COMPUTATIONAL METHODS FOR ENABLING DIGITAL TWINS

TRACK NUMBER 700 – DIGITAL TWINS

D. GIOVANIS[†], M. GUO[‡], D. LOUKREZIS[*], D. MANVELYAN[*]

[†]Johns Hopkins University, Baltimore, MD, USA
dgiovan1@jhu.edu

[‡]University of Twente, Enschede, Netherlands
m.guo@utwente.nl

[*]Siemens AG, Technology, Munich, Germany
{dimitrios.loukrezis, diana.manvelyan}@siemens.com

Key words: computational science and engineering; digital twins; modeling, simulation, and optimization; reduced order modeling; scientific computing; uncertainty quantification.

ABSTRACT

The Digital Twin is a cornerstone technology concept within the ongoing 4th industrial revolution. By connecting physical assets to their digital replicas, Digital Twins offer unprecedented opportunities for innovation in industrial design and operation, for example, with respect to design optimization, decision support, and online (real-time) monitoring, to name but a few relevant applications. To enable disruptive Digital Twin innovations, methods stemming from the fields of scientific computing and computational science and engineering are continuously developed and optimized to address the corresponding challenges.

This minisymposium aims to address novel developments with respect to computational methods that are crucial for the realization of Digital Twins and their application for challenging industrial problems. Exemplary topics of interest include:

- *Executable* Digital Twins by means of model order reduction, reduced order modelling, or surrogate modelling, such that fast albeit accurate model evaluations during system operation are possible.
- *Uncertainty-aware* Digital Twins by means of probabilistic simulation, uncertainty propagation, and (Bayesian) model calibration.
- *Hybrid* Digital Twins that fuse physic-based and data-driven modelling, simulation, and optimization methods, thus combining “the best of two worlds”.

This list is by no means exhaustive, and several other topics of interest can also be considered, provided that they feature a connection to Digital Twin technologies and applications.

REFERENCES

[1] Manvelyan, Diana, Bernd Simeon, and Utz Wever. "A physics-based model reduction approach for node-to-segment contact problems in linear elasticity." *International Journal for Numerical Methods in Engineering* 123.23 (2022): 5937-5963.

[2] Kurz, Stefan, Herbert De Gersem, Armin Galetzka, Andreas Klaedtke, Melvin Liebsch, Dimitrios Loukrezis, Stephan Russenschuck, and Manuel Schmidt. "Hybrid modeling: towards the next

level of scientific computing in engineering." *Journal of Mathematics in Industry* 12.1 (2022): 1-12.

[3] Upadhyay, Kshitiz, Dimitris G. Giovanis, Ahmed Alshareef, Andrew K. Knutsen, Curtis L. Johnson, Aaron Carass, Philip V. Bayly, Michael D. Shields, and K. T. Ramesh. "Data-driven uncertainty quantification in computational human head models." *Computer Methods in Applied Mechanics and Engineering* 398 (2022): 115108.

[4] Bigoni, Caterina, Mengwu Guo, and Jan S. Hesthaven. "Predictive Monitoring of Large-Scale Engineering Assets Using Machine Learning Techniques and Reduced-Order Modeling." *Structural Health Monitoring Based on Data Science Techniques* (2022): 185-205.