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Using Digital Twins for Predicitive Maintenance

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The main goal of this work is to create a framework which can be used to create digital twins of production lines for predictive maintenance. Following [1], we want to combine a model library of various reduced basis models with an interpretable machine learning approach, which selects the "correct" models for each production step based on real-time sensor values of the physical assets. The digital twin of the whole production line can be used to predict upcoming failure states.
As data of real production lines often lacks quality or is not sufficiently labeled, we first want to construct a tensile testing machine, which tests 3D printed samples for tensile strength and cyclic fatigue. This enables us to generate realistic data while still being able to control the input parameters through the 3D printing settings of the samples. The physical stress of the 3D printed samples can be simulated in an offline stage for various load cases using a Finite-Element method to build a reduced basis. As the material degenerates under cyclic load, we want to do this for various material settings to create a model library similar to [1]. During the online stage, the "correct" reduced basis model can be determined using a machine learning algorithm, e.g. CARTs. As an alternative approach, we want to build a pure data-driven model using machine learning.
Using model order reduction for digital twins is no new idea and can e.g. be found in [2]. Furthermore, the application of digital twins for predictive maintenance was already discussed in [3]. Nonetheless, due to the lack of software solutions, this approach is not very widespread among production companies. We want to tackle this issue by creating a framework which still can be applied even if some processes are not physically modeled or are not modeled with a high accuracy. In these cases, machine learning should take the role of the reduced basis models.

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