THU.1.C.1

Author : Marco Salucci - ELEDIA Research Center (ELEDIA@UniTN – University of Trento), Trento, Italy & ELEDIA Research Center (ELEDIA@L2S – UMR 8506), Gif-sur-Yvette, France

Co-Authors : Marco Salucci (ELEDIA Research Center (ELEDIA@UniTN – University of Trento), Trento, Italy & ELEDIA Research Center (ELEDIA@L2S – UMR 8506), Gif-sur-Yvette, France) | Paolo Rocca (ELEDIA Research Center (ELEDIA@UniTN – University of Trento), Trento, Italy

TITLE : INNOVATIVE LEARNING-BY-EXAMPLES APPROACHES FOR REAL-TIME NDT/NDE OF COMPLEX STRUCTURES

ABSTRACTS

Non-destructive testing and evaluation (NDT&E) is aimed at non-invasively evaluating the structural integrity of complex structures and guarantee human safety in many civil and industrial (e.g., aerospace and nuclear) applications. Within this context, probing the structure under test (SUT) through electromagnetic (EM) fields and processing the resulting “signature” measured over an external observation domain allows one to retrieve preliminary diagnoses before proceeding with ad-hoc (often invasive) repairing/substitution actions. Typical NDT&E analyses can be subdivided into a sequence of inter-connected tasks aimed at progressively infer the SUT status. More in detail, the first task is aimed at detecting the presence of one or multiple defects with respect to a (a-priori known) healthy scenario. Then, a second task is devoted to estimate qualitative information such as the number and the position of the detected targets, while a third step is aimed at retrieving a guess of their shape and size. Finally, depending on the targeted application, a fourth task is the estimation of quantitative information (i.e., material composition) on the imaged defects.

Although fast and accurate EM forward solvers have been recently introduced, many state-of-the-art imaging approaches are not suitable for applications where an immediate feedback is required because of their iterative nature and the resulting very high computational load. On the other hand, learning-by-examples (LBE) strategies recently attracted particular attention since they can yield accurate and robust diagnoses with real-time capabilities. LBE methods are based on the generation of a training database of input/output pairs to build a computationally fast surrogate model of the (unknown) inverse operator relating measurements and SUT status. More in detail, such a process can be seen as a three-step procedure aimed at (a) reducing the dimensionality of the input/data space by identifying a reduced set of features carrying the largest information on the predicted output (i.e., the SUT descriptors), (b) collecting the lowest possible number of I/O training samples able to accurately model the underlying physical phenomena, and (c) train a machine learning (ML) algorithm with good generalization capabilities in order to effectively process previously unseen data during the on-line test phase. Accordingly, this work is aimed at providing an overview of the most recent advances on LBE techniques as applied to NDT&E scenarios, highlighting their current limitations and challenges as well as envisaging future trends including their natural evolution within the ever-growing deep learning framework.

KEYWORDS

NDT/NDE | Learning-by-Examples (LBE) | Real-Time Inversion | Deep Learning |