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MODEL CALIBRATION AND DAMAGE DETECTION FOR A DIGITAL TWIN

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Numerical models are an essential tool in predicting and monitoring the behavior of civil structures. Inferring the model parameters is a challenging tasks as they are often measured indirectly and are affected by uncertainties. Digital twins couple those models with real-world data and can introduce additional, systematic sensor uncertainties related to the sensor calibration, i.e. uncertain offsets and calibration factors.

In this work, the challenges of data processing, parameter identification, model selection and damage detection are explored using a lab-scale cable stayed bridge demonstrator. By combining force measurements in the cables with displacement measurements from both laser and stereo-photogrammetry systems, the elastic parameters of a three-dimensional finite element beam model are inferred. Depending on the number of sensors and the number of datasets used, parametrizing the sensor offsets and factors easily exceeds a total number of 100 parameters. With a real-time solution of the problem in mind, a highly efficient analytical variational Bayesian approach [1] is used to solve it within seconds. An analysis of the required assumptions and limitations of the approach, especially w.r.t. to the computed evidence, is provided by a comparison with dynamic nested sampling [2] in a simplified problem.

Finally, by inferring the value of additional damage parameters along the bridge, the method is successfully used to detect the location of an artificially introduced weak spot in the demonstrator bridge.

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