POLITECNICO DI TORINO
Repository ISTITUZIONALE

Surrogate modelling of aerospace structures for damage detection and classification

Original
Surrogate modelling of aerospace structures for damage detection and classification / Pagani, A.; Carrera, E.. - (2018). ((Intervento presentato al convegno 1st International Conference on Mechanics of Advanced Materials and Structures (ICMAMS) tenutosi a Torino, Italy nel 17-20 June, 2018.

Publisher:
MAMS

Published
DOI:

(Article begins on next page)

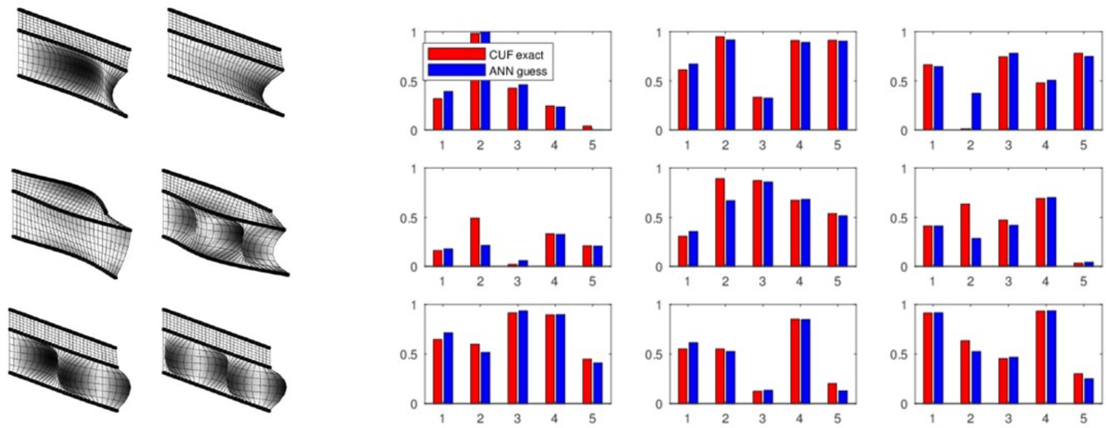
ICMAMS 2018
First International Conference on Mechanics of Advanced Materials and Structures
Turin, 17-20 June 2018
www.icmams.com

SURROGATE MODELLING OF AEROSPACE STRUCTURES FOR DAMAGE DETECTION AND CLASSIFICATION

E. Carrera[1] and A. Pagani[1,*]

[1] *Mul*[2] Team, Department of Mechanical and Aerospace Engineering, Politecnico di Torino, Italy
[*] Corresponding author: alfonso.pagani@polito.it

Artificial neural networks (ANNs) are inspired by the impressive cognitive and data processing capabilities that are typical of biological neural networks and have been widely employed in the last few decades for various engineering applications, including image processing, pattern recognition, diagnostic systems, and complex function approximations. In this work, multilayer perceptrons are utilized for vibration-based damage detection of multi-component aerospace structures. A back-propagation algorithm is utilized along with Monte Carlo simulations and advanced structural theories for training ANNs, which are able to detect and classify local damages in structures given the natural frequencies and the associated vibrations modes. The latter ones are feed into the network in terms of Modal Assurance Criterion (MAC), which is a scalar representing the degree of consistency between undamaged and damaged modal vectors.



(a) Representative vibration modes of damaged structure

(b) Damage detection by ANN

Figure 1: Component-wise damage detection of a three-stringer spar.

Dataset and ANN training process is carried out by means of Carrera Unified Formulation (CUF), according to which refined structural theories with component-wise capabilities can be implemented in a hierarchical and unified manner. As demonstrated in previous works [1], CUF is able to provide vibration characteristics of structures for a wide range of damage scenarios, see Fig. 1a. In this manner, trained ANNs can approximate complete mapping of the damage distribution, even in case of low damage intensities and local defects in single components (stringers, spar caps, webs, etc.). Preliminary results are given in Fig. 1b, which shows predicted versus actual damage intensities for a multiple damaged three-stringer spar.

References

[1] E. Carrera, A. Pagani, and M. Petrolo. Free vibrations of damaged aircraft structures by component-wise analysis. *AIAA Journal*, pages 3091–3106, 2016.