the engine based on the measurement acquired. In each iterative cycle, meta-heuristic optimization is performed on the machine-learning-based model to search for the best parameters, which are then used as the initial parameters for generating DoE plan of the next cycle. The iteration is repeated until the optimal parameters of that operating point are found. To verify the effectiveness of the proposed approach, experiments on both simulation engine in commercial software and real