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Model Order Reduction of Large Thermal FEM models by Machine Learning Methods

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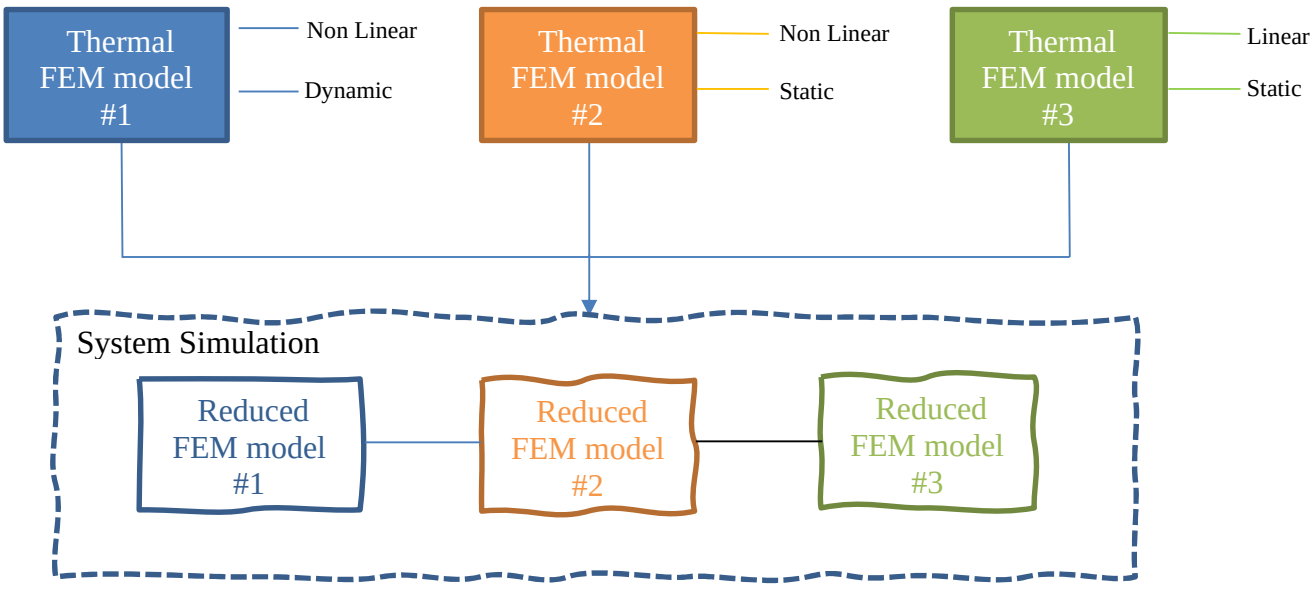
Abstract

Simulation based engineering is becoming crucial recent years on development process of high-tech systems. High-performance computing and efficient numerical algorithms have made high-fidelity FEM/CFD analysis flexible in geometries of ever increasing complexity. Despite continued advances in software and hardware areas, FEM simulations remain too costly for routine analysis and design of thermal systems where hundreds of designs must be evaluated. Reduced-order models (ROMs) offer a promising approach to overcome expensive high-fidelity simulations

Data based ROM methods (DB-ROM), such like physics based neural network or deep learning, getting attention recent years by project groups. In this study, we present some basic steps towards reducing the size of a large thermal FEM model by using commercial simulation packages – Ansys Twinbuilder and Siemens Amesim ROM tools. DB-ROM was applied on a generic problem that is similar to real life problems we encounter at development process of ASML's litho-machines. Static and dynamic, linear and non-linear thermal FEM models are reduced down to much smaller size by machine learning and singular value decomposition type of reduction methods. Reduced full order FEM models are implemented in a system simulation environment. Ansys Twinbuilder and Siemens Amesim softwares are compared based on reduced model creation process and ROM accuracy. Computation time&resources required to simulate load cases were reduced down to factor of 100-1000 thanks to the ROM methods.



Reduced order models, Machine Learning, FEM