ADAPTIVE PARAMETRIC IDENTIFICATION OF A CLASS OF DETERIORATING HYSTERETIC BEHAVIOR

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The modeling of nonlinear hysteretic behavior in structural and mechanical systems has been an area of considerable interest for the purposes of modeling the dynamic behavior and the energy dissipation and to track the oft-observed deterioration that accompanies the hysteresis. For models that are intrinsically time-invariant (not exhibiting deterioration) and use variation in the parameters to indicate deterioration, the identified parameters depend on the specific input history and cannot be used for simulation under arbitrary excitation. A preferable class of models would exhibit deterioration with a set of fixed model parameters. The authors developed a generalized Masing model based on the observed memory behavior of distributed element models that can model non-deteriorating and deteriorating hysteretic behavior with fixed parameters [1]. The deterioration in this model is based on Iwan's assumptions in [2]. This model is highly efficient in capturing deterioration and its parameters are physically meaningful. This latter point is of great importance to modeling in general, but in particular when performing model identification for the purposes of health monitoring and damage detection. Although this model has fixed parameters, real-time identification of them requires modification of the parameters from their inaccurate initial estimates. Hence, adaptive parametric identification of this model is the focus of this study.

Due to the very general nonlinear nature of the model, nonlinear optimization methods are used for the adaptive identification. The classic optimization methods work through several iterations to minimize a fixed objective function of the already known data. But here, the optimization should be performed as new data becomes available. Furthermore, timely processing of the data is essential. Therefore, several modifications are suggested to apply classic optimization methods to the adaptive identification problem. A changing objective function is defined to be minimized which is an error function over a shifting window of recent data. Also, only one iteration is performed in each time step. A variation of the steepest descent method is used with significant modifications. To help achieve the best performance for any given problem, a set of guidelines and a priori numeric tests are suggested to design the identification scheme based on gross information about the model and the expected input. Noisy and noise-free cases are included in the study. The designed identification scheme has very good performance in identifying the correct values of the parameters. The set of guidelines proposed by the authors are a contribution toward having more effective autonomous identification schemes, using minimal information about the model and input.

References

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