{A Physics-Informed Neural Networks Framework for Model Parameter Identification of Beam-Like Structures

Rafael Teloli*[1], Roberta Tittarelli , Patrice Le Moal , Emmanuel Ramasso , and Morvan Ouisse

[1]SUPMICROTECH, Université de Franche-Comté, CNRS, Institut FEMTO-ST – Université de Franche-Comté, Centre National de la Recherche Scientifique, Ecole Nationale Supérieure de Mécanique et des Microtechniques, Université de Technologie de Belfort-Montbeliard, Centre National de la Recherche Scientifique : UMR6174, Université de Technologie de Belfort-Montbeliard : UMR6174 – France

Résumé

This study introduces an innovative approach that employs Physics-Informed Neural Networks (PINNs) to address inverse problems in structural analysis. Specifically, this technique is applied to the 4th order partial differential equation (PDE) of the Euler-Bernoulli formulation to estimate beam displacement and identify structural parameters, including damping and elastic modulus. The methodology incorporates PDEs into the neural network's loss function during training, ensuring it adheres to physics-based constraints. This approach simplifies complex structural analysis, even when explicit knowledge of boundary conditions is unavailable. Importantly, the method reliably captures structural behavior without resorting to synthetic noise in data - an experimental application is put forward to validate the framework. This study represents a pioneering effort in utilizing PINNs for inverse problems in structural analysis, offering potential inspiration for other fields. The characterization of damping, a typically challenging task, underscores the versatility of methodology. The strategy is initially assessed through numerical simulations utilizing data from a finite element solver and subsequently applied to experimental datasets. The presented methodology successfully identifies structural parameters using experimental data and validates its accuracy against state-of-the-art techniques. This work opens new possibilities in engineering problem-solving, positioning Physics-Informed Neural Networks as valuable tools in addressing practical challenges in structural analysis.

*Intervenant