MSc thesis

Using Physics Informed Neural Networks for High voltage research

Background

Due to the worldwide need for strong reduction of greenhouse gases to suppress the ongoing climate changes the electrical energy system is under large changes. An important part of the development of high voltage equipment needed for this challenge is to predict the insulation performance of air around such equipment. Today the performance of air as an insulation media are studied experimentally and by simulations using the so-called finite element model (FEM).

During the last years researchers in AI have started to develop a method called Physics Informed Neural Networks (PINN)\(^1\). PINN uses advanced physics described by partial differential equations that are incorporated in a neural network model. This approach has some advantages over FEM for solving very large or nonlinear problems. The target of the present MSc work is to build further on a MSc work from 2022\(^2\) and to explore how PINN can be used to study the Inverse problem of ionic charge dynamics in air insulation.

Work description:

In the work you will investigate how PINN can be used to solve an Inverse problem for electrical field and transport of ionic charges in air in a simple geometry. The work will be done step by step to build up an experience of using PINN for HV Physics applications.

The following tasks are to be accomplished:

- Literature study on related topics
- Getting familiar with the existing charge dynamic PINN model for the forward problem
  - Make some initial improvements of the performance
- Implement a PINN model that solves the Inverse problem of the charge dynamics model
- Investigate possibility to further improve the model
- Add additional physics into the PINN model (if time allows)
- Write a MSc thesis report, including: implementation of PINN and recommended future work

Pre-requisites: 1) Experience in Python programming or similar 2)Taken basic courses in Linear algebra and Calculus 3) Experience with Neural networks and AI

Beneficial skills: 1) Knowledge in Physics, 2) Finite element simulations

This MSc thesis work will be done at Chalmers and is part of collaboration between Chalmers and Hitachi Energy Research (HER). The starting time is January 2023 or earlier. A remuneration from HER will be paid at completion of the work. A part of the work could be done at HER in Västerås, as an option. For information contact: Adj. Prof. O. Hjortstam (HER/Chalmers), olof.hjorstam@hitachi-powergrids.com, Ass. Prof C. Häger (Chalmers), christian.haeger@chalmers.se, Prof. Y. Serdyuk (Chalmers), yuriy.sedyuk@chalmers.se

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