International Journal of Applied Electromagnetics and Mechanics 69 (2022) 125–126
DOI 10.3233/JAE-229002
IOS Press

Editorial

Special issue on electromagnetic fields in mechatronics, computer sciences, electrical and electronic engineering

The worldwide community active in the broad area of computational electromagnetics – which grew up substantially in the last decades – gathers academic and industrial researchers who utilize field based numerical models with the manyfold scope of designing new devices, predicting the behavior of prototypes, or interpreting measurements.

Accordingly, in this special issue (SI) of the IJAEM, a collection of 14 papers, selected after a peer review procedure, covers the main subjects of interest for the community.

A group of papers is focused on optimal design methods: on the one hand, attention is paid to surrogate models with new approaches like neural networks, while on the other hand, multiple design criteria are considered at a time, leading to a multi-objective optimization. A confirmed subject of research is the investigation of the properties of magnetic materials utilized in electrical machines; in fact, the most widespread applications considered in the SI are power devices like electric motors, for instance salient pole synchronous generators or permanent magnet synchronous motors. However, special applications ranging from sensors in biological systems to superconductors in electrical machines and energy harvesting systems are also addressed.

An emerging new tendency is the use of machine learning techniques for developing surrogate models of fields. In particular, convolutional neural networks are especially attracting due to their capability of handling the bitmap image of a field distribution in a region of interest. The training of this class of networks is usually based on a sequence of finite-element analyses; therefore, once a neural network is trained, it can be used as a surrogate model and placed in an optimization loop: this way, the computational burden is limited to the net training, while the computation of field-related objective functions is almost inexpensive.

More likely than not, field analysis is the common ground upon which models of specific devices are developed: in fact, field-based models are especially suited to predict the behavior of devices exhibiting complex shapes and non-linear material properties, or to synthesize new devices characterized by better performance or lower cost with respect to existing prototypes. The main development in the area is intimately related to the deep understanding of physical processes which in turn is fostered by advanced numerical methods.

In general, one of the most important messages which comes out of the SI is that university and industry should cooperate in a closer way to dominate the challenges of product innovation. In fact, technical challenges set requirements and criteria for the development of numerical methods: one of the main aims

is reducing complex problems of field analysis ad synthesis to the search for cost-effective approximate solutions based on user-friendly tools.

All in one, the collection of papers here presented provides an updated scenario of contemporary computational electromagnetics in the area of low-frequency electromagnetism.

Eventually, the editors are grateful to all the authors for their valuable contributions as well as to the Editor-in-Chief of the Journal for the opportunity of addressing a wide international audience.

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