Special Session Title:

Transfer learning for Structural Health Monitoring: innovations and applications

Organizers

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Abstract

The recent developments in computer science and sensor technology have contributed to enhancing the spread of Artificial Intelligence-based SHM methods. However, the availability of sufficient labeled data covering various environmental conditions and different health states often poses a significant challenge for the application of supervised learning in real-world monitoring scenarios, making it difficult to develop models capable of providing contextual information and robust damage assessment algorithms. Moreover, typical Machine Learning (ML) classifiers fail to generalise across different domain distributions, meaning that each SHM system would require a bespoke ML algorithm. With the purpose of handling the diverse structural properties, environmental characteristics and sensor data within a given population (i.e. group) of monitored structures, Transfer Learning (TL) presents a potential solution. Conventional ML models are adapted to leverage knowledge from a source structure and afterwards enhance diagnosis on a related target domain with missing or scarce information. This special session aims to explore the latest innovations and applications of TL techniques in SHM, including practical implementations, experimental findings and new methodologies to enhance the quality of damage assessment across multiple structural configurations. Specifically, the interest is to discuss TL-based solutions to sparse data in real-world SHM challenges, relating to similarity quantification, sensor network heterogeneity and variability in environmental conditions. The session aims to contribute to bridge the gap between theoretical developments and practical deployment of TL in SHM, in view of more informative and reliable monitoring systems that can be implemented across diverse structures and infrastructures. Some of the key topics of interest in this session include:

- TL-based strategies for SHM.
- Utilisation of domain-invariant features.
- Understanding the influence of environmental conditions in TL.
- Damage assessment across multiple structural configurations.
- Similarity quantification between structures to ensure positive transfer.
- Data-fusion TL to handle sensor network heterogeneity.
- Finite Element Models to enhance knowledge transfer.
- Solutions to the lack of labeled data.