Master project, 2020-2021

— Investigation of the machine learning on the magneto-mechanics numerical computation of transformer—

Supervisor: Zuqi Tang, **zuqi.tang@univ-lille.fr**, L2EP – Univ. Lille

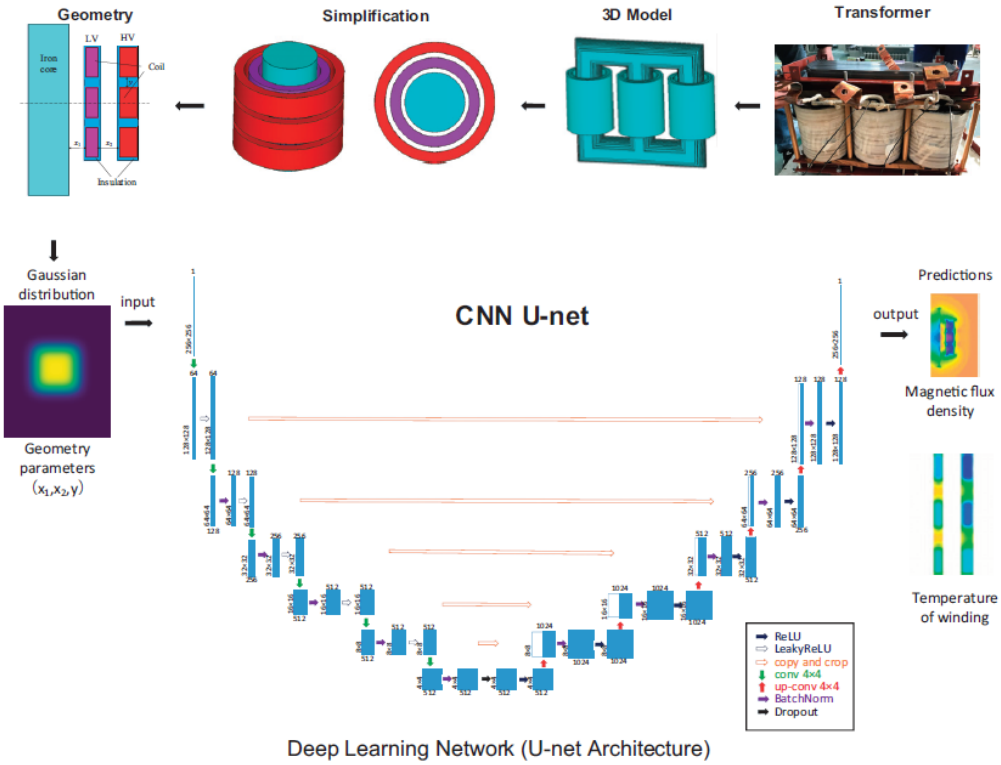
Ruohan Gong, **ruohan.gong @univ-lille.fr**, L2EP – Univ. Lille

Context

With the increasing scale of the power grid, the short-circuit fault of power transformer threatens the stability and reliability of the whole power system more and more seriously, which has gradually attracted the attention of relevant researchers. In the case of sudden short circuit of the power transformer, the peak short-circuit current flowing through the transformer winding can be over 10 times its rated operating current. Under the combined action of this impulse current and magnetic field, the winding will be subjected to a huge electrodynamic force that may deform the winding and leads to the destruction of the winding insulation or reduce the mechanical strength of the winding. Transformer windings are damaged by this force impact, which accumulates gradually through multiple short-circuit shocks. Once this potential safety hazard breaks out, it will cause serious destruction to the power grid. Therefore, revealing the influence of transformer short-circuit electrodynamic force on windings has a positive guiding role in its structure optimization and short-circuit tolerance. However, this destructive test for power transformer is very expensive, so the main research method for this problem is still the numerical calculation. On the other hand, due to the complicated winding structure, the traditional numerical computation method is also very time-consuming and inefficient.

Objective

The objective of the study dedicated to use deep learning, in particular, the convolutional neural network (CNN) as an auxiliary tool and an acceleration method for numerical calculation of the magneto-mechanics problems.



Deep Learning Network (U-net Architecture)

Work steps

1 Bibliography on the subject
2 Understand the simulation scheme for magneto-mechanics couplings
3 Understand the training process for the deep learning
4 Apply the CNN for different quantity of interest in the magneto-mechanics simulations

Key word

Magneto-mechanics, deep learning, convolutional neural network

References

[1] R. Gong and Z. Tang, "Convolutional neural network U-net applied to multi-physics analysis for transformer," in International Conference on the Computation of Electromagnetic Fields, July 2019.
[2] A. Krizhevsky, I. Sutskever, and G. E. Hinton, "Imagenet classification with deep convolutional neural networks," in Advances in Neural Information Processing Systems 25, pp. 1097–1105, Curran Associates, Inc., 2012.
[3] O. Ronneberger, P. Fischer, and T. Brox, "U-Net: Convolutional Networks for Biomedical Image Segmentation.," Medical Image Computing and Computer-Assisted Intervention, MICCAI, 2015.
[4] Ahn H M, Lee J Y, Kim J K, et al. "Finite-element analysis of short-circuit electromagnetic force in power transformer", IEEE Transactions on Industry Applications, 2011, 47(3): 1267-1272.
[5] Yang B, Wang S H, HuangFu Y P, et al. "Dynamic deformation analysis of power transformer windings by considering the effect of elasticity characteristics of kraft paper", International Conference on Applied Superconductivity and Electromagnetic Devices (ASEMD), Beijing, China, 2013: 395-398.
…..