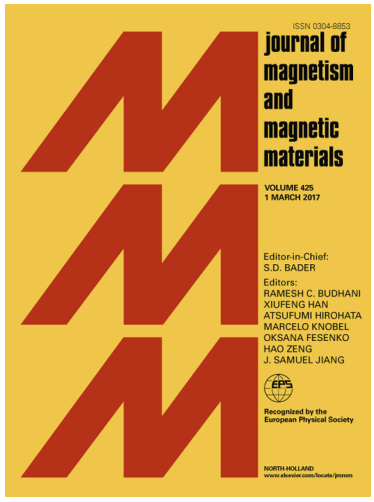

Research articles

Application of metaheuristic algorithms to the identification of nonlinear magneto-viscoelastic constitutive parameters

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Application of metaheuristic algorithms to the identification of nonlinear magneto-viscoelastic constitutive parameters

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Abstract

Metaheuristic algorithms offer a robust and convenient method to solve highly nonlinear optimisation problems in engineering applications. In this work we evaluate the effectiveness of a collection of canonical algorithms at performing parameter identification for nonlinear constitutive laws that describe coupled, magnetic-field responsive materials. To achieve this, we define an objective function that captures the influence of many physical measurements recorded during experimental analysis of a coupled material, and incorporates the influence of experimental uncertainty. A benchmark of the algorithms is conducted through the evaluation of a magneto-visco-elastic material by means of numerically-derived parallel-plate rotational rheometry. The effectiveness of each algorithm at matching the fictitious, but representative, experimental data was considered using two different metrics. In addition to the ranking based on a non-parametric statistical test, we consider an ad-hoc criterion that accounts for only the top performing candidate solutions. It is determined that the continuous real and discrete bitstring genetic algorithm provide the best overall performance in terms of the accuracy of the predicted parameters, while globally-elitist simulated annealing provides the best compromise between accuracy and computational efficiency. When experimental uncertainties exist (which is always the case for data determined within a laboratory setting), it has been observed that the strong link between constitutive parameters and physical material properties, which is typically assumed, no longer holds.

Keywords: Nonlinear magneto-visco-elasticity; parameter identification; metaheuristic algorithms; constitutive model; experimental uncertainty

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