SAS-PINN: An Enhanced Physics-Informed Neural Network for 2-D Time-Domain Electromagnetic Field Computation of Power Transformer

Ruimin Zhu[1], Xutao Cong[1], Shiyu Pu[1], Ning Lin[2], Venkata Dinavahi[3]

[1]North China Electric Power University, [2]Powertech Labs Inc., [3]University of Alberta

In this paper, an enhanced physics-informed neural network (PINN) framework is proposed for accurate time-domain electromagnetic field computation in power transformers. To address the numerical stiffness and convergence challenges arising from steep field gradients between ferromagnetic cores, dielectric materials, and multi-layer windings, the high-frequency representation capability of the SIREN network architecture is leveraged. A novel adaptive collocation point sampling strategy is developed to dynamically refine spatial-temporal sampling resolution in high-gradient regions, effectively balancing numerical accuracy with computational efficiency. The proposed framework rigorously embeds Maxwell's equations and composite boundary conditions into the loss formulation, establishing a surrogate model for 2D electromagnetic field computation. Numerical results demonstrate a two order-of-magnitude reduction in prediction error compared to vanilla PINNs with random sampling strategy. This breakthrough enables efficient simulation of time-domain multi-physics fields in complex electromagnetic devices featuring intricate geometries and multi-material interfaces.

979-8-3315-8138-1