An MCMC approach powered by a multi-fidelity deep neural network surrogate for damage localization in civil structures

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This work presents a stochastic approach for the health monitoring of civil structures, tailored for the task of damage localization in case of slow damage progression. The Bayesian identification of damage parameters is achieved through a Markov chain Monte Carlo (MCMC) sampling algorithm, used to sequentially update its posterior probability conditioned on noisy sensors observations. To enable the MCMC analysis to run in real-time or quasi real-time, a multi-fidelity deep neural network surrogate model is adopted to accelerate the computation of the conditional likelihood, in place of the numerical model of the monitored structure. The surrogate model learns from few high fidelity and several low fidelity simulated data, such to alleviate the computational burden of the supervised training stage. Results relevant to a numerical case study prove remarkable accuracy under the effect of measurement noise and varying operational conditions.