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PHYSICS-INFORMED MACHINE LEARNING FOR INVERSE PROBLEMS IN CONDITION MONITORING

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Abstract Text: Modern societies heavily rely on an efficient and highly available transport infrastructure, to provide their citizens with goods and services. To keep the highway and railway network fit-for-service, monitoring, repair and replacement of bridges must be ensured even with limited financial and human resources. The structural monitoring of bridges in particular is a manual process that becomes significantly more time-consuming as the structures age and their condition deteriorates. To meet the growing demand for cost-effective monitoring and damage assessment solutions, interpretable digital methods for continuous, sensor-based condition monitoring of structures are essential.

Starting form a mechanical model of a structure that takes the system state into account when responding to loads in terms of measurable quantities, such as displacements or accelerations, the task of damage assessment, including detection, localization and quantification, is formulated as inverse problem of system identification. This talk presents an overview of scientific machine learning methods that can contribute to solving this inverse problem, including physics-informed neural networks and FEM-based neural networks or sparse Bayesian learning [1, 2].

Selected methods are tested with a numerical benchmark problem of a two-span beam structure [3]. The benchmark problem specifically accounts for variable operational and environmental conditions, such as variations of the ambient temperature regularly faced when monitoring bridges. Moreover, an extension to real-world sensor data from a measurement campaign on a two-span bridge and a comparison with base-line operational modal analysis models is planned [4].

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