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ENHANCED BAYESIAN MODEL UPDATING FOR STRUCTURAL HEALTH MONITORING VIA DEEP LEARNING

Matteo Torzoni[1*], Andrea Manzoni[2] and Stefano Mariani[3]

[1] Dipartimento di Ingegneria Civile e Ambientale, Politecnico di Milano,
Piazza L. da Vinci 32, 20133 - Milano (Italy),
matteo.torzoni@polimi.it
[*]Presenting author

[2] MOX, Dipartimento di Matematica, Politecnico di Milano,
Piazza L. da Vinci 32, 20133 - Milano (Italy),
andrea1.manzoni@polimi.it

[3] Dipartimento di Ingegneria Civile e Ambientale, Politecnico di Milano,
Piazza L. da Vinci 32, 20133 - Milano (Italy),
stefano.mariani@polimi.it

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The present work focuses on enhancing an automated Bayesian procedure for structural health monitoring (SHM) by means of deep learning. Learnable feature extractors and surrogate models ruled by deep neural networks are data-driven computing methodologies, that have been recently shown crucial in enabling reliable real-time SHM procedures. These machine learning paradigms are here hybridized with physics-based modeling to efficiently deal with SHM through a Markov chain Monte Carlo sampling algorithm, which eventually allows to update the probability distribution of the structural state, conditioned on noisy sensor observations. The data-driven models are synergically exploited for the evaluation of the (conditional) likelihood function in place of more computationally expensive finite element models, to enable an effective structural analysis to be performed in, or close to real-time. Physics-based models of the structure are first adopted to generate training datasets, accounting for different and sound loading and damage conditions. Whenever possible, this offline data generation is speeded up through a model order reduction strategy for parametrized systems, while a multi-fidelity scheme is adopted to look for an optimal trade-off between computational burden and accuracy in the predicted quantities of interest, namely observables or damage-sensitive features. Two case studies, an L-shaped cantilever beam and a portal frame railway bridge, are adopted to highlight the performance of the proposed procedure.