The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Interpretable and Scalable Reduced Order Modelling for Digital Twins in Manufactoring

Valentina Zambrano[1], Salvador Izquierdo[1], Manuel Laspalas[1],

[1] Instituto Tecnológico de Aragón - ITAINNOVA, C/ María de Luna 7-8, 50018 Zaragoza (Spain), vzambrano@itainnova.es, https://www.itainnova.es/

Keywords: *Digital Twin, Reduced Order Modelling, Industry 4.0, DIGITbrain*

The introduction of Digital Twins (DTs) in Industry 4.0 (I4.0) is experiencing an important increase, due to the efficienncy in results retrieval through virtual models of industrial physical systems' (e.g., process, machinery, production line) behaviour under different operating conditions. Due to the challenges faced by I4.0, a European H2020 Project was proposed. The DIGITbrain project (*https://digitbrain.eu/*) aims for the development of an integrated digital platform to provide Small and Medium-sized Enterprises (SMEs) access to DT technology. Within this context several models for DTs can be created using CAELIA™, an authoring tool developed at ITAINNOVA for Reduced Order Model (ROM) [1] generation and management. ROMs are a physically-informed data-driven models used for computing virtual representations of physical systems, assimilate real-time data, build multicomponent systems and retrieve real-time results. CAELIA™ROMs are obtained through the Twinkle library (which can work both on dense and sparse data, and it is especially designed for unstructured data), and are based on self-adapted Tensor Rank Decomposition (TRD), according to Equation 1 (for further details please refer to [2]).

$$F(v_1, \ldots, v_N) = \sum_{m=1}^{M} \alpha_m \prod_{n=1}^{N} f_{m,n}(v_n) \tag{1}$$

where M is the ROM's approximation order of the series expansion and $\alpha_m, m = 1, \ldots, M$ are weighting coefficients.

CAELIA™'s ROMs are a valuable tool for DT development, considering that these are not only capable of forecasting unexplored behaviours of virtualised system, but can also serve for operating conditions' optimization, finding the best conditions to obtain the desired result.

REFERENCES

[1] M.P. Mignolet, A. Przekop, S. Rizzi and S.M. Spottswood, *A review of indirect/non-intrusive reduced order modeling of nonlinear geometric structures*. Journal of Sound and Vibration. 2013 May;332.10:2437-2460

[2] V. Zambrano, R. Rodríguez-Barrachina, S. Calvo and S. Izquierdo, *TWINKLE: A digital-twin-building kernel for real-time computer-aided engineering*. SoftwareX. 2020 Feb;11:100419