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Combining PyAnsys and APDL to optimize the dynamic behavior of large Electric Motors using the NSGA-II algorithm

During the last 15 years ABB has developed a finite element model of their ring motors using Ansys APDL. The model generation, the meshing, the solution, and the post-processing of the results is based on a full parametric model where the whole simulation process was completely automated. No user input is required other than the introduction of the initial parameters needed to run the analysis. The ring motor finite element model has more than 20'000 lines of APDL code and requires about 650 input parameters. One of the main challenges in such a complex model is the large amount of design iterations needed to define the optimum frame structure in terms of material cost that meets the static and dynamic stiffness requirements. A proof-of-concept study has been performed where an optimization algorithm called NSGA-II was programmed in Python. The NSGA-II algorithm proposes optimized geometry parameters for the Ansys model of the ring motor which then returns the results back to the NSGA-II algorithm. The link between Python and Ansys was established through PyMAPDL, which integrated the APDL code and the NSGA-II algorithm as two main functions that are called during the optimization process until a predefined termination criteria is achieved. The outcome of this proof-of-concept study were several optimal solutions where the natural frequencies of the most important in-plane natural frequencies of the ring motor were increased up to 17.3% compared to a reference ring motor. What has been shown is just one of the benefits of being able to combine Python and Ansys to create more complex analysis which could not easily have been achieved in either tool on its own. Another benefit is the ability to wrap a Python GUI around the previously mentioned APDL macros thereby creating a customized design tool for more automated calculation processes of components, in this case a ring motor for gearless mill drives.

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